AeroSafety WORLD

MAINTENANCE FATIGUE
Awareness training needed

MANAGING ANOMALIES
Cockpit cooperation essential

VISUALIZING SAFETY
Turning data into pictures

TOXIC CAPTAINS
Cockpit unhappy, unsafe

DISORIENTATION, POOR CRM

SPIRAL DIVE

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

MARCH 2012

Cranfield UNIVERSITY

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Cranfield University is delighted to share the great news that it has been awarded a Queen's Anniversary Prize for its world-leading contribution to aviation safety through research and training in accident investigation. For over 50 years, we have worked closely with the aviation industry to ensure safe and efficient operations. Cranfield has trained over 1,000 air accident investigators and safety managers for national investigation agencies, military, airlines, regulators and manufacturers.

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THE QUEEN'S ANNIVERSARY PRIZES
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2011

Value Proposition

In the last issue, I wrote about some of the high points of what we are doing at Flight Safety Foundation. This month, I am going to go a little deeper into our operations and how we are able to function. First off, the support of our members is very valuable, and if you are one, we thank you! If you aren't, then you should be. The largest amount of our operating budget comes from members' support. The technical projects, research, advocacy, safety communication and shaping of safety culture and policy come from the support you provide through your membership.

As a matter of fact, 47 percent of the Foundation's operating funds come from all entities of membership support. When I say all entities, I mean the individuals, institutions, governments, manufacturers, corporations, students, business aviation operations, airlines, airports, and the maintenance, repair and overhaul facilities that constitute our membership.

Later this year, the Foundation will roll out a new membership structure and "value proposition" for each category of membership. Value proposition is a large part of what we believe a member should receive for their support. We are often told by many of our members that they believe that supporting the Foundation is the right thing to do. After all, we have been an advocate for the best practices in aviation safety since 1947. However, others tell us that within their organizations they have to answer the question, "What do we get for our membership?" This newly defined value proposition will answer that question, and make it easier to make a case for supporting the Foundation. At the very minimum, you can tell those who ask that the information from the Foundation's website and *AeroSafety World* magazine keeps you on top of developments in the realm of safety worldwide, but there's more.

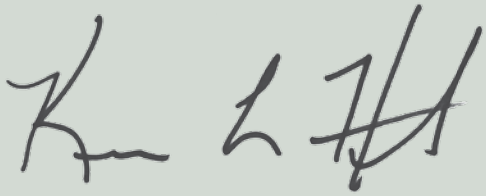
Look for the new membership structure to be unveiled about October, and please think about your budget in order to join for 2013. You are going to hear me say this many times: If you have to choose one safety resource to keep you in touch with what is taking place in the industry, Flight Safety Foundation is the one.

The other area that I would like to draw your attention to is our outreach activities. Outreach keeps our members and the aviation/aerospace industry informed on current hot topics such as lessons learned from an incident or accident, and on the long-range issues that need our attention. While our outreach activities do not directly constitute a large percentage of the contributions to our operating funds, they are very important to maintain our visibility as an effective, impartial, independent and international organization.

We do a variety of interviews with print, radio and television media. Bill Voss, our chief executive officer, maintains an intensive schedule, traveling to locations all across the globe to attend and speak at industry conferences, visit government and industry organizations, and call on our members. I also have increased my travel as of late, doing the same; however, my main function is to keep the offices running smoothly and efficiently.

The Foundation appreciates your support.

Be safe.

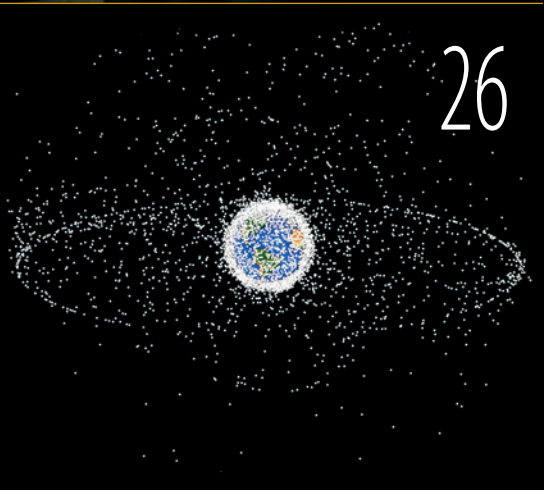


Capt. Kevin L. Hiatt
Chief Operating Officer
Flight Safety Foundation

AeroSafetyWORLD

contents

March 2012 Vol 7 Issue 2



features

departments

28

34

43

About the Cover
This 737 flew a meandering path before plummeting into the Mediterranean.
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Serving Aviation Safety Interests for More Than 60 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,075 individuals and member organizations in 130 countries.

Member**Guide**

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THE RARE Go-Around

Let's face it: Go-arounds are inconvenient. They make you late, burn more gas, complicate air traffic situations and often scare the heck out of your passengers, who probably think you did something wrong. Inconvenient, yes, but essential to safe flying.

The Foundation's *Approach and Landing Accident Reduction Tool Kit* was developed to reduce the risk of this most common form of accident, and one of the key elements of the advice it contains is the warning against unstabilized approaches. Early in the approach, the focus should be on maintaining or regaining a stabilized approach. At the end, however, there is but one remedy if the approach is still unstabilized: go around.

Most pilots are aware of this advice and do not dispute its general validity. However, recent studies from Airbus and the U.S. Federal Aviation Administration have shown that although unstabilized approaches are rare — only 3–4 percent of all approaches — only 2–3 percent of the unstablized approaches end in a go-around. Right now, the Foundation is participating in an industry effort to understand the problem more fully, but earlier this year, Rudy Quevedo, FSF deputy director of technical programs, launched a social network discussion on LinkedIn.

"Annually approximately 30 percent of the industry accidents are runway excursions," Quevedo said. "Many of these excursions are the result of unstable approaches. Statistically, approximately 97 percent of unstable approaches continue to landing, despite policies and procedures that dictate otherwise. The runway excursion accident rate can be dramatically reduced by a higher compliance rate of go-around policies, specifically — the decision to go around when appropriate." He asked, essentially, why go-arounds are so rare and how that can be changed.

The discussion on this topic has been very good. These points have been raised:

- Whenever pilots fight through an unstabilized approach to a safe landing, unsafe behavior is reinforced.
- Pilots are motivated by pride or company pressure to "get the job done."
- Reduced fuel loads arriving at destinations.
- The fatigue issue, which boosts the "need" to get down while diminishing the pilot tools available to achieve the desired outcome.
- Inadequate training on stabilized approaches and go-arounds, and on crew resource management, to avoid getting into situations where a go-around is necessary.
- Inadequate management response to evidence of high rates of unstabilized approaches and low rates of go-arounds.
- Inadequate management knowledge about the state of operations, i.e., no or poor monitoring programs in place.
- Both pilot flying and pilot monitoring must be empowered to call for a go-around. It should go without saying that airline policies do not penalize pilots who do go around.

Many real-world situations dirty the water when discussing clear guidelines for when a go-around is crucial. Even though the decision is cast as a binary yes/no, "we will always have some gray area, and the challenge is to define that area so well that it can be handled in standard operating procedures, training in pilot decision making, approach planning, conducting the approach, etc.," one commenter said. A good example of this is an approach where all of the elements are nailed except for one, and that one is drifting toward the correct numbers.

You'll be hearing more about this in the very near future as the industry go-around information effort gets into some meat in its study. It will be worth following closely.

J.A. Donoghue
Editor-in-Chief
AeroSafety World

The Foundation would like to give special recognition to our Benefactor, Patron and Contributor members. We value your membership and your high levels of commitment to the world of safety. Without your support, the Foundation's mission of the continuous improvement of global aviation safety would not be possible.

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MARCH 19–23 ➤ Aircraft Maintenance Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/AMI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

MARCH 26–30 ➤ CRM Instructor's Course. Integrated Team Solutions. London Gatwick. <sales@aviationteamwork.com>, <bit.ly/w3AIYA>, +44 (0) 7000 240 240.

APRIL 3–6 ➤ AEA International Convention and Trade Show. Aircraft Electronics Association. Washington, D.C. <www.aea.net/convention/DC2012>, +1 816.347.8400.

APRIL 16–17 ➤ Emergency Response Planning Workshop. National Business Aviation Association and The VanAllen Group. San Antonio, Texas, U.S. Donna Raphael, <draphael@nbaa.org>, <bit.ly/yurqwz>, +1 202.478.7760.

APRIL 16–20 ➤ OSHA/Aviation Ground Safety Course. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, <case@erau.edu>, <bit.ly/wtWHln>.

APRIL 16–20 ➤ Aircraft Accident Investigation Course. Barbados Civil Aviation Training Center and Spranza. Christ Church, Barbados. <bcatc@avsec-center.org>, 772 905 3106.

APRIL 16–27 ➤ Aircraft Accident Investigation Course. U.S. National Transportation Safety Board. Ashburn, Virginia, U.S. <TrainingCenter@ntsb.gov>, <1.usa.gov/xSLl64>, +1 571.223.3900.

APRIL 17–18 ➤ Evaluation of Safety Management Systems Course. CAA International. London Gatwick Airport area. <Training@caainternational.com>, <www.caainternational.com>, +44 (0)1293 768821.

APRIL 18–19 Corporate Aviation Safety Seminar. Flight Safety Foundation and the U.S. National Business Aviation Association. San Antonio, Texas, U.S. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/CASS>, +1 703.739.6700, ext. 101.

APRIL 23–27 ➤ Aviation Safety Program Management Course. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, <case@erau.edu>, <bit.ly/wtWHln>.

APRIL 25 ➤ AViCON: Aviation Disaster Conference. RTI Forensics. New York. <www.rtiforensics.com/news-events/avicon>, +1 410.571.0712; +44 207 481 2150.

MAY 3–7 ➤ IFALPA Annual Conference. International Federation of Air Line Pilots' Associations. Paris. <www.ifalpa.org/store/2012Ann1.pdf>.

MAY 8–9 ➤ Human Factors for Aviation Managers and Technicians Workshop (Initial). Grey Owl Aviation Consultants. Buffalo, New York, U.S. Richard Komarniski, <Richard@greyowl.com>, <www.greyowl.com/courses/desc_hf-phase1.html>, +1 204.848.7353.

MAY 14–15 ➤ HFACS/HFIX Workshop. HFACS Inc. Amsterdam. <dnlmccn@yahoo.com>, <hfacs.com/store/hfacshfix-workshop-amsterdam-netherlands>, 800.320.0833.

MAY 14–16 ➤ SMS Audit Procedures Course. Aerosolutions. Ottawa. <aerosolutions@rogers.com>, <bit.ly/wdrCOC>, +1 613.821.4454.

MAY 14–16 ➤ European Business Aviation Convention and Exhibition (EBACE). European Business Aviation Association and U.S. National Business Aviation Association. Geneva. Gabriel Destremaut, <gdestremaut@ebaa.org>, +32 2-766-0073; Donna Raphael, <draphael@nbaa.org>, +1 202.478.7760; <www.ebace.aero/2012>.

MAY 15–16 ➤ Third European Safety Management Symposium. Baines Simmons. London. <info@bainessimmons.com>, <bit.ly/ttot0B>, +44 (0)1276 855412.

MAY 20–22 ➤ FAA/AAAE Airfield Safety, Sign Systems and Maintenance Management Workshop. American Association of Airport Executives and U.S. Federal Aviation Administration. Houston. <AAAEMeetings@aaae.org>, <bit.ly/u5aSjh>.

MAY 21–25 ➤ Maintenance Accident Investigation Course. $(L/D)_{max}$ Aviation Safety Group. Portland, Oregon, U.S. <info@ldmaxaviation.com>, <bit.ly/iYEGyI>, 877.455.3629, +1 805.285.3629.

MAY 22–24 ➤ ATCA Technical Symposium. Air Traffic Control Association, U.S. Federal Aviation Administration and U.S. National Aeronautics and Space Administration. Kenneth Carlisle, <ken.carlisle@atca.org>, <www.atca.org/techsymposium>, +1 703.299.2430, ext. 310.

JUNE 11–12 ➤ Flight Operations Manual Workshop: Employing IS-BAO. National Business Aviation Association. Chicago. Sarah Wolf, <swolf@nbaa.org>, <bit.ly/ye4ei9>, +1 202.783.9251.

JUNE 12–13 ➤ Evaluation of Safety Management Systems Course. CAA International. Manchester Airport area. <Training@caainternational.com>, <www.caainternational.com>, +44 (0)1293 768821.

JUNE 14–15 ➤ Overview of Aviation Safety Management Systems Training. ATC Vantage. Tampa, Florida, U.S. Theresa McCormick, <tmccormick@atcvantage.com>, <atcvantage.com/sms-workshop.html>, +1 727.410.4759.

JUNE 18 ➤ Implementing a Just Culture. Baines Simmons. Surrey, England. <info@bainessimmons.com>, <bit.ly/whV9l4>, +44 (0)1276 855412.

JUNE 25–29 ➤ IBSC Conference. International Bird Strike Committee. Stavanger, Norway. <IBSCStavanger@gyro.no>, <www.int-birdstrike.org>, +47 6128 7320.

JULY 9–13 ➤ Cabin Safety Investigation Course. (L/D)max Aviation Safety Group. Portland, Oregon, U.S. <info@ldmaxaviation.com>, <bit.ly/dY1qMp>, 877.455.3629, +1 805.285.3629.

JULY 9–15 ➤ Farnborough International Airshow. Farnborough, England. <www.farnborough.com/airshow-2012>.

AUG. 6–17 ➤ Aircraft Accident Investigation Course. (L/D)max Aviation Safety Group. Portland, Oregon, U.S. <info@ldmaxaviation.com>, <bit.ly/w9LKXD>, 877.455.3629, +1 805.285.3629.

OCT. 23–25 ➤ 65th annual International Air Safety Seminar. Flight Safety Foundation. Santiago, Chile. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/iass>, +1 703.739.6700, ext. 101.

Aviation safety event coming up? Tell industry leaders about it.

If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early. Send listings to Rick Darby at Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or <darby@flightsafety.org>.

Be sure to include a phone number and/or an e-mail address for readers to contact you about the event.

Safety News

Fatigue Survey

Jeppesen is planning an industry-wide survey later this year to gather fatigue data from pilots and cabin crewmembers; the data ultimately will be used as part of a study to determine how crew fatigue issues develop.

Jeppesen said sleep and performance scientists will use the information gathered through the survey, scheduled for April, to help "improve and evaluate scientific fatigue models such as the Boeing Alertness Model." Jeppesen is a subsidiary of The Boeing Co.

Jeppesen said that, to coincide with the study, a variation of the CrewAlert application — CrewAlert Lite — is available free on the iTunes App Store. The application is designed to "simplify capturing schedule information, sleep and wake periods and fatigue assessments … [and enable] crew to predict fatigue risk using the Boeing Alertness Model," Jeppesen said.

New Standards for First Officers

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Pilots hired as first officers for U.S. passenger and cargo airlines would be required to have 1,500 flight hours under a proposal outlined by the Federal Aviation Administration.

The proposed rule would require first officers to hold an airline transport pilot (ATP) certificate and an aircraft type rating, which requires training and testing for a specific airplane type. Under current requirements, first officers must hold a commercial pilot certificate and have a minimum of 250 hours of flight time. Most major airlines, however, already have requirements that are considerably higher.

The proposed rule would make exceptions for pilots with fewer than 1,500 flight hours if they have an aviation degree or experience as a military pilot; those pilots could receive a "restricted privileges ATP" if they complied with certain other requirements.

The proposed rule stems from a requirement included in a 2010 law that mandated that airline first officers have at least 1,500 flight hours.

Public comments on the proposed rule will be accepted until April 29.

First I-4D Flight

The first "initial four-dimensional (I-4D) flight" — a flight involving the usual three-dimensional trajectory, plus time — was conducted in early February, with test pilots flying an Airbus A320 from Toulouse, France, to Copenhagen, Denmark, and Stockholm, Sweden.

I-4D flight is considered a cornerstone of the Single European Sky ATM [Air Traffic Management] Research (SESAR) program and the first step toward more predictable flights, SESAR said in a statement discussing the Feb. 10 flight.

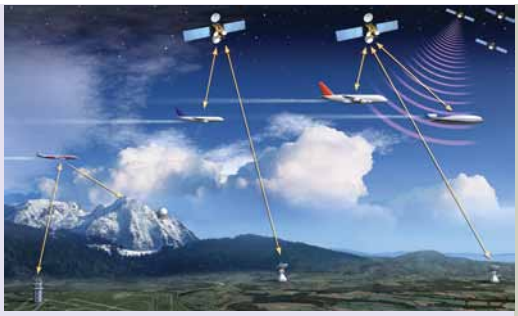
© Airbus S.A.S. 2012

"Greater certainty about the positions of every airspace user in the sky at any given moment will improve safety as well as flight predictability," the SESAR program said. "The more efficient resource planning which this allows will in turn enable a greater carrying capacity for both airports and the European sky in general."

SESAR characterized I-4D as a "major step toward full 4D operations." In I-4D, "the capability of the aircraft FMS [flight management system] to provide very accurate trajectory predictions and execute a required time of arrival (RTA) at a defined three-dimensional waypoint can be exploited by both en route controllers for demand/capacity balancing, metering of flows by applying a controlled time over or by TMA [terminal maneuvering area] controllers sequencing for arrival management by applying a controlled time of arrival," SESAR said.

I-4D is expected to be implemented in Europe in 2018, SESAR said.

Air Safety Targets



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Europe has met the safety targets established by the European Civil Aviation Conference (ECAC) for reducing accidents related to air traffic management (ATM), the Eurocontrol Safety Regulation Commission (SRC) says.

In 2010, Eurocontrol received more data on ATM-related incidents than in previous years, "which reflects an improvement in the reporting culture," the SRC said in its annual safety report for 2011.

Data analysis identified a number of safety areas in need of improvement, the report said, adding that "a critical concern is raised on the lack of resources and qualified staff at a national level dedicated to safety data collection and analysis."

New ATC Network

The U.S. Federal Aviation Administration (FAA) has approved the use of an ARINC high frequency data link (HFDL) network for future data link air traffic control communications.

ARINC said that the FAA's action means that aircraft that already use HFDL for long distance operational communications also will be able to use it for communications with ATC.

The technology is known as FOH, or FANS (Future Air Navigation System) 1/A Over HFDL. ARINC said that FOH data link "provides an inexpensive global alternative to satellite-based global communications and … is expected to be most beneficial in controlled oceanic airspace such as the North Atlantic and Pacific flight routes."

Tests Urged for Overhead Bins

The installation design for overhead luggage bins and attached passenger service units (PSUs) in some Boeing 737s should be modified to prevent the PSUs, which contain passenger supplemental oxygen and reading lights, from separating during accidents and potentially injuring passengers, the U.S. National Transportation Safety Board (NTSB) says.

In a series of safety recommendations to the U.S. Federal Aviation Administration (FAA), the NTSB noted that several accidents have occurred in the past three years in which overhead bins and PSUs on next generation 737s (737NGs, including 737-600s, -700s, -800s and -900s) separated from their attachments. This probably increased the number of passenger injuries, especially head and facial injuries, the NTSB said.

In the most recent of four accidents cited by the NTSB, an Aires Airlines 737-700 crashed short of the landing runway at San Andreas Island Airport in Colombia on Aug. 16, 2010, killing two of the 127 people aboard. Fifteen others were seriously injured and 66 received minor injuries.

The accident is still under investigation by the Colombian Civil Aviation Authority, but early findings showed that 24 of the 30 PSUs installed in rows 1 through 5 fell when their outboard clamps fractured, along with nearly all of the PSUs in rows 10 through 27, the NTSB said. Preliminary information indicates that some passengers received skull fractures, cuts on the head and face, and other head injuries.

In all four accidents, the NTSB said, "the overhead bin and PSU installations were of common design and manufactured, installed and inspected per Boeing specifications."

In all cases, "two polymer plastic clamps attach the outboard side of the PSU to the aircraft rail and fuselage side wall," the NTSB said, noting that Boeing records show that the clamp was designed in 1980 and based on an older clamp design but with modifications to improve its strength and fit.

The NTSB recommended that the FAA "modify the design and test requirements for the attachment points of passenger service units to account for the higher localized loading that results from the relative motion of the attachment structure."

The FAA also should require modification of the installation design of the overhead bins and PSUs manufactured by Boeing and installed in 737NGs "so that the PSUs remain attached to the bins or are captured in a safe manner during survivable accidents," the NTSB said.

Another recommendation called on the FAA to "review the designs of manufacturers other than Boeing for overhead bins and … PSUs to identify designs with deficiencies similar to those identified in Boeing's design and require those manufacturers, as necessary, to eliminate the potential for PSUs to separate from their attachments during survivable accidents."

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U.S. Government Says No to LightSquared

U.S. federal agencies say there is "no practical way" to mitigate the potential interference of the LightSquared planned wireless mobile broadband network with existing global positioning system (GPS) receivers and have taken steps to bar the company from beginning commercial operations.

The National Telecommunications and Information Administration, the agency that coordinates government use of the radio spectrum, said in mid-February that, after months of tests to identify the scope of the problem and analysis of proposed solutions, "it is clear that LightSquared's proposed implementation plans, including operations in the lower 10 MHz, would impact both general/personal navigation and certified aviation GPS receivers.

"We conclude at this time that there are no mitigation strategies that both solve the interference issues and provide LightSquared with an adequate commercial network deployment."

In response, the Federal Communications Commission (FCC), noting that it had "clearly stated from the outset [of LightSquared's presentation of its plans] that harmful interference to GPS would not be permitted," said that it would not lift an earlier order that prohibited LightSquared's commercial operations "unless harmful interference issues were resolved."

© Mark Evans/iStockphoto

After the FCC's action, LightSquared Chairman and CEO Sanjiv Ahuja said that company officials are "committed to finding a solution and believe that if all the parties have that same level of commitment, a solution can be found" (*ASW*, 2/12, p. 1). He subsequently resigned as CEO.

Expanded Directive

The European Aviation Safety Agency (EASA) has expanded on its January directive for detailed visual inspections of the wings of certain Airbus A380s (*ASW*, 2/12, p. 9) and is now calling for high frequency eddy current inspections of the wings of all A380s currently in service.

Airworthiness Directive (AD) 2012-0026, issued Feb. 8, says that all A380s that have accumulated fewer than 1,216 flight cycles must undergo the inspections "before or upon completion of" 1,300 flight cycles.

Airplanes with more than 1,216 flight cycles but fewer than 1,384 cycles must have the inspections within six weeks or 84 flight cycles, whichever occurs first after the Feb. 13 effective date of the AD.

Airplanes with 1,384 flight cycles or more must undergo the inspections within three weeks after Feb. 13.

If any cracks are detected, Airbus must be contacted for approved instructions prior to the next flight, the AD said. Inspection results are to be reported to Airbus within two days after the eddy current inspections, the AD says.

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In Other News …

Despite heavy snowfall and unusually cold temperatures, **European airports** are doing a better job than they did a year ago in clearing snow from runways, deicing aircraft and coordinating actions with officials at other airports, according to Siim Kallas, European Union vice president responsible for transport. … The International Civil Aviation Organization says that its Continuous Monitoring and Oversight section — responsible for the **Universal Safety Oversight Audit Programme** (USOAP) — has been recertified to the ISO 9001:2008 standard for quality management systems. … After years of short-term budget extensions, the U.S. Congress and President Obama have agreed on a $63.4 billion **authorization bill** to fund the Federal Aviation Administration through 2015.

Compiled and edited by Linda Werfelman.

Spiral Dive

BY MARK LACAGNINA

An overwater departure on a dark, stormy night ends in the Mediterranean.

Following a night takeoff from Beirut, Lebanon, the flight crew of Ethiopian Airlines Flight 409 acknowledged an air traffic controller's assignment of a heading to keep the Boeing 737-800 away from isolated thunderstorms over the Mediterranean. The instruction was repeated — and acknowledged — several times, but the crew never established the aircraft on the assigned heading. Ground radar showed that the 737 flew a meandering path for about five minutes before entering a steep turn and descending rapidly to the sea, killing all 90 people aboard.

Based on the findings of an investigation team commissioned by the Lebanese Ministry of Public Works and Transport, the final report concluded that the probable causes of the Jan. 25, 2010, accident were "the flight crew's mismanagement of the aircraft's speed, altitude, headings and attitude through inconsistent flight control inputs, resulting in a loss of control." The report also faulted the flight crew for "their failure to abide by CRM [crew resource management] principles of mutual support and calling deviations."

Contributing factors were "the increased workload and stress levels that … most likely led to the captain's reaching a situation of loss of situational awareness similar to subtle incapacitation and the [first officer's] failure to recognize it or to intervene accordingly," the report said.

Unfamiliar Airport

Flight 409 was bound for Addis Ababa, Ethiopia, with 82 passengers, a flight security officer, five cabin crewmembers and the two pilots. The

Thomas Ingendorn/Jetphotos.net

Investigators determined that the captain likely experienced spatial disorientation and lost control of this 737.

flight crew had flown to Beirut the previous day and had 25 hours of rest.

The captain, 45, held type ratings for the 737-700/800 and the Fokker 50. His 10,233 flight hours included 188 hours as pilot-in-command (PIC) of 737s and 1,042 hours as a Fokker PIC. He was hired by Ethiopian Airlines in 1989 and flew agricultural aircraft for nine years before being assigned as a first officer in de Havilland Twin Otters, 737s and 757s. He was promoted to a Fokker captain in 2008 and completed training as a 737 captain less than two months before the accident.

The captain's most recent training in CRM and upset prevention and recovery had been completed in December 2007.

"Interviews conducted with the captain's superiors, trainers and next of kin revealed that he had a nice personality, was very polite, open to take criticism, healthy, did not smoke or drink alcohol, [and] was keen on reading and sports," the report said.

The first officer, 24, had 673 flight hours, including 350 hours as a 737 first officer. He had been transferred to the operations division of Ethiopian Airlines after graduating from its flight academy in January 2009. He completed CRM and upset prevention and recovery training in March 2009 and was endorsed as a 737 first officer in August.

"Interviews with the first officer's superiors, trainers and friends revealed that he had a nice personality and was a good student, who [had] graduated among the best six in the flight academy," the report said.

Weather conditions at Beirut Rafic Hariri International Airport at the time of the accident were described as fair, with calm winds and no precipitation, but there was significant thunderstorm activity west and southwest of the airport, over the Mediterranean.

"During the preflight preparation phase, the crew was heard on the CVR [cockpit voice recorder] discussing various operational issues … and conducting the appropriate briefing and checklists," the report said. "In addition … the crew was heard discussing their layover in Beirut and a meal which could have affected the quality of their sleep prior to … the flight. However, their tone of voice and discussions were normal during that phase. The captain was also heard confirming that this was his first flight into Beirut."

Clearance Changes

After the passengers were boarded, the crew obtained their instrument flight rules clearance to Addis Ababa. The clearance included a standard instrument departure that initially called for a slight right turn after takeoff from Runway 21 to intercept the 220-degree radial of a VOR (VHF omnidirectional radio) located on the airport; the initial altitude was 3,000 ft.

The crew was taxiing the aircraft to Runway 21 when the airport traffic controller told them to line up on the runway and report ready for takeoff. The first officer, the pilot monitoring, reported ready for takeoff at 0235 local time. The controller cleared the crew for takeoff and issued a revised departure procedure that called for an "immediate" right turn toward CHEKA, a VOR located 31 nm (57 km) north of the airport.

The 737 was lifting off the runway when the controller again revised the clearance, instructing the crew to turn right to an initial heading of 315 degrees (Figure 1, p. 14). The first officer acknowledged the instruction and set the assigned heading on the aircraft's mode control panel (MCP).

The captain was hand flying the aircraft. Company procedure called for engaging the autopilot at 400 ft above ground level on departure but allowed for hand flying with flight director guidance below 10,000 ft in good weather and low traffic activity to maintain proficiency. Noting that the flight crew was aware of the convective activity in the area, the report said, "The captain's decision to fly manually was a major contributor toward the degradation of the situation."

The first officer did not call for the "After Takeoff" checklist, as required by standard operating procedure, and there was no indication

Ethiopian 409 Flight Path

1 0036:33 Takeoff power set
2 0037:08 Rotation
3 0037:20 Landing gear up
4 0037:39 ATC: "check turn right initially heading 315"
5 0038:18 Flaps 1 degree
6 0038:36 ATC: "Sir, I suggest due to weather to follow heading 270"
7 0039:02 HDG selection 270 degrees
8 0039:46 ATC: "Ethiopian 409 turn right heading 270"
9 0040:03 Max pitch attitude: 38° nose up
10 0040:21 ATC: "Turn right heading 270 now"
11 0041:05 ATC: "Ethiopian 409 you're going to the mountain, turn right heading 270"
12 00:41:14 Max roll angle: 118.5° left

ATC = air traffic control; HDG = heading

Note: Coordinated universal times shown

Source: Lebanese Ministry of Public Works and Transport

Figure 1

on the cockpit voice recording that the pilots accomplished the checklist items.

'What Heading?'

The aircraft was in a right turn and climbing through 2,000 ft at 0238, when the first officer established radio communication with Beirut Control. The controller cleared the crew to climb to Flight Level 290 (approximately 29,000 ft). The first officer acknowledged the instruction and set the assigned altitude in the MCP.

The controller then said, "Sir, I suggest for you, due to weather, to follow heading two seven zero to be in the clear for fifteen to twenty miles, then go to CHEKA."

The captain asked the first officer, "Two one, say again?" The first officer relayed the question to the controller, saying, "Confirm heading two one zero?" The controller replied, "Ethiopian 409, sir, negative. To proceed direct CHEKA, sir, turn left now, heading two seven zero." The captain asked, "Left heading two seven zero?" as the first officer was acknowledging the instruction, saying, "Roger, left heading two seven zero." The captain asked, "OK, what heading did he say?" As the first officer set the assigned heading on the MCP, he told the captain, "Two seven zero is set."

During this exchange, the captain had continued the right turn through the selected heading of 315 degrees, and the bank angle had increased beyond 35 degrees, triggering two enhanced ground-proximity warning system "BANK ANGLE" warnings.

About 54 seconds after confirming the assigned heading, the controller said, "Ethiopian 409, follow heading two seven zero, sir. Follow heading two seven zero. Turn right heading two seven zero now."

"This was associated with a sharp left [control] wheel input … which resulted in a roll angle of 45 degrees, reaching a maximum of 64 degrees left [bank] and triggering five automatic 'BANK ANGLE' calls," the report said.

Out of Trim

The captain apparently was not following the flight director commands on his primary flight display and "was most likely unaware of the bank angle he was himself generating," the report said. Moreover, despite almost constant manual flight control inputs, the captain did not trim the controls. "That surely increased [his] workload and was surely not compatible with basic flying skills requiring the aircraft to be continuously in trim when flying manually in order to relieve the pressure on the control column, allowing the pilot to focus on managing the flight."

The 737 was turning left through 237 degrees when the captain rolled right and eased forward pressure on the control column. The aircraft began to pitch nose-up, and the indicated airspeed, which had reached 243 kt, began to decrease.

The report said that the flight crew likely became preoccupied at this point with a sudden onset of heavy rain, the sound of which was recorded by the CVR. The captain told the first officer to engage the autopilot, which indicated that he "felt uncomfortable with manually controlling the aircraft and that he was looking for a solution," the report said. There was no reply from the first officer, who may not have heard the command. In addition, the captain continued to make manual flight control inputs, which would have prevented the autopilot from engaging.

At 0239, the controller again said, "Ethiopian 409, follow heading two seven zero. Turn right heading two seven zero."

The first officer replied, "Right heading two seven zero, roger," and told the captain, "Two seven zero set."

The aircraft was climbing through 7,250 ft when indicated airspeed decreased from 159 kt to 141 kt and the stick shaker (stall warning) activated. The stick shaker remained on for 27 seconds. The 737's angle-of-attack reached 18 degrees, and two more "BANK ANGLE" warnings were generated.

"What is that?" the captain asked. He repeated the question two more times in a louder voice. The report said that the question likely did not refer to a single item, such as the stick shaker or bank angle warnings, but to "the global situation, indicating that he didn't understand why the situation was degrading in such a way."

'Go Around'

Indicated airspeed had decreased to 120 kt when the aircraft stalled at about 7,700 ft, pitched nose-down and rolled left, reaching a bank angle of 68 degrees. The captain "reacted by significantly pulling the control column back and bringing the wheel to the right, while putting some pressure on the right rudder pedal," the report said. "Those actions did not completely match what was expected as a reaction to a stall" — that is, to apply nose-down elevator control.

While making these control inputs, the captain said "go around" five times. The first officer replied, "Roger, go around."

"The throttles were pushed full forward for [an] instant, then pulled back a little for a few seconds and then pushed again violently enough [for the sound] to be recorded on the CVR," the report said.

The CVR again recorded sounds consistent with heavy rain as the controller said, "Ethiopian 409, follow heading two seven zero, sir. Follow heading two seven zero. Turn right heading two seven zero now." The first officer replied, "Roger, roger."

One minute before impact, the captain pushed the control column forward, and airspeed increased to 238 kt as the airplane

The captain apparently was not following the flight director commands on his primary flight display.

descended through 6,000 ft. "The column was then relaxed toward neutral, and the airplane began to pitch up, [climb] and slow down again … while the left wheel input and right rudder input were maintained," the report said.

The captain relaxed pressure on the right rudder pedal, and the aircraft rolled left. Airspeed was decreasing through about 200 kt when the first officer said, "The speed is dropping." The captain replied, "OK, try to do something. Hold this thing." The report said that the captain's statement indicated that he needed help but was not able to specify what type of help he needed. The first officer responded only by saying "speed."

The captain again cross-controlled the aircraft, applying full left aileron while holding right rudder.

The aircraft's pitch attitude began to decrease after reaching a maximum of 31 degrees nose-up, but the left bank angle continued to exceed 35 degrees. Two more "BANK ANGLE" warnings were recorded before the captain applied right aileron and right rudder. The stick shaker activated again as angle-of-attack increased, reaching a maximum of 26 degrees as the aircraft stalled for the second time.

The captain again cross-controlled the aircraft, applying full left aileron while holding right rudder. He then applied increasing back pressure on the control column for 17 seconds. Airspeed was 150 kt when the 737 reached 9,000 ft. The captain neutralized the flight controls, but the left bank continued to increase.

'Overwhelmed'

The aircraft was heading east, toward mountainous terrain on shore, when the controller said, "Ethiopian 409, you're going to the mountain. Turn right now, heading two seven zero."

The first officer keyed the microphone for about three seconds but made no verbal response. The report said that he likely "was overwhelmed by what was going on, which had left him speechless."

The left bank angle reached a maximum of 118.5 degrees as the aircraft descended in a spiral dive through 7,300 ft, with airspeed increasing through 228 kt. "Over the next 10 seconds, as the pitch attitude reached 63.1 degrees nose-down, large left and right wheel inputs were made," the report said.

Airspeed was more than 7 kt above the aircraft's maximum certified dive speed of 400 kt and vertical acceleration was 4.76 g (that is, 4.76 times standard gravitational acceleration) when the 737 struck the water about 5 nm (9 km) south of the airport at 0241:30. The impact occurred four minutes and 59 seconds after the initiation of the takeoff roll; the aircraft had been airborne for four minutes and 17 seconds.

The investigation revealed no sign that icing or a mechanical malfunction played a role in the accident, and there was no evidence that the aircraft had been struck by lightning. "The flight profile was the direct result of the flight control inputs and thrust settings," the report said, noting that post-accident simulations indicated that the upset was recoverable with proper control and power inputs until the last few seconds of the flight.

The report said that the captain's performance likely had been affected by spatial disorientation, loss of situational awareness and subtle incapacitation that resulted from the high stress and workload induced by the late-night departure in a relatively unfamiliar aircraft and from an unfamiliar airport flanked by high terrain on one side and thunderstorms on the other, with a junior first officer, and possible indigestion and fatigue from the meal that had affected the quality of his sleep.

The "passiveness" of the first officer, evident from the absence of callouts of deviations from flight control parameters and air traffic control instructions, was ascribed to his possible reluctance to challenge the captain. The experience gradient between the pilots "could also explain why [the first officer] did not take over control of the aircraft, even when requested to help," the report said, noting that the first officer might have asked himself, in effect, "If the experienced captain cannot handle it, will I be able to?"

This article is based on the Lebanese Ministry of Public Works and Transport "Investigation Report on the Accident to Ethiopian 409, Boeing 737-800, Registration ET-ANB, at Beirut, Lebanon, on 25th January 2010." ET 409, January 2012.

Fatigue Awareness

Report urges awareness, education and data-gathering to combat fatigue among aviation maintenance personnel.

BY LINDA WERFELMAN

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Aviation maintenance managers and their employees must be made more aware of the risks associated with fatigued workers, specialists in aviation maintenance human factors say, calling for development of a basic awareness campaign as the most important step in fighting workplace fatigue.

They presented their recommendations in a December 2011 report released by the U.S. Federal Aviation Administration (FAA)

'We must make fatigue a public issue if change is going to occur.'

Office of Aerospace Medicine. The proposals — in the form of a prioritized list — were developed during a March 2011 workshop aimed at addressing fatigue in aviation maintenance ("Top 10 Anti-Fatigue Actions").

"We must make fatigue a public issue if change is going to occur," the report said. "An organized and integrated movement may be necessary to change laws, improve education and create awareness."

Workshop delegates — representing the FAA, Transport Canada and the aviation industry — said the fatigue awareness campaign should be led by the FAA and should involve labor unions, professional and industrial organizations, scientists and government.

Increased awareness of the problem is likely to fuel efforts to develop a means of measuring fatigue, the report said, citing efforts in the automobile and trucking industry to use eye-blink technology to gauge driver fatigue.

"High-visibility events drive public and industrial awareness of fatigue," the report said. "Events that expose fatigued pilots or air traffic controllers receive extensive media coverage. For each of the public events, numerous other occurrences avoid discovery."

Fatigue is prevalent in industries such as aviation maintenance that operate day and night, the report added, and the related risks "must remain high priority even when the topic is not in the news."

Along with fatigue awareness, the workshop delegates emphasized the associated need to "continue and expand fatigue countermeasure education."

"Training efforts must demonstrate the benefits of proper rest to the employee and to the employer," the report said, citing several studies. "It must show 'what's in it for me.' It must also teach executives and managers to schedule work, overtime and rest in a safe manner. Education must present the science of sleep and scheduling in an understandable and useful manner. Most importantly, education must motivate learners to modify any poor habits that cause fatigue."

Fatigue education for maintenance personnel should begin during their initial training, the report said.

In addition, fatigue education should extend to friends and family members, "who must learn about proper rest and schedules to ensure that their loved one is safe at work," and to the U.S. Congress, which has "applied considerable pressure to alter fatigue-related rules for pilots" but not for maintenance personnel, the report said.

Workshop delegates "felt that such education might encourage the FAA to address the fatigue safety risk with improved regulations," the report added. "Of course, the industry delegates from both management and labor used the adage, 'Be careful what you wish for.'"

The FAA Maintenance Fatigue Research Program already has developed and distributed materials for fatigue education, including posters, videos, a fatigue symptom checklist and a fatigue risk assessment tool.[1]

Top 10 Anti-Fatigue Actions

1. Enhance employer and worker fatigue awareness.
2. Continue and expand fatigue countermeasure education.
3. Support and regulate fatigue risk management systems (FRMS).
4. Quantify safety and operational efficiency impact of fatigue.
5. Regulate hours of service limits.
6. Establish baseline data of fatigue risk with existing event reporting systems.
7. Integrate fatigue awareness into safety culture.
8. Ensure that FRMS is considered in safety management system programs.
9. Create and implement fatigue assessment tools.
10. Improve collaboration of FRMS within and across organizations.

Source: U.S. Federal Aviation Administration

FRMS

The workshop delegates also called for action to support and regulate fatigue risk management systems (FRMSs) in aviation maintenance (*ASW*, 9/11, p. 23).

FRMS has not been widely implemented in aviation maintenance organizations although it has become common in the railroad and commercial trucking industries, and for flight crews.

Where an FRMS is in place, improvements have been noted in personal health and well-being, safety and cost, the report said. For example, one international trucking firm has

reported savings of millions of dollars in health care costs.

FRMSs must be designed specifically for each organization, the report said, adding, "One size does not fit all. Effective fatigue risk management requires that everyone take responsibility for the problem and use multiple strategies to reduce fatigue."

In an aviation maintenance FRMS, the first goal is to reduce fatigue to an acceptable level by using fatigue-reduction interventions such as "duty time limits, scientific scheduling, napping, education, excused absences and, in some instances, medical testing and treatment."

The second goal is to reduce fatigue-related errors.

"Despite efforts to ensure that employees are well-rested and alert when they report for duty, it is not possible to eliminate fatigue from the workplace," the report said. "Interventions can involve two approaches: measures directed toward reducing the risk of the individual and measures directed toward reducing the risk of a task for a fatigued worker.

"For example, reducing the risk of a task by taking work breaks and simplifying work task steps can help. We should not assign fatigued workers to critical tasks. Matching the worker to the task is part of an FRMS."

The workshop delegates said that, as an alternative to an FRMS, they favored allowing companies to demonstrate how they plan to manage fatigue among maintenance personnel, in part by establishing a maximum service limit and detailing "how they will manage fatigue if they choose to exceed the regulated service limits."

Better Data

Despite anecdotal evidence of long hours and fatigue-related mistakes, formal fatigue data are relatively limited, the report said.

"When fatigued mechanics or crewmembers make errors, they are often attributed to procedural errors, memory lapse or mistaken communication," the report said. "Typically, an event investigation does not have a sufficient root-cause analysis to determine if fatigue was a significant contributing factor."

As a result, the cost and the impact on safety of fatigue-related errors are unknown.

The report cited sweeping changes in the U.S. trucking industry after improvements in data gathering, including "semi-annual fatigue countermeasure training, health and wellness coaching, evaluation of sleep disorders and proactive fatigue management." Anticipated regulatory changes include the addition of sleep apnea testing to routine commercial motor vehicle physical exams.

Among the data needed by government and the aviation industry are estimates of the financial effects of fatigue and fatigue-related damage, the extent of risk to flight safety because of maintenance fatigue, the cost of implementing FRMSs and the probability that having an FRMS could have prevented a fatigue-related event.

After the industry has data on the financial and safety risks of fatigue, appropriate interventions can be implemented further and the effects of those interventions can be assessed, the report said.

2010 Survey

The workshop delegates also endorsed a regulatory move to limit hours of service — a move the report characterized as consistent with the high priority assigned to FRMS regulation. The report cited a 2010 survey by the FAA-Industry Maintenance Fatigue Working Group that resulted in unanimous agreement among those voting that the FAA should propose a duty-time rule for maintenance personnel.

"At the workshop and in the working group, delegates felt that neither industry nor individuals would fully address fatigue without a regulation," the report said. "Many believed that an FRMS could supplement the hours-of-service limits if equivalent levels of safety were demonstrated."

The report noted that, worldwide, regulatory duty-time limits vary widely. In China, for example, no more than eight hours of work may be scheduled each day. The current FAA rule allows for 24 hours, and the International Federation of Airworthiness (IFA) recommends a limit of 12 hours, or 16 hours with overtime. Maximum hours that may be worked per month range from 196 to 646 hours, the report said, noting IFA's recommendation of a maximum of 288.

The report suggested that a U.S. regulation could be developed using IFA recommendations, information gathered through the fatigue working group and FRMS data.

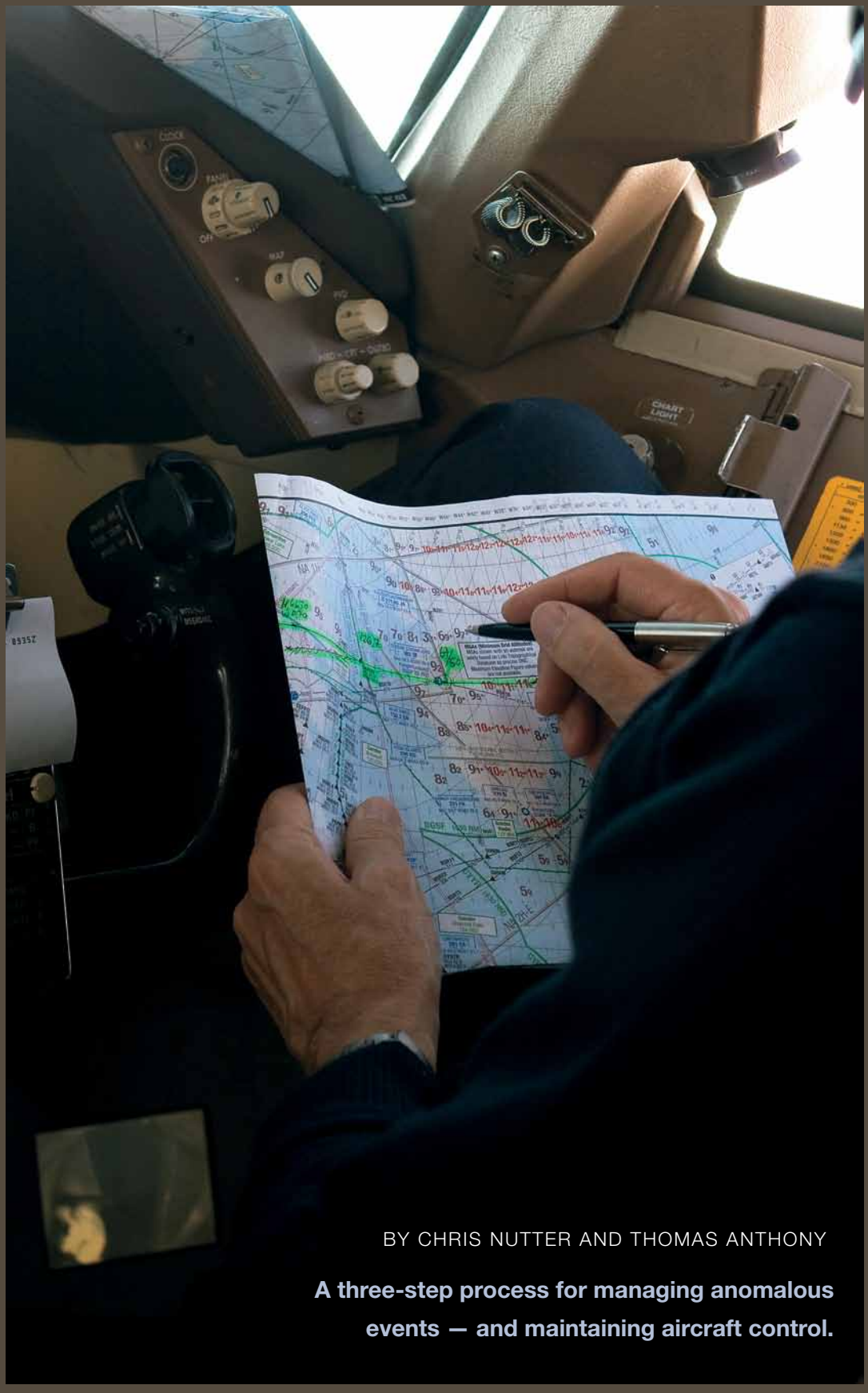
An "hours of service" rule alone is not adequate, the report said, adding that regulations should be implemented that are "flexible to different types of operations and maximize safety."

This article is based on OAM report DOT/FAA/AM-11-19, "Fatigue Solutions for Maintenance: From Science to Workplace Reality," written by Katrina E. Avers, William B. Johnson, Joy O. Banks, Darin Nei and Elizabeth Hensley. Johnson is the FAA chief scientific technical adviser for human factors in maintenance; the others are employed by the FAA Civil Aerospace Medical Institute.

Note

1. The information is available on the Maintenance Fatigue Section of the FAA website, <mxfatigue.com>.

The IHTAR Model



BY CHRIS NUTTER AND THOMAS ANTHONY

A three-step process for managing anomalous events — and maintaining aircraft control.

Pilots are problem solvers. Recently, with the proliferation of automated cockpits, problems have elicited the question: "Why is the airplane is doing that?" These types of problems, involving *anomalous events* with unknown causes, often are the hardest to solve and present some especially difficult hazards.

Anomalous events can divert the attention of the flight crew from their normal safety-critical duties and create abnormal levels of confusion and pressure. The power of anomalous events to absorb the flight crew's attention cannot be underestimated. In some cases, they have the unnerving and completely absorbing effect of a hand grenade rolling into the cockpit and stopping between the two pilots.

The IHTAR ("I have the aircraft and radios; you have everything else") model is a process for managing anomalous events and preventing them from becoming anomalous emergencies. This procedural model is designed to do two things: first, to maintain the operational integrity of the aircraft ("fly the airplane"); and second, to establish a communication process that facilitates the solving of the anomalous event.

Although exacerbated by increasing automation, the power of anomalous events to seduce flight crewmembers into trying to solve the problem while diverting them from the essential task of flying the aircraft is not new. Several accidents serve as clear examples.

Eastern Airlines Flight 401, a Lockheed L-1011, crashed near Miami on Dec. 29, 1972, following a suspected nose landing gear malfunction on approach, a go-around and assessment of the problem in level flight on a downwind leg. The U.S. National Transportation Safety Board (NTSB) concluded that the flight crew became preoccupied with the malfunction and failed "to monitor the flight instruments during the final four minutes of flight and to detect an unexpected descent soon enough to prevent impact with the ground."

Six years later, on Dec. 28, 1973, the crew of United Airlines Flight 173, a McDonnell Douglas DC-8, heard an unusual noise and felt the airplane yaw when the landing gear was extended on descent to Portland (Oregon, U.S.) International Airport. Air traffic control (ATC) provided vectors to allow the crew time to deal with the problem. About an hour later, the DC-8 crashed near the airport, due to what the NTSB concluded was "the failure of the captain to monitor properly the aircraft's fuel state and to properly respond to the low fuel state and the crewmember's advisories regarding fuel state. This resulted in fuel exhaustion to all engines. His inattention resulted from preoccupation with a landing gear malfunction and preparations for a possible landing emergency. Contributing to the accident was the failure of the other two flight crewmembers either to fully comprehend the criticality of the fuel state or to successfully communicate their concern to the captain."

IHTAR

"I have the aircraft and radios; you've got everything else."

Nearly 29 years later, on Sept. 28, 2007, American Airlines Flight 1400, an MD-82, was departing from St. Louis when the crew observed an engine fire indication and several other abnormalities, including the absence of an indication that the nose landing gear had extended during the return to the airport (*ASW*, 9/09, p. 34). The crew conducted a go-around, used emergency procedures to extend the gear and landed without further incident. The engine fire, which substantially damaged the MD-82, had been caused by an improper starting procedure. Regarding the crew's handling of the anomalous event, NTSB concluded that "the pilots failed to properly allocate tasks, including checklist execution and radio communications, and they did not effectively manage their workload; this adversely affected their ability to conduct essential cockpit tasks, such as completing appropriate checklists."

These crews were all highly trained, experienced and professional. What went wrong?

Anomalous Event Management

We believe that current airline training programs over-focus on practicing checklist

responses to discrete failures. The time has come to integrate procedures that enable the crew to manage and solve anomalous events. The IHTAR model provides a framework for *anomalous event management* (AEM).

This AEM process comprises three steps akin to three waypoints on an airway to resolution (Figure 1). These waypoints are: IHTAR, HITSI and WAYFI. The following scenario illustrates the model in action.

An air carrier aircraft is at 3,000 ft on an instrument approach. Everything is normal until, at about the same moment, the captain — the pilot flying (PF) — and the first officer — the pilot not flying/pilot monitoring (PNF/PM) — notice a warning light illuminate. There is no apparent cause of the configuration warning. The captain acknowledges the situation. The first officer confirms.

The captain then says, "OK, I have the aircraft and the radios [IHTAR]. You've got everything else." The captain stabilizes the aircraft in airspeed, altitude and position. He reiterates to the first officer, "I have the aircraft and ATC. See what you can find out about the condition." The crew agrees to abort the approach and climb to a safe altitude to manage the problem.

Waypoints to Resolving Anomalous Events

IHTAR = I have the aircraft and the radios, you've got everything else.
HITSI = Here is the way I see it.
WAYFI = What are you finding?
KRES = Resolution International

Source: Chris Nutter and Thomas Anthony

Figure 1

The captain tells the approach controller, "We have an aircraft configuration problem and are unable to continue our approach. We need a little time to sort this out." The controller provides vectors out of the approach pattern and assigns a higher altitude.

The captain stabilizes the aircraft on the assigned vector and altitude, and summarizes the situation: "Here is the way I see it [HITSI]. ATC has taken us out of the pattern, so we have enough time and altitude to look into the warning light situation. Our destination remains the same. Does that sound right to you?" The first officer concurs, and the captain reiterates, "OK, again, I have the aircraft and the radios, you look into the warning light."

The first officer proceeds to investigate the cause of the warning light. After a suitable interval, the captain asks the first officer, "What are you finding [WAYFI]?"

The captain listens as the first officer reports her assessment but continues to pay primary attention to control of the aircraft. He asks the first officer to restate what she has found so far because something about the assessment does not make sense or seems out of place. The captain seeks clarity or further assessment by saying, "Huh, I wonder why that would be occurring."

ATC calls and asks if the crew needs more time. The captain replies in the affirmative. Just as this happens, the first officer says, "I think I've found it." She explains the apparent cause of the problem and the solution. The captain affirms that the first officer's findings are correct and works with her to complete the appropriate checklists.

During this process, the captain has communicated with dispatchers and flight attendants, and apprised the passengers of the situation, while maintaining the aircraft in level flight on the assigned vector and at the assigned altitude.

Having assurance that the aircraft has been returned to normal operating condition, the captain radios ATC: "We are back to normal operations and request the approach." ATC assigns vectors and an approach clearance, and the flight lands without incident.

In this scenario and in the accident flights summarized previously, the initiating anomalous events were similar, but there were different event management strategies and different outcomes. In the accident flights, there was *no* established

process for handling the anomalous events. In this case, the crew used the IHTAR model.

Task Prioritization

The *Oxford English Dictionary* defines *anomalous* as "unequal, unconformable, incongruous." An anomalous event doesn't fit. It doesn't make sense. It's one that we can't figure out. The IHTAR model provides pilots with a means of making sense of an anomalous event and solving it while maintaining control of the aircraft.

The first step, IHTAR — "I have the aircraft and radios, you've got everything else" —effectively accomplishes the "aviate, navigate, communicate" task prioritization that has served so well throughout the history of aviation. It does so as "Job 1" in a deliberate process designed for redundancy using *dynamic maneuvering monitoring* and established checklist procedures to assure flight control. Dynamic maneuvering monitoring clearly identifies roles as to who is expected to monitor what and when — and in doing so, ensures that both crewmembers do not become directly involved in the solution of the anomalous event or fail to ensure that aircraft path and configuration changes are accomplished safely.

The model acknowledges the captain's responsibility to designate the PF and the PNF/PM, and allows for the captain, if desired, to designate the first officer as PF while he or she exercises as PNF/PM what might be vastly more experience in directly working the problem. In any case, IHTAR ensures that one pilot maintains aircraft control and situational awareness, and continues to communicate with ATC, which can provide the time and space needed to allow for resolution of the problem.

The second step, HITSI — "Here is the way I see it" — follows the assignment of the essential flying and problem-assessment tasks, and allows the captain to summarize the situation as he/she sees it and to identify the critical elements. It puts the captain and the first officer on the same page *and*, just as importantly, gives the first officer the opportunity to provide additional insight and perspective in answering the question: "Does that sound right?"

HITSI is a transitional step that allows both crewmembers to start the process of anomalous event management with the same mental picture, minimizing preconceptions.

While the captain might have more experience to draw from in order to frame the situation, the first officer may also bring perspectives that would help.

The final step, WAYFI — "What are you finding?" — presents an important question that does not focus the first officer on any particular concern or limit cognition to a predefined system or component. Rather, it is open-ended, asking for the view of the situation from another set of eyes and an independent assessment about the initial indication or condition.

WAYFI enables discovery. It does not force the first officer to "solve the problem" and thereby create a condition of myopic problem fixation. Rather, by asking the first officer to report what he/she is finding, it allows the flight crew — as a problem-solving team — the opportunity to notice non-linear, non-obvious relationships that are significant to resolving the anomalous event.

In essence, while the first officer proceeds to investigate and report what he/she is finding regarding the problem, the first officer is the "pilot flying the problem," and the captain is the "pilot monitoring the problem."

Because an anomalous event is a problem that defies direct identification, it is necessary that a method of resolving such situations be able to draw from the combined and complete experience of the flight crew. These situations are ill-suited to linear checklist solutions until the exact cause of the anomalous event is identified. The WAYFI step allows the captain to utilize his comprehensive training in a non-directive manner while monitoring the reports of the first officer. It, in essence, facilitates the

subconscious processing of information leading to problem resolution. It evokes perceptions and questions such as, "Huh? That doesn't sound right." It allows the "little voice" at the back of every pilot's mind the opportunity to be heard.

WAYFI is a structured dialog. And dialog, in itself, is *heuristic*, which loosely translates from the Greek *heurka* to: Eureka, I have found it! A heuristic process is a process of discovery. It is a synergistic process that facilitates and generates new insights among the participants. It is like a handball game in which the ball gains energy, rather than loses it, each time it strikes the wall.

Another analogy is William Faulkner's observation about the process of writing. He said, "I never know what I think about something until I read what I've written on it."

New Approach

The evidence that event management should be considered as a new approach in pilot training is compelling.

In their book *The Multitasking Myth*, authors Loukia Loukopoulos, R. Key Dismukes and Immanuel Barshi make the point that standard operating procedures, including emergency procedures, are presented as serial procedures — that is, to be conducted in order, one step at a time.[1] This creates the expectation that emergencies can be resolved in a serial manner. Such is not the case in the real world of aircraft operations and especially not in the case of anomalous events.

NTSB Member Robert Sumwalt, a former airline captain and president of a research organization called Aviatrends, pointed out the critical importance of effective flight crew monitoring skills in a review of several reports and studies (*Flight Safety Digest*, 3/99, p. 1). A common finding among the studies was that many of the observed monitoring problems involved preoccupation with other duties. Sumwalt also noted the finding of a relationship between monitoring errors and the crews' preoccupation with non-monitoring tasks.

The results of a recent study of 1,020 U.S. air carrier and commuter airline accidents from 1990 to 2002 indicated the potential benefit of developing specific event management training, standardized throughout a company and perhaps the commercial aviation industry.[2] The study found that:

- Overall, nearly 70 percent of the commercial aviation accidents were associated with some type of aircrew or supervisory error.
- Approximately half of the accidents were associated with at least one skill-based error, and more than a third involved decision errors.
- Crew resource management (CRM) was a factor in approximately 20 percent of the major air carrier accidents.
- There had been little impact on reducing any specific type of human error over the study period.

The finding that, despite a low accident rate, the industry had not improved on human error for more than a decade, is stunning. It implies that highly trained, experienced and professional crews will continue to make errors that result in fatal accidents. It is a warning shot that we need something new, different, more effective and more reliable to manage anomalous events.

Basic "skills training" may have reached a practical limit, and what may be needed is a well developed event management strategy — a context in which to employ those skills. As the airline industry prepares for an era of retirements, a new generation of pilots and ever-increasing automation, the time

Investigators faulted the flight crew's task allocation after an engine fire and several other abnormalities afflicted an MD-82 in 2007.

U.S. National Transportation Safety Board

has come to improve what hasn't worked and to lay a foundation for more effective training.

Training for the Real World

We believe that anomalous event management training, as represented in the IHTAR model and with associated AEM policies and procedures, can improve airline pilot training programs. AEM involves a comprehensive plan and a disciplined execution. Training today does not emphasize enough how to develop that plan and how to execute the plan in a manner that keeps everyone "on task" and avoids distraction, omission and undetected error.

It should be recognized as well that problem-solving in an environment pressurized by an anomalous event presents an additional factor that must be included in the training syllabus.

Many of today's training programs are excellent, but accident/incident investigations and data analyses have shown that we need new training that embraces real-world factors and incorporates a new topic: event management. The industry needs to design, develop and train new ideas for systematic methods to manage events; use redundant processes to assure a high reliability operation; and integrate CRM, threat and error management (TEM) and line operations safety audit (LOSA) lessons and best practices.

In a column titled "Myths and Training," William R. Voss, president of Flight Safety Foundation, raised the same issues in relation to the Air France 447 accident (*ASW*, 7–8/11, p. 1):

"This tragedy compels us to ask some tough questions about training. Do we spend so much time driving simulators around at low altitudes with one engine out that the real risks are only discussed in the break room? This issue extends far beyond Air France and Airbus; it is about an industry that has let training get so far out of date that it is irrelevant, and people are left filling in the blanks with folklore."

While flying as a line captain for US Air, Robert Sumwalt established a cockpit procedure similar to the IHTAR call-out to clearly identify who was flying the aircraft and who had responsibility to perform other tasks.

Regarding the Jan. 15, 2009, ditching of US Airways 1549 in the Hudson River, NTSB concluded that a contributing factor in the survivability of the accident was "the decision making of the flight crewmembers and their crew resource management." This accident highlighted the challenges that crews face in managing abnormal and emergency events, and the success that is achievable when these events are well-managed.

WAYFI
"What are you finding?"

The IHTAR model directly addresses the challenges presented by anomalous events, giving crews a redundant, highly reliable and repeatable process to initiate AEM. Dynamics will always impose requirements to modify the process, but at least a well-trained AEM process can help crews embark on a path to maintain aircraft control and logically manage all of the components of an event for a successful conclusion.

We believe that the IHTAR model establishes an AEM procedure that optimizes the abilities of a crew to communicate and resolve anomalous events before they become anomalous emergencies.

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Thomas Anthony is director of the Aviation Safety and Security Program at the Viterbi School of Engineering, University of Southern California.

Notes

1. Loukopoulos, L.D.; Dismukes, R.K.; Barshi, I. *The Multitasking Myth: Handling Complexity in Real-World Operations*. Burlington, Vermont, U.S.: Ashgate Publishing Co. 2009.

2. Shappell, S.; Detwiler, C.; Holcomb, K.; Hackworth, C.; Boquet, A.; Wiegmann, D. *Human Error and Commercial Aviation Accidents: A Fine-Grained Analysis Using HFACS.* DOT/FAA/AM-06/18. FAA Office of Aerospace Medicine. July 2006.

Extraterrestrial Debris

The controlled re-entry of NASA's Upper Atmosphere Research Satellite in September 2011 likely deposited about 500 kg (1,100 lb) of surviving debris into an ocean.

A notice to airmen that spacecraft fragments could fall through European airspace prompted a quick risk assessment.

BY WAYNE ROSENKRANS

The remote possibility that an uncontrolled re-entry of orbital debris, also called space debris, could endanger civil airspace falls far outside normal experience. *Space debris* is defined at the international level as "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional."[1]

Before initiating controlled spacecraft re-entries, U.S. programs must demonstrate that the probability of human casualty from the "surviving" debris — that is, debris not rendered harmless by atmospheric *demise* (objects being consumed by burning) — will not be greater than 1 chance in 10,000, says the U.S. National Aeronautics and Space Administration (NASA).[2]

In January, a de-orbiting spacecraft inspired the Russian Federal Space Agency (ROSCOSMOS) and Eurocontrol to direct the world's attention to orbital debris re-entry issues such as reasonable preparedness, mitigations and limiting human casualty risk. The issues somewhat paralleled those surrounding the April 2010 eruption of the Eyjafjallajökull volcano in Iceland.

Equivalent gaps in decision-making methods regarding orbital debris re-entry events — beyond

Images: U.S. National Aeronautics and Space Administration

alerting the aviation community — have not been identified, based on a brief *ASW* review of space agency summaries of known risks and mitigations.

A number of documents outline the high-level issues and specify mitigation procedures required by national authorities. For example, according to the Inter-Agency Space Debris Coordination Committee (IADC), a forum for space agencies from 11 nations and Europe, "If a spacecraft or orbital stage is to be disposed of by re-entry into the atmosphere, debris that survives to reach the surface of the Earth should not pose an undue risk to people or property. This may be accomplished by limiting the amount of surviving debris or confining the debris to uninhabited regions, such as broad ocean areas. … The operator of the system should inform the relevant air traffic and maritime traffic authorities of the re-entry time and trajectory and the associated ground area."[3]

NASA notes that "using materials that tend to demise [limiting the number and size of orbital debris fragments that survive] upon re-entry remains one of the more important strategies in reducing the debris risk to persons on the Earth."[4]

European Alert of 2012

Eurocontrol placed its Network Management Directorate on standby status, then alert status, "for the possible uncontrolled re-entry of the Russian satellite, Phobos Grunt, into Europe's busy airspace," according to its summary of the January event. Eurocontrol said, "[ROSCOSMOS] announced that it was expected to fall somewhere on Earth between Saturday and Monday, 14–16 January 2012. But they could not predict when — neither date nor time — or where this re-entry would happen, as it was affected by many changing factors, such as solar [space] weather and the spacecraft's orientation.

"On Sunday, the middle of the re-entry window, the [Eurocontrol] Network Management Operations Centre received a copy of an international NOTAM [notice to airmen] from the Russian authorities, requesting European states to close their airspace for a two-hour period."

On that day, Eurocontrol facilitated a coordination process and conducted a teleconference for European air navigation service providers (ANSPs) and aircraft operators.

"A number of ANSPs issued a NOTAM warning operators of the potential hazard but given the uncertainty as to the area of possible re-entry, no further action [such as closing airspace or grounding aircraft] was proposed," Eurocontrol said. "The satellite landed in the Pacific Ocean, some distance away from the Chilean coast."

Controlled vs. Uncontrolled

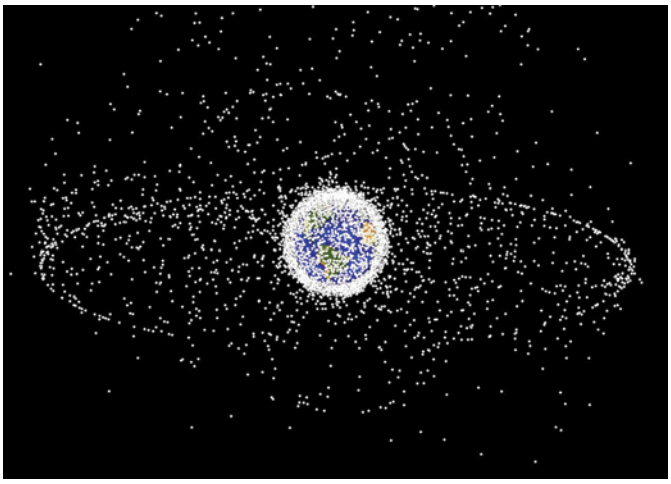
European Space Agency (ESA) scientists in 2009 explained how, other than by failure to propel a spacecraft into an intended orbit or beyond the Earth's gravity, even intact spacecraft ultimately experience an uncontrolled re-entry. "Satellites launched into low Earth orbit are continuously exposed to aerodynamic forces from the tenuous upper reaches of the Earth's atmosphere," ESA said. "Depending on the altitude, after a few weeks, years or even centuries, this resistance will have decelerated the satellite sufficiently so that it re-enters into the atmosphere. At higher altitudes — i.e., above 800 km [500 mi] — air drag becomes less effective, and objects will generally remain in orbit for many decades."

NASA and its counterparts draw sharp distinctions between the relative risks to people from controlled versus uncontrolled re-entries of spacecraft, including implications of the survival of debris long enough to reach aircraft altitudes. NASA said, "An uncontrolled re-entry is defined as the atmospheric re-entry of a space structure in which the surviving debris impact cannot be guaranteed to avoid landmasses. … Usually, large objects that have impacted the ground are from uncontrolled entries or orbital decay, so the impact point cannot be calculated exactly."

To read an enhanced version of this story, go to <flightsafety.org/aerosafety-world-magazine/march-2012/space-junk>.

Notes

1. IADC. "IADC Space Debris Mitigation Guidelines." IADC-02-01, Revision 1. September 2007.
2. NASA. "Process for Limiting Orbital Debris." *NASA Technical Standard NASA-STD-8719.14A*. Dec. 8, 2011.
3. IADC.
4. NASA. *NASA Handbook for Limiting Orbital Debris.* NASA Handbook 8719.14, July 30, 2008.



BY WAYNE ROSENKRANS

Visualization of synthesized safety data confirms the theories of analysts and investigators.

Now I See

Turning numbers into pictures often happens at a late stage, or as an afterthought, within aviation safety processes, say several specialists involved in U.S. government-industry system safety efforts and accident investigation. Awareness of revolutionary data visualization techniques has accelerated, however, among analysts and investigators. The implications affect sifting through vast volumes of recorded flight data for operator-level insights, generating tables and charts from the templates built into worksheets or databases, and replaying individual aircraft events with flight data animation software, they said.

Instead of expecting aviation safety analysts or accident investigators to focus first on raw data, then graphically communicate analytical results, data visualization facilitates and guides analysis from the earliest stage. Some specialists noted that overlaying data on geospatial/terrain imagery in Google Earth Pro, ESRI ArcGIS or equivalent software offers this capability.

Geospatial software has been used since the October 2009 launch of the U.S. Federal Aviation Administration (FAA) Aviation Safety Information Analysis and Sharing (ASIAS) program. "The ability to blend all ASIAS data sources easily has greatly improved," said James M. Reed, senior multi-discipline systems engineer, Aviation Safety Analysis, at the MITRE Corp. Center for Advanced Aviation System Development (CAASD), the not-for-profit, FAA-funded research center that has stewardship of ASIAS data.

Visualization 1 (top); Visualization 2 (right)

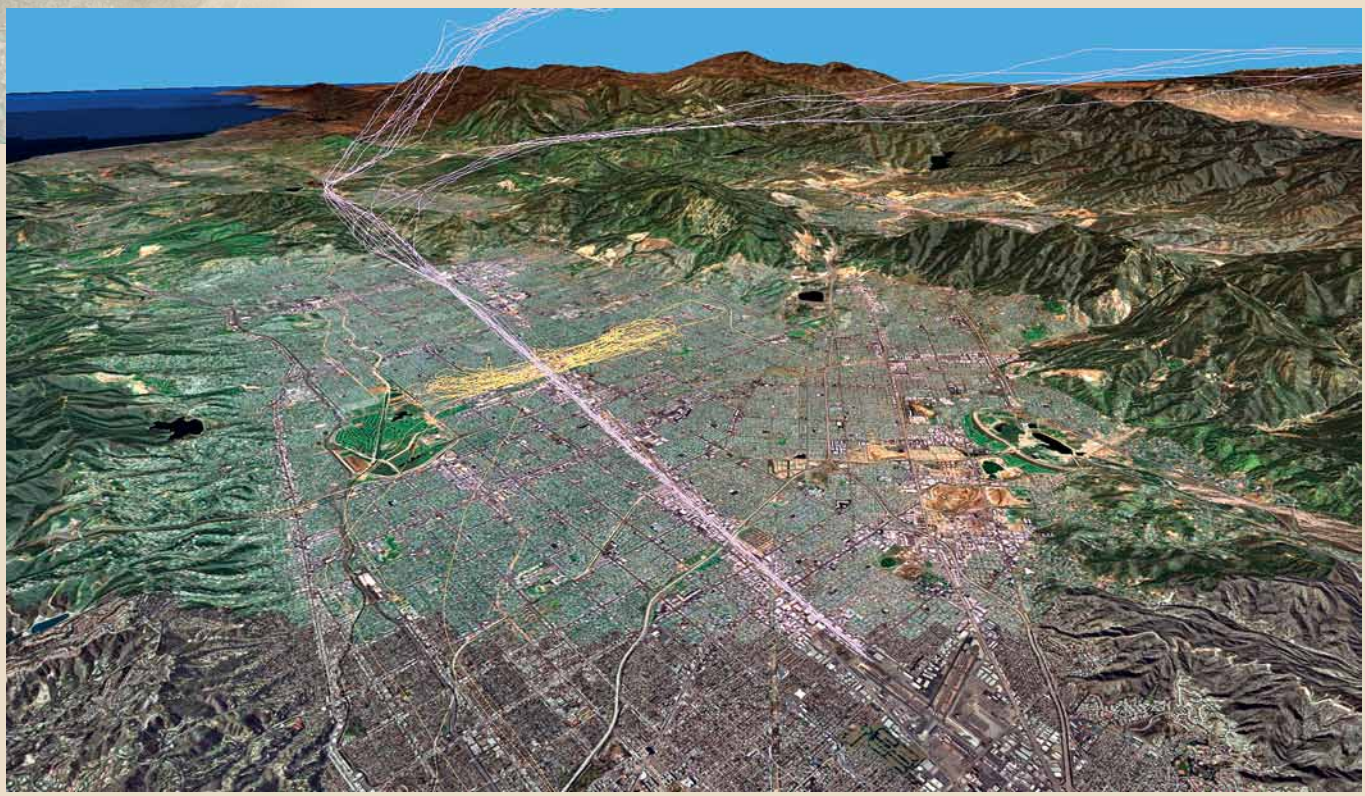
Developers of one of the data visualization software tools used by CAASD, called Tableau, have summarized common obstacles to effective visual analysis of data: "A major stumbling block to widespread adoption is that most people are not trained in the graphical design principles needed to construct graphical presentations that support their reasoning process or communicate their analytical results to others. … They struggle with numbers that are slow to read and do not show patterns or trends. … Users typically start visual analysis with vague tasks in mind, which are refined and transformed as they see graphical views of data. … Skilled users … require a system that attends to the graphic details so that they can stay in the flow of visual analysis."[1]

ASIAS and CAASD briefed *AeroSafety World* and provided examples of using data visualization for extracting system-level, risk-reduction insights from government-owned and airline-owned data sources. ASIAS equips and trains its participating airlines to compare their own safety metrics with industry benchmarks derived from de-identified, aggregate data contributed by the flight operational quality assurance (FOQA) programs of all participants (*ASW,* 11/11, p. 32). Boeing Commercial Airplanes shared additional data visualization experiences during Flight Safety Foundation's 64th annual International Air Safety Seminar (IASS) in Singapore in November.

Beautiful Evidence

To study traffic alert and collision avoidance system (TCAS) resolution advisories (RAs) near a U.S. general aviation airport located along an approach to a major airport, ASIAS and CAASD analysts conducted data fusion, integration and analyses with several types of data visualization, said Randy McGuire, program manager, Aviation Safety Analysis, CAASD. One of the final products was a heat map (Visualization 1), a method of depicting the concentration of RAs with the densest shown as a red circle, he said. This image is a close-up view of one of several dozen concentrations published by ASIAS on a U.S. map (*ASW,* 8/09, p. 34).

"The highest concentration of events is at the center of the circle, and as viewers move away from that, fewer and fewer events have occurred per unit area," Reed said. "The two-dimensional



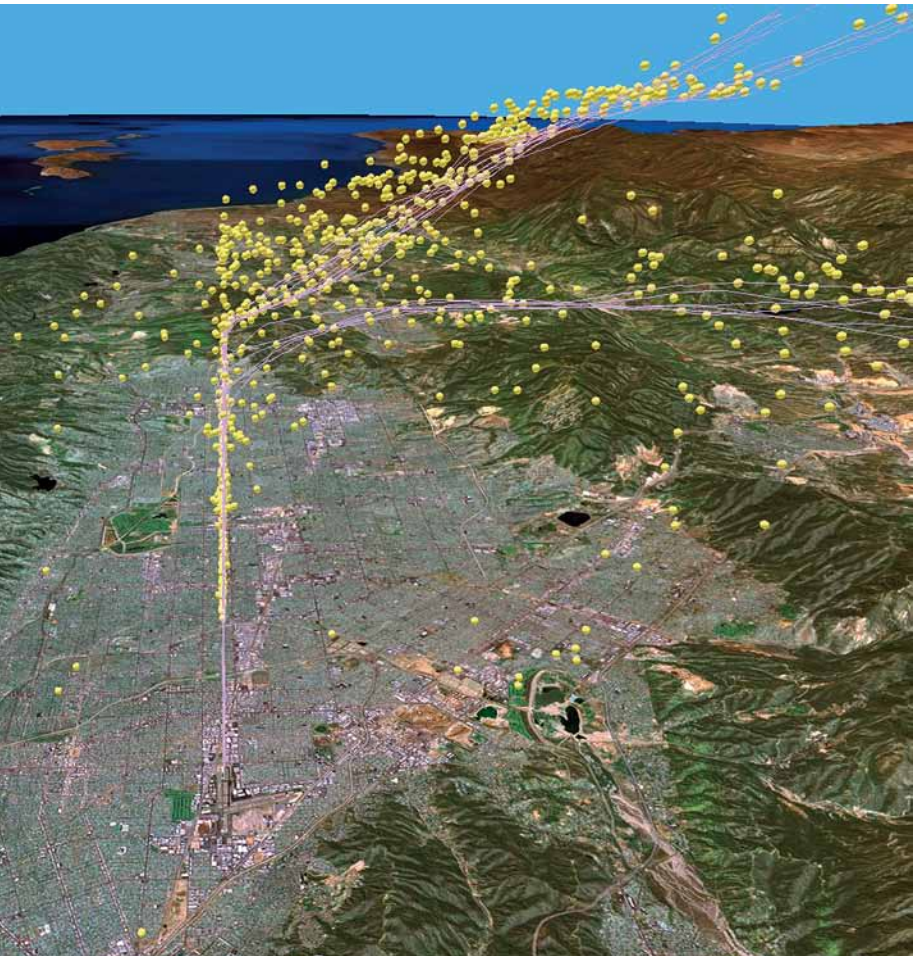
Images: © MITRE Corporation

[2-D] clustering algorithm does not take into account the differences in altitude of RAs, so in reality many are invisibly stacked up on top of each other. We prefer high-fidelity, 3-D tools to look at the altitude dimension. These tools enable us to 'fly around,' change the perspective, and change the vertical scale and symbols/colors. We fuse a lot of data into a common picture that we can then manipulate."

The first step en route to the heat map was visualizing the flow of aircraft into the airport using about two hours of radar track data from the FAA's National Offload Program, McGuire said. "As it turns out, the major flow [depicted as purple lines, Visualization 2, p. 29] overflies … the yellow tracks of a traffic pattern with pilots doing practice touch-and-go landings in the familiar racetrack pattern."

Another step (Visualization 3) added evidence to the analysts' preliminary theory, said Michael Basehore, the FAA program manager for ASIAS. "Each of the yellow spheres is where the FOQA aircraft itself got a TCAS RA," he said. "When we put these actual RAs on top of the radar tracks, we saw that they coincided with the incoming Federal Aviation Regulations Part 121 traffic, and where each RA intersects with the general aviation traffic. The reason the RAs don't match up identically with the radar tracks is that FOQA data are de-identified but they did confirm that the RAs occurred where the typical traffic pattern was."

Visualization 3



The next-to-last step (Visualization 4) replayed actual radar-track data through emulation software, generating purple diamonds where TCAS RAs hypothetically could occur given how TCAS algorithms had handled the real-world encounters (*ASW,* 10/11, p. 26). "All that the FOQA data could indicate was that TCAS RAs occurred in these locations," McGuire said. "The data did not tell us anything about the other aircraft involved in the RAs. We went back and looked at the radar data, and then we were able to develop the software emulator using the radar data as an input and, as an output, whether or not TCAS RAs would occur. We replayed all the traffic for hot spot areas in the National Airspace System to determine if we could find out why those RAs were occurring."

McGuire noted that, to declutter this image, some yellow/blue lines (radar tracks) underlying the purple diamonds were hidden to emphasize the major flows on the approach route studied. Tracks of aircraft just passing by the area also were hidden even if the aircraft crew had received an RA.

ASIAS receives FOQA data from about 30 percent of the total commercial flights in the United States, Basehore said. "We can now run the radar tracks through this emulator, and the emulator extrapolates where we could have seen a TCAS RA if we had had FOQA data from all the flights," he said. The results of this data visualization further confirmed what was occurring near the two airports under review.

ASIAS also performs dynamic analysis of airspace, in which real-time data visualizations

show aircraft symbols moving along their radar tracks in relation to surrounding aircraft and to Google Earth Pro terrain. Dynamic analysis helps analysts to comprehend the complex geometries of aircraft interaction from any angle, altitude or direction.

"We can display one data source at one point, then bring up another source of data on another screen and see if that confirms what is happening," Basehore said. "We've got the capability to do these on multiple screens using multiple databases at one time."

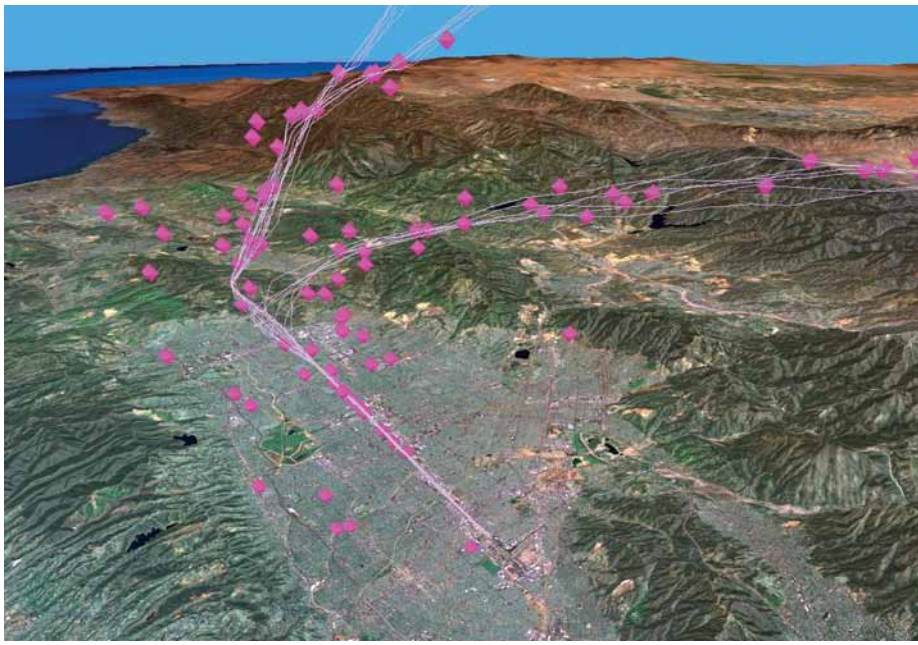
Airline Data Visualization

Less visually arresting — but equally important — types of data visualization also are available to both ASIAS analysts and analysts at participating airlines. "We use Tableau quite extensively for data-manipulation analytics as our preferred method now for visualizing the aggregate data," said Alex Alshtein, project team manager, Aviation Safety Analysis, CAASD. "Tableau is very powerful for us because we can see over time how things may change such as a different airspace or a different runway end."

ASIAS focuses, with rare exceptions, on systemic solutions. "Tableau generates curves telling us the normal behavior for all the aircraft using this particular airport or runway end, for example," Basehore said. "We would look at a particular aircraft if we saw something out of the norm — far off on the tail of the curve — and see why it was different from all the others."

ASIAS researchers are working on a capability for airline analysts to use Tableau's dashboard interface to query the FAA's radar surveillance data, instantly and automatically generating overlays on geospatial imagery and helping users to think more clearly about spatial relationships, Alshtein said. (Dashboards are groups of possible selections and windows containing query results, all of which change to fit the context of the information sought.)

Tableau dashboards customized by ASIAS also graphically display trends and quickly reveal "rapid upticks at a particular location," and by how many statistical standard deviations events differ from normal operations, Basehore said.



Visualization 4

"One of the ASIAS metrics in Tableau is 'missed approach,' so an airline analyst can see an aggregate view of all airports, or drill down into a specific airport or a specific runway end over time," Alshtein said, showing a map of the United States generated by this software. "The size of each circle representing an airport symbolizes the number of operations at the airport. Circles also are color-coded so that if their rate of missed approaches is higher than usual, the airport is red; if it is lower than usual, the airport is green."

Such a data visualization may show, for example, that the root of most unstabilized approaches among all the airlines serving an airport has been a complicating geographic factor at just one runway end under certain prevailing winds, Basehore said.

Data visualization focuses analysts' attention, at an opportune moment, on whether a significant safety issue exists, Basehore added. "Instead of having to look at everything, the tool at least 'taps them on the shoulder' and says, 'You need to go over here and look at this aspect in more detail' or 'Something is different here than everywhere else.'"

One caveat emphasized to participating airlines is that FOQA-event definitions adopted

by ASIAS — such as the one for *unstable approach* — may differ from those used operationally by an airline's flight crews or by the airline's FOQA analysts, he said. CAASD analysts visit these airlines to learn about their safety research and to train airline analysts to take full advantage of Tableau and other data visualization methods "to get them all up to the same level so that they can take advantage of the processes we are developing at ASIAS," Basehore added.

Google Earth Pro

During aircraft accident investigations, data synthesis and visualization with Google Earth Pro extend the capabilities of older methods, said Simon Lie, associate technical fellow and senior air safety investigator, Aviation Safety, Boeing Commercial Airplanes. Other geospatial software that models and presents 3-D data also would support the methods Boeing uses in safety investigations. He said that data visualization already stands out as a proven "high-bandwidth communication tool" — that is, promoting comprehension of complex data far more quickly than older methods. The capability supports today's investigations involving thousands of flight data parameters, messages via aircraft communications addressing and reporting systems, and data from emergency locator transmitters and non-volatile memory in aircraft systems.

Conventional time-history plots of data points from flight data recorders remain an important tool for detailed study of parameter values such as altitudes and airspeeds, and their variation over time, Lie said. With the chronological advantages of such plots comes a significant shortcoming: "The learning curve required to quickly interpret the plot shows it is not necessarily a natural way of looking at the data," he said. "It is difficult to form a 3-D mental picture of what is happening on a flight path based solely on parameter traces."

FOQA-data animations — highly regarded for the depiction of spatial relationships — "make some beautiful pictures and some very realistic-looking scenes, probably more realistic than some of the data that underlies them — and there is a danger in that," according to Lie. Moreover, investigators find themselves repeatedly "fast-forwarding" and "rewinding" through the sequential images of animations when trying to explain complex causal relationships separated by time intervals.

Other animation shortcomings include limitations in the models of aircraft performance, instrument depiction and scenery. "In particular, the instruments and the functions on the photorealistic primary flight display and other instruments are very complex," he said. The simulation may incorporate technically inappropriate content from a flight operations manual instead of from the complete, proprietary engineering description, Lie noted.

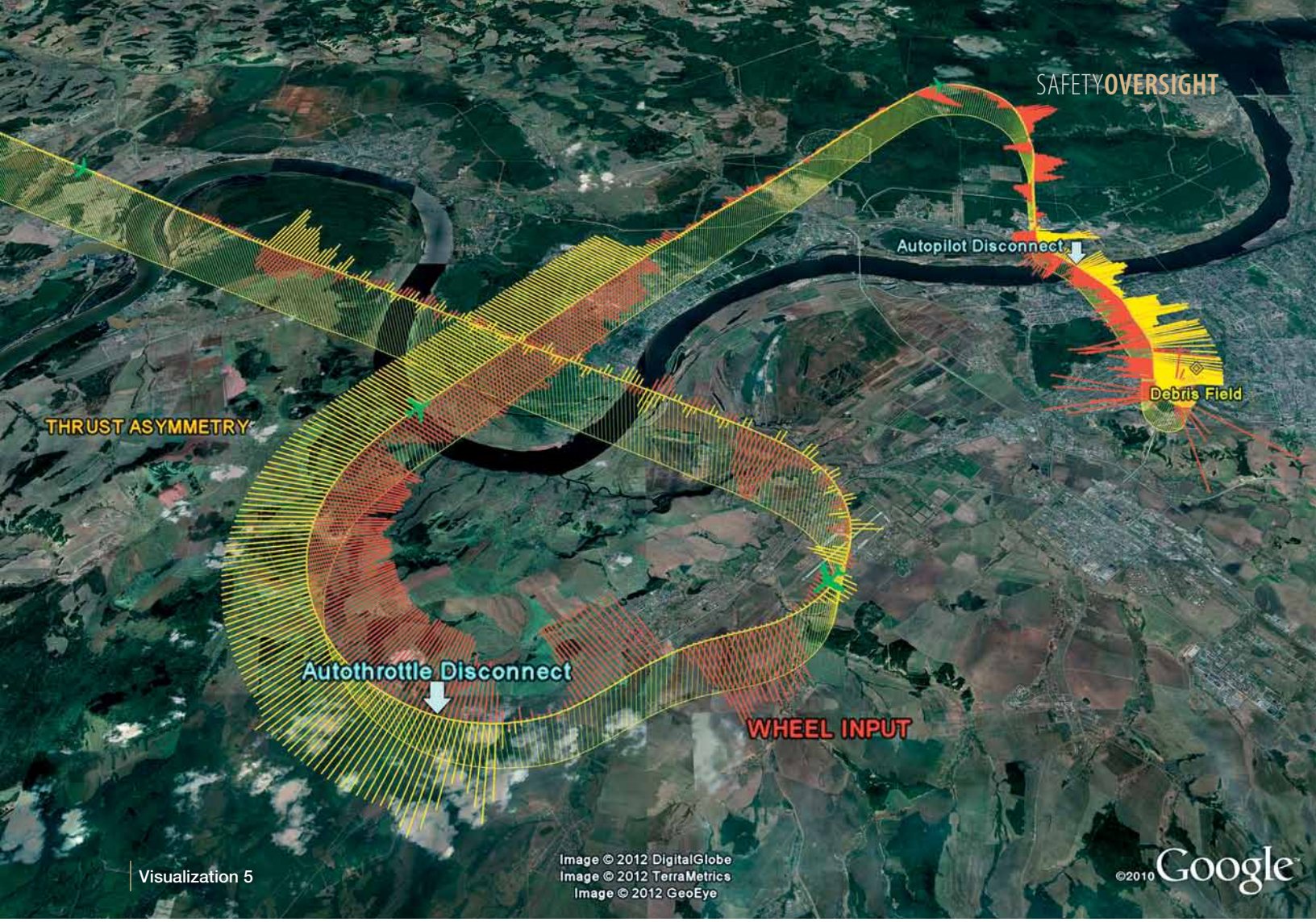
Combining chronological and spatial relationships in ways that are natural and intuitive even for non-experts, Google Earth Pro "capitalizes on the innate ability to process visual scenes that each and every one of us has," Lie said. The visualizations have been effective at showing both types of relationships all in one scene, he said. The main limitation noticed is the lack of the precise values or parameters seen in a conventional worksheet, table or plot.

The value to aviation safety of Google Earth Pro is not so much the satellite-based terrain imagery "painted" onto geometric contour shapes. Rather, Boeing investigators are most interested in overlaying 2-D and 3-D objects such as flight paths created from data, and selecting or deselecting these objects during analysis. Most such objects are created by converting recorded data and derived data into place marks — points specified by latitude, longitude, altitude and time — via Keyhole markup language, an international geospatial standard.

Lie presented one data visualization of the flight path of a Boeing 737-300 depicting the effects of an onboard navigation problem and subsequent safe landing at an airport that the flight crew found by visual searching. The image was based on coordinates recorded by the flight data recorder. A false track generated and recorded by one of the inertial reference computers on the airplane was compared with an estimated actual track derived from heading, airspeed and altitude data determined to have been accurate.

In another example, data visualization of intersecting coverage by two radar antenna sites in relation to a 737-400 track, overlaid on Google Earth Pro terrain imagery, clarified whether an aircraft could have flown out of radar range before it was lost at sea.

The most revealing advancement so far has been overlaying non-geometric data on geospatial imagery. Lie cited Boeing's investigation of one flight crew's effective response to a 777 engine power rollback event. "We colored the flight path based on the difference in oil temperature between the two engines," Lie said. This data visualization helped investigators to identify significant moments during the sequence of ice accretion on the fuel-oil heat exchanger, engine rollback, descent, time interval for flight crew intervention by retarding throttles, melting of ice and the resumption of normal flight.



Visualization 5

To analyze an approach-phase accident, investigators included simultaneous overlays of non-geometric parameters on both terrain and a scaled approach chart. The non-geometric method supports the use of layers representing data for thrust asymmetry as a yawing force, N1 rotor speed in relation to throttle position, control wheel displacement, radar altimeter data, autothrust disconnect location, airspeed, stick shaker activation, location of a stall recovery attempt, satellite weather images, lightning strike data, and text from transcribed cockpit voice recorders and air traffic controller voices.

One product in the set (Visualization 5) included vectors — perpendicular lines representing magnitude and direction of forces — along the flight path. The purpose was to show over time the thrust asymmetry as yellow lines protruding from the flight path, and the contemporaneous control wheel inputs as red lines. For example, a large control wheel displacement was clearly visible during straight and level flight.

"When both parameters are combined, the relationship between thrust asymmetry and control wheel becomes instantly evident — as does the combined effects … just prior to the loss of control," Lie said. "Google Earth allows this 3-D scene to be rotated and viewed from different angles."

Once the autothrottle had been disconnected in this situation, the asymmetric thrust condition became a function of the flight crew's selection within the available thrust range. "At low thrust settings, there was almost no asymmetry; at very high thrust settings, there was no asymmetry," he said. "During level off, there was a lot of thrust asymmetry. … It appears that they never recognized it."

In summary, CAASD's Reed said, "Visualization gives us the ability … to link patterns to our expert knowledge. The insights — the various clues to improve safety — would be much more difficult to obtain if we did not have these tools."

Note

1. Mackinlay, Jock D.; Hanrahan, Pat; Stolte, Chris. "Show Me: Automatic Presentation for Visual Analysis." *IEEE [Institute of Electrical and Electronics Engineers] Transactions on Visualizations and Computer Graphics.* Volume 13 (November 2007). <www.tableausoftware.com/whitepapers/show-me-automatic-presentation-visual-analysis>.

Joining In

A new law sets a timetable for incorporating unmanned aircraft into U.S. airspace.

BY LINDA WERFELMAN

With 900 types of unmanned aircraft systems (UAS) worldwide and a legislative mandate to speed UAS integration into the national airspace, the U.S. Federal Aviation Administration (FAA) is poised to propose rules later this year to regulate some aspects of UAS operations.[1]

Although proposed regulations have been under development for months, the legislation, signed into law by President Obama on Feb. 14, specifies that unmanned aircraft (UAs) — sometimes called unmanned aerial vehicles, drones or radio-controlled aircraft — must be safely integrated into the system no later than Sept. 30, 2015, and that a comprehensive plan for accomplishing the integration must be developed within nine months. That plan should provide not only a timeline but also a definition of "acceptable standards for operation and certification of civil unmanned aircraft systems," requirements for operators and pilots, and a designation of airspace for "cooperative manned and unmanned flight operations," the law says.

The new law also dictates that the first phase of the effort — the designation of six test ranges in which UAs will be flown in the same airspace as traditional aircraft — should be accomplished within six months of the bill-signing date, in cooperation with the National Aeronautics and Space Administration and the Department of Defense, which already operate their own test sites.

"Technology is advancing to the point where we now know these systems can reliably fly," said Michael Toscano, president and CEO of the Association for Unmanned Vehicle Systems International (AUVSI). "The next step is to work on the regulations that govern the rules of the sky to

U.S. Federal Aviation Administration

The U.S. National Aeronautics and Space Administration has flown Northrop Grumman's Global Hawk to study hurricane development.

ensure that unmanned aircraft do no harm to … manned aircraft or to people or property on the ground."

The Air Line Pilots Association, International (ALPA) has been cautious about the idea of sharing airspace with an increasing number of unmanned aircraft.

"No UAS should be allowed unrestricted access to public airspace unless it meets all the high standards currently required for every other airspace user," ALPA said in a UAS white paper.[2] "The aircraft must be designed to have the same types of safety features; reliable, redundant systems; and maneuverability as the other airspace users. UAS operators must meet all the certification and fitness requirements of air carriers, and the 'pilots' flying the UAS aircraft must meet equivalent training qualification and licensing requirements as pilots of aircraft in the same airspace."

The FAA asked in early March for public comments on the process to be used in selecting the six test sites, which Transportation Secretary Ray LaHood said would "help us ensure that our high safety standards are maintained as the use of these aircraft becomes more widespread."

The agency said it was especially interested in comments on whether the sites should be managed by government or a private company, what research activities should be undertaken and what geographic and climate factors should influence the site selection. The FAA plans to accept comments through early May and then to develop test site requirements, designation standards and oversight.

Under the new law, some of the smallest UAs could be in the air very soon. The law says that, within 90 days of its Feb. 14 enactment, plans should be in place for a simplified process to allow government public safety agencies to operate UAs that weigh 4.4 lb (2.0 kg) or less, provided the UAs are operated during daylight, within the operator's line of sight at less than 400 ft above ground level (AGL), in uncontrolled airspace and at least 5 mi (8 km) from any airport "or other location with aviation activities."

The goal, according to AUVSI and other supporters, is to "get law enforcement and fire fighters immediate access to start flying small systems to save lives and increase public safety." Detractors, including the American Civil Liberties Union (ACLU), worry less about aviation safety than they do about fears that these smallest UAs represent an assault on privacy, "bringing us a large step closer to a

U.S. National Aeronautics and Space Administration

Bell Helicopter's Eagle Eye originally was intended for use in surveillance and reconnaissance work.

U.S. Coast Guard

surveillance society in which our every move is monitored, tracked, recorded and scrutinized by the authorities."[3]

Other provisions of the new law call for the development within six months of plans that will allow "small" UAs — those weighing less than 55 lb (25 kg) — to operate "for research and commercial purposes" in the U.S. Arctic, day and night, beyond lines of sight. The law is intended to designate permanent areas for the these UAS operations and to "enable overwater flights from the surface to at least 2,000 ft in altitude, with ingress and egress routes from selected coastal launch sites." A notice of proposed rulemaking (NPRM) is expected later this year to propose regulations dealing specifically with small UAs.

The law also will require the FAA to create and update annually a five-year "roadmap" for introducing UAS into the National Airspace System (NAS). Under the legislative timetable, the first version of the roadmap is due to be approved early in 2013.

The FAA also will be required to study UAS human factors and the causes of UAS accidents.

Several occurrences — most of them involving military UAs — already have been reported, including the Aug. 2, 2010, temporary loss of control of a U.S. Navy MQ-8B Fire Scout, an unmanned helicopter manufactured by Northrop Grumman, that strayed into restricted airspace around the U.S. Capitol. News reports at the time quoted military officials as saying that they considered sending fighter jets to shoot it down.

The reports said that the aircraft had taken off from the Navy's Patuxent River test facility in southern Maryland on a routine test flight. About 75 minutes later, it lost its control link with Navy operators on the ground. The aircraft then flew about 23 nm (43 km) northwest and into the restricted Air Defense Identification Zone around Washington.[4,5]

A report in the *Navy Times* said that Navy operators switched to a different ground control station to restore the control link and direct the aircraft to return to the Navy airfield, where it landed. No one was injured and the aircraft was not damaged in the incident, which officials attributed to "a software anomaly that allowed the aircraft not to follow its pre-programmed flight procedures." The software subsequently was modified, they said.

In another incident, an Air Force Lockheed C-130 cargo plane and an AAI Corp. RQ-7 Shadow UA collided over Afghanistan on Aug. 15, 2011. Preliminary reports said no one was injured in the incident and that the C-130 received minor damage but was landed safely.[6]

An earlier accident — the April 25, 2006, crash of a General Atomics Aeronautical Systems Predator B near Nogales, Arizona, U.S.

— prompted the U.S. National Transportation Safety Board (NTSB) to issue its first report on a UA crash, as well as 22 safety recommendations, many of which involved the integration of UAS into the NAS, and to voice its concerns about differing standards for UAs and traditional, manned aircraft (*ASW*, 12/07, p. 42).[7]

"This investigation has raised questions about the different standards for manned and unmanned aircraft and the safety implications of this discrepancy," said Mark V. Rosenker, who at the time was the chairman of the NTSB. Noting the need for rigorous pilot training, regardless of whether the trainee handles a manned aircraft or a UAS, he added, "The pilot is still the pilot, whether he [or she] is at a remote console or on the flight deck."

'Inherent Differences'

The FAA has echoed that sentiment, although the agency says that "the inherent differences from manned aircraft, such as the pilot removed from the aircraft and the need for 'sense and avoid,' [mean that the] introduction of UAS into the NAS is challenging for both the FAA and aviation community."[8]

Those challenges have prompted a re-examination of some of the most fundamental aspects of aviation safety, the agency said in its *FAA Safety Briefing* magazine, which quoted UAS Program Policy and Regulatory Lead Stephen Glowacki as saying, "What we've experienced with UAS is almost a retrograde action in terms of trying to understand aviation. In many ways, we're forced to re-evaluate the same things we thought we understood."[9]

As an example, he cited the new concept of having a cockpit on the ground, perhaps many miles away from the aircraft, and some related questions, including whether a UAS cockpit should be required to have the same door security system as the flight deck of a commercial airliner and whether a UAS pilot should be required to wear a seatbelt.

Military Roots

Historically, UAS have been flown in support of military and security operations, and the U.S. military currently has about 7,500 UAS in service, many of them in Afghanistan. In recent years, UAS use has spread to public use aircraft — those operated by law enforcement and government agencies — which fly them on operations including search and rescue, border patrol, fire fighting, environmental monitoring and disaster relief. Other flights involve research by public universities.

AUVSI's Toscano said future uses of the "revolutionary-type technology" are likely to include oil and pipeline monitoring, crop dusting and other civil and commercial operations. Those commercial operations are likely to include photography, aerial mapping, monitoring crops, advertising, communications and broadcasting.

"A whole new industry will emerge, inventing products and accomplishing tasks we haven't even thought of yet," Toscano said.

Under existing procedures, the FAA issues certificates of authorization (COAs) that permit flights of public use UAS. The FAA says that, in issuing a COA, which usually is effective for a specified length of time — typically one year — and with specified requirements, it may limit operations in some way, such as by including a requirement to operate only under visual flight rules or only during daylight. Under a COA, an operator may be required to coordinate flights with air traffic

The SIERRA, designed by the U.S. Naval Research Laboratory and developed by the U.S. National Aeronautics and Space Administration, has been used in air sampling and low-altitude surveys of remote areas.

U.S. National Aeronautics and Space Administration

control and to equip its UAS with a transponder before operating in some types of airspace. In addition, because a UAS cannot "see and avoid" other aircraft, it must be accompanied by an observer or a chase aircraft that stays in contact with the UAS during operations outside of restricted airspace.[10]

The number of COAs being issued has soared in the last few years, from 146 in 2009 to 298 in 2010. Through June 2011, 251 COAs were issued.

Existing policies also permit private recreational operators to operate model aircraft under terms discussed in FAA Advisory Circular 91-57. Operations typically are restricted to below 400 ft AGL and away from airports and air traffic.

Civilian Operations

The NPRM will include new policies, procedures and approval processes aimed at allowing civilian operators to launch UAS commercial ventures.

With the NPRM, the FAA will be "laying the path forward for safe integration of civil UAS into the NAS," the agency said. "An evolved transition will occur, with access increasing from accommodation to integration into today's NAS, and ultimately into the future NAS as it evolves over time."[11]

According to FAA projections, the greatest near-term growth in civil and commercial operations will be with small UAS because their size makes them adaptable for many uses and should keep initial costs and operating costs relatively low.

The FAA says it already has received public comments on the use of small UAS, from their supporters, who believe that, because of their size, they should be subject to minimal regulation, and from critics who view them as a threat to manned general aviation aircraft as well as to people and property on the ground.

Critical Issues

The FAA has faced a number of key issues in drafting the NPRM, including the need for UAS, whose pilots are not in a position to actually see other air traffic, to instead be equipped to sense and avoid potential conflicts.

An Army official has been quoted as saying, for example, that if the RQ-7 involved in the Afghanistan midair collision had been equipped with a sense-and-avoid system, the accident could have been avoided.[12]

Other issues include the lack of UAS regulations, including regulations regarding pilot and crew qualifications, medical certification, aircraft certification and the layout and certification of ground control stations; and the increasing demand for the FAA to process more and more applications from UAS operators for COAs or special airworthiness certificates, which are issued for experimental category aircraft.

As the number of UAS in the skies has grown, so has the realization of related risks, such as the reliability of the control link between a UA and its pilot and what procedures should be followed in case the link is lost, the FAA said.

Among the other issues under consideration is what level of risk will be considered acceptable as UAS become more established and their numbers continue to increase.

"The FAA's main concern about UAS operations in the NAS is safety," the agency said. "It is critical that UAS do not endanger current users of the NAS, including manned and other unmanned aircraft, or compromise the safety of persons or property on the ground."

Notes

1. A UAS includes not only a UA but also the supporting system, typically consisting of a ground control station and command and control links, that enables its flight.
2. ALPA. *ALPA White Paper: Unmanned Aircraft Systems — Challenges for Safely Operating in the National Airspace System*.
3. Stanley, Jay; Crump, Catherine. *Protecting Privacy From Aerial Surveillance.* ACLU, December 2011.
4. Cavas, Christopher P. "Lost Navy UAV Enters Washington Airspace." *Navy Times*. Aug. 25, 2010. <navytimes.com/news/2010/08/navy-uav-enters-dc-082510>.
5. Associated Press. "Errant Drone Near D.C. Almost Shot Down." <cbsnews.com/2100-201_162-6854119.html>.
6. Hodge, Nathan. "U.S. Says Drone, Cargo Plane Collide Over Afghanistan." *Wall Street Journal*. Aug. 17, 2011.
7. No one on the ground was injured in the crash, but the Predator B — owned by U.S. Customs and Border Protection and operated as a public use aircraft — was substantially damaged. The NTSB said the probable cause of the accident was "the pilot's failure to use checklist procedures" while switching operational control from one console to another at the ground control station.
8. FAA. *Fact Sheet: Unmanned Aircraft Systems*. July 2011.
9. Hoffmann, Tom. "Eye in the Sky." *FAA Safety Briefing* Volume 49 (May/June 2010): 20–23.
10. FAA.
11. Ibid.
12. Warwick, Graham. "UAV Collision Bolsters Sense-and-Avoid." *Aviation Week & Space Technology*. Aug. 18, 2011.

A captain who makes the cockpit environment acrimonious can be a safety risk.

The Toxic Captain

BY ROBERT I. BARON

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Shortly after takeoff from Douala, Cameroon, on a dark night with convective activity in the area, the pilots of Kenya Airways Flight 507, a Boeing 737-800, lost control of their aircraft. The captain experienced confusion and spatial disorientation while trying to manually recover. His inputs greatly exacerbated the bank angle, and the aircraft entered an unrecoverable spiral dive.

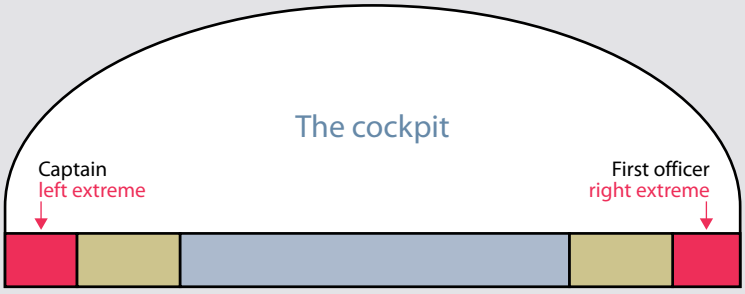
The Cameroon Civil Aviation Authority determined the probable cause to be "loss of control of the aircraft as a result of spatial disorientation ... after a long slow roll, during which no instrument scanning was done, and in the absence of external visual references on a dark night. Inadequate operational control, lack of crew coordination, coupled with the non-adherence to procedures of flight

monitoring, [and] confusion in the utilization of the [autopilot], have also contributed to cause this situation."[1]

This accident was the result of missed opportunities, at the organizational level, to address the captain's documented deficiencies in both his flying skills and crew resource management (CRM). The official investigation highlighted the captain's known psychological traits and deficiencies before, as well as on the day of, the accident. They included his strong character and heightened ego; authoritative and domineering attitude with subordinates; paternalistic attitude toward the first officer on the accident flight; documented deficiencies in upgrade training, which included CRM, adherence to standard procedures, cockpit scan and situation awareness; a "touch of arrogance" and "insufficient flight discipline." There had been numerous recommendations that he attend remedial training.[2]

Sometimes a captain with a personality of this type is paired with a first officer who lacks the ability and/or experience to voice concerns related to the captain's decisions and actions. The Cameroon accident investigation revealed that the first officer was known to be reserved and nonassertive, and that he was subdued by the captain's strong personality. He was concerned about the weather but did not question the decision to depart.[3]

'Ideal Crew-Pairing Zone' Versus Kenya Airways Flight 507



Note: The ideal crew pairing is in the center of a scale from dominating, at left, to submissive, at right. The extremes represent the situation on the flight deck of Kenya Airways Flight 507.

Source: Robert I. Baron

Figure 1

Polar Opposites

A crew pairing such as this, where there is a strong, domineering captain combined with a reserved and nonassertive first officer, represents polar opposites in terms of crew coordination, adherence to CRM principles, standard operating procedures and general communicative ability. Another perspective suggests that the "trans-cockpit authority gradient" in this accident crew was much too steep.[4] At best, a crew pairing should fall into what I call the "ideal crew-pairing zone" (Figure 1). In the Kenya Airways accident, the crewmembers were at the left and right extremes.

The topic of crew pairing deserves much more attention. However, the main subject of this article is the behavioral tendencies of "toxic captains" and how the organization handles them.

The term "toxic captain" is not likely to be found in a flight training manual. Some people know from unhappy experience what it implies. I define a toxic captain as a pilot-in-command who lacks the necessary human and/or flying skills to effectively and safely work with another crewmember in operating an aircraft. Additionally, the toxic captain, at times, can make the cockpit environment so acrimonious that the successful outcome of the flight may be in serious jeopardy.

The pilot-in-command of Flight 507 could be categorized as a toxic captain. His deficiencies were not hidden or hard to detect. In fact, deficiencies documented in the captain's records clearly indicated red flags and potential problems. Additionally, multiple first officers did not want to fly with the accident captain because of his reputation for an overbearing personality and arrogant attitude.

One of the clearest ways to determine if there is a "toxic captain problem" is to collect and analyze reports, provided they are made. If only one first officer has reported an issue with a particular captain in, for instance, a one-year period, it was probably just an isolated incident. However, if 15 different first officers during that year went on record that they did not feel comfortable with,

or want to fly with, a certain captain, it is safe to assume the problem lies with the captain.

The toxic captain may not have had an accident; however, it may just be a matter of time, as the toxic leadership behaviors go unchecked. Take, for example, the following report from an air carrier first officer that was submitted to the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS):

> *I just finished a trip with the most unprofessional, nonstandard, weak and violation-prone captain at my air carrier, on a 13-day intra-Asia flight. I must have caught 30 or more of his mistakes. If I missed some, it was because I was getting yelled at. The whole trip he tried to get me to quit, but I didn't. On the 12th day, he tried to get off the trip, but the company didn't let him. We are both under company review. This man is a menace to aviation and an accident waiting to happen.*[5]

Two additional examples come from the U.S. Federal Aviation Regulations Part 135 charter domain in which toxic captains created an extremely hazardous flight deck environment. In the first example, the captain slapped the headset off the first officer's head while the first officer was flying an approach. The captain was reacting to the new first officer having trouble maintaining the proper approach speed. In the second example, the captain lashed out at the first officer for the duration of a four-hour flight because, according to the captain, the first officer "could not do anything right." During the entire trip, the first officer was subjected to harsh criticism about his flying skills and other negative comments. So bad was the climate in the cockpit that after they landed and stepped out of the aircraft, the first officer punched the captain in the face. The captain then struck back, and a full-fledged altercation ensued. Both pilots spent the night in jail.

I knew both of these first officers. While, at the time, they were both new and inexperienced, there is never justification for a captain to treat a first officer so disrespectfully. Yet, this type of toxic behavior seems to be more ubiquitous in aviation than many realize.

Hiding in Plain Sight

The fundamental question is why are these toxic captains, who pose a significant safety risk, allowed to fly for a commercial operator? They typically are not concealed in the system. They are usually well known to other flight crewmembers and to flight attendants. They may even have documented deficiencies that have been ignored by the airline, as with the Flight 507 captain.

The captain slapped the headset off the first officer's head while the first officer was flying an approach.

Reasons may exist at the organizational level or at the individual level. The following are examples from the organizational aspect:

- It could be one of the unusual cases in which the airline is unaware of the toxic captain.
- The organization has, perhaps tacitly, recognized the captain's behavior but believes it is a personality issue rather than a safety risk.
- The organization is fully aware, by virtue of safety reports and deficiencies documented in training records, that the captain may be a safety risk. However, the organization feels that the safety risk is minimal and not worth the effort to mitigate.
- The managers responsible, at the organizational level, for addressing technical and behavioral deficiencies in flight crews do not want an awkward confrontation with a captain, perhaps very senior, who has been with the airline for decades. In my opinion, that was at least partially the case with the Flight 507 captain. There was a lack of assertiveness, or the ability to speak up to the captain, from the instructor level up to and including upper-level management. All of this was exacerbated by Kenya's "high power distance" culture, in which citizens tend to accept authoritarianism in employee-to-employer relations.[6]

Some factors at the individual level are these:

- Above all, the captain may not acknowledge that he or she has a problem. Many captains believe that the other crewmembers are the source of cockpit strife.
- Some of the captain's arrogance and egotism may actually be a coping mechanism used to ameliorate personal insecurities. The captain may feel more in control of situations by making other crewmembers feel weak.
- Captains from a military background, where strong hierarchical gradients and clear positions of power are standard, may have difficulties adapting to their new environment. It is hard for some captains to fully assimilate into civil aviation, where effective leadership styles may be diametrically opposed to those used in the military.
- Related to the above, the captain may not buy into CRM principles and the teamwork concept. He or she may believe that CRM is only for weak pilots and that CRM is psychobabble with the sole purpose of making crewmembers enjoy each other's company on a long trip.

Remediation or Termination?

An airline has basically two options for taking a proactive position toward the toxic captain. The first option is *remediation,* or an attempt by the airline to confront the captain and apply some kind of intervention. The second option is *termination*, which may be appropriate; however, there may be union issues that complicate this option. Termination may also mean that the captain simply goes to another airline and continues to be a safety risk.

Remediation of a toxic captain is the preferred option. However, this can be difficult. It is extremely hard to change ways of doing things when they have been done that way for a long time. It is also very difficult to try to change someone's ingrained psychological traits and attributes. In many cases, remediation may be out of the question. Some of those vitriolic personality traits may never be reversible.

That brings us to the second option for resolution of the toxic captain, termination of employment. This can be a very awkward, uncomfortable undertaking by the airline. However, in some cases, where remediation has been, or would be, ineffective, this may be the only viable option. At the time of the Flight 507 accident, the captain clearly should not have been in command of a commercial aircraft with responsibility for 114 lives, including his own. All perished in that accident.

I recommend that all flight operations take the toxic captain issue seriously. There are typically red flags and incidents that precede far more serious events. If not considered part an operation's safety management system (SMS), this type of aberrant behavior undoubtedly needs to be addressed in the safety risk management section of the operator's SMS. If Kenya Airways had approached this differently, the outcome of Flight 507 might have been different.

Do you have a toxic captain in your flight operation?

Robert I. Baron, Ph.D., is the president and chief consultant of The Aviation Consulting Group. He has more than 23 years of experience in the aviation industry and is an adjunct professor at Embry-Riddle Aeronautical University and Everglades University.

Notes

1. Cameroon Civil Aviation Authority (n.d.). *Technical Investigation Into the Accident of Kenya Airways B737-800*, p. 57.
2. Lacagnina, M. "Beyond Redemption: Spatial Disorientation Turned a Minor Upset Into a Major Accident." *AeroSafety World* 5(7), 24–27. August 2010.
3. Ibid.
4. Edwards, E. "Stress and the Airline Pilot." In *BALPA Medical Symposium.* London, 1975.
5. NASA ASRS Accession no. 603942.
6. Hofstede, G. *Cultural Dimensions.* ITIM International, 2009.

Voluntary Revelations

© Chris Sorensen Photography

Air Traffic Safety Action Program reports boost the quantity and quality of NASA's ASRS database content.

BY WAYNE ROSENKRANS

The Air Traffic Safety Action Program (ATSAP) in the United States has generated a far higher volume of voluntary safety reports from air traffic controllers[1] compared with this work group's historic reporting, new data show. Officials of the Aviation Safety Reporting System (ASRS) say that the candor, details and other subjective attributes of ATSAP report quality also have improved significantly since ASRS began processing copies of these reports on Nov. 12, 2009.

Before ATSAP was launched, ASRS — the 36-year-old program funded by the U.S. Federal Aviation Administration (FAA) and administered by the National Aeronautics and Space Administration (NASA) Ames Research Center — had been the only independent U.S. program to directly receive such reports from controllers.

Controller reports in 2010 and 2011 jumped from about 1 percent of the previous total annual ASRS intake of reports to about 10 percent, says Linda Connell, program director, NASA ASRS.

Direct intake of reports by ASRS from controllers about their errors, safety events and concerns now is much lower than in the past (Figure 1). "There is still some flow [of non-duplicative controller reports in 2012] that does not come through the ATSAP mechanism," Connell said. "We never know whether those controllers still are not aware of ATSAP, or they don't want to talk about a certain issue through that mechanism." Direct reports assure the information is still obtained, she added.

ATSAP operates under a relatively new model, labor agreement and FAA policy, with different rules for the confidential and non-punitive treatment of reports accepted, investigated and resolved by local event review committees (ERCs).

Under the ASRS model, NASA reads and triages all reports within three days (typically 1.14 days in 2012). If the report fits ASRS acceptance criteria, the controller who filed the report receives specified protections against FAA disciplinary action, except when events involve criminal activities or accidents.

"In our mission, we stay away from enforcement or corrective action or follow-up," Connell said. "To the best of our abilities, we provide information that is relevant for somebody else to look at and move forward. If we look at a pilot-initiated report and match it to an ATSAP report about the same event, we can ask, 'Why did this happen?' … with rich information to begin to untangle the answer. If people only work with 'stove-piped' information, they [risk making] decisions about the cause in isolation, in a vacuum."

From 2001 through 2011, ASRS intake included 25,293 direct-to-ASRS and ATSAP reports from controllers, she said. Of these, 17,216 (68 percent) were ATSAP reports — all received near the end of 2009, in 2010 and in 2011.

Over the 10-year period, the direct-to-ASRS reports totaled 8,077 (32 percent of all controller reports), with the lowest number, 56, in 2011 and the highest number, 1,689, in 2006. Following the transitional year of 2009, the annual total of ATSAP reports reached 8,474 in 2010. In 2011, the program received 7,826 ATSAP reports.

ASRS analysts assign "reported anomaly" types at the intake stage for both ATSAP and direct-to-ASRS reports, said Charles Drew, ASRS program manager for Booz Allen Hamilton, a NASA contractor. These categories are not mutually exclusive.

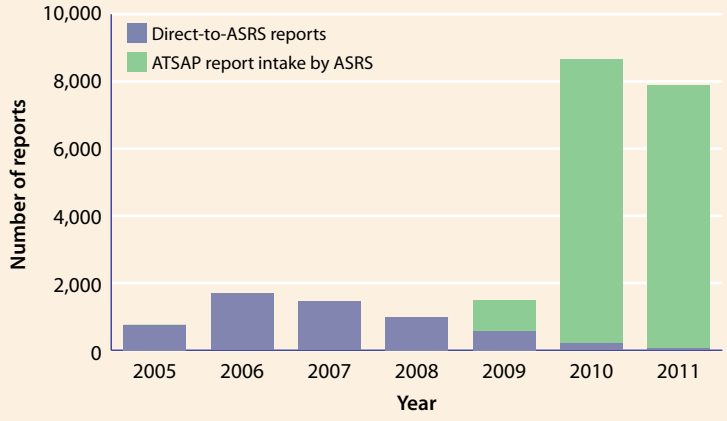
In 2011, the predominant categories — those to which more than 10 percent of reports were assigned — were "ATC issue–all types" (84.7 percent), "deviation–procedural/published material/policy" (62.2 percent), "airspace violation–all types" (20.5 percent), "deviation–procedural/clearance" (18.3 percent) and "conflict–airborne conflict" (14.6 percent).

ASRS keeps a subset of data, excluding the narrative, from every report received (219,092 in 2008–2011) in its internal screening dataset. Analysts then subjectively select a subset of all reports for the Full Form Database accessible online to the public (an estimated 22 percent were controller reports in 2008–2011, compared with 13 percent from all work groups).

To read an enhanced version of this story, go to <flightsafety.org/aerosafety-world-magazine/march-2012/atsap-asrs>.

1. This article refers only to *controllers* but the FAA's policy applies to "all ATO [Air Traffic Organization] personnel directly engaged in and/or supporting air traffic services and only to events that occur while acting in that capacity."

FAA Controllers[1] Accelerate Voluntary Safety Reporting



ASRS = Aviation Safety Reporting System; ATSAP = Air Traffic Safety Action Program; FAA = U.S. Federal Aviation Administration

Note:

1. The FAA policy on voluntary, non-punitive safety reports to ATSAP applies to "all ATO [Air Traffic Organization] personnel directly engaged in and/or supporting air traffic services and only to events that occur while acting in that capacity."

Source: Ames Research Center, U.S. National Aeronautics and Space Administration

Figure 1

NTSB cites pilot determination to return to home base in connection with two fatal EMS helicopter crashes in 2010.

Heading for Home

BY LINDA WERFELMAN

The U.S. National Transportation Safety Board (NTSB) has cited the pilot's decision to fly into instrument meteorological conditions (IMC) as the probable cause of two fatal crashes in late 2009 and early 2010 of emergency medical services (EMS) helicopters.

Each crash killed all three people aboard — the pilot and two aeromedical personnel — and each involved a Eurocopter AS350. The NTSB issued final reports on both accidents in mid-January.

The first of the two crashes occurred at 2331 local time on Sept. 25, 2009, 1.92 nm (3.6 km) southwest of Georgetown County Airport in Georgetown, South Carolina.

The multi-leg operation began about 2023 when the helicopter left Conway–Horry County Airport (HYW) in Conway to pick up a patient from Georgetown Memorial Hospital for transfer to the Medical University of South Carolina in Charleston (MUSC). After the transfer was completed, the helicopter was flown to Charleston Air Force Base/International Airport for refueling. At 2302, the pilot told MUSC flight control that he was leaving Charleston for HYW with a flight nurse and flight paramedic aboard; at 2316, he said he was flying at 110 kt and 1,000 ft above mean sea level (MSL) and that he expected to arrive at HYW in 29 minutes.

A routine flight update was due 15 minutes later, but there were no further communications

Eurocopter AS350

The Eurocopter AS350 is a light five/six-seat utility helicopter first flown in 1974.

The first versions to be marketed were AS350 Bs, with either Avco Lycoming or Turbomeca Arriel turboshaft engines. The AS350 B2s, with uprated engines and transmissions, were certified in 1989; the B3s, with digital engine controls, were first flown in 1997.

Both models have a maximum takeoff weight of 4,960 lb (2,250 kg). Maximum cruising speed at sea level is 134 kt for the AS350 B2 and 140 kt for the B3, and maximum rate of climb at sea level is 1,752 fpm for the B2 and 2,028 fpm for the B3. Range at recommended cruising speed with maximum fuel is 362 nm (670 km) for the B2, and 352 nm (652 km) for the B3.

Source: *Jane's All the World's Aircraft*

from the helicopter, and MUSC flight control activated the emergency action plan. Sheriff's deputies located the wreckage about 0206 on Sept. 26.

The 45-year-old commercial pilot had reported two months earlier that he had 4,600 flight hours, including 3,736 hours as a naval aviator in the U.S. Marine Corps. He had ratings for single- and multi-engine airplane, rotorcraft helicopter, instrument airplane and instrument helicopter, and a second-class medical certificate.

Although he had experience in IMC, he was no longer instrument current and was not required to be, because the operator — Omniflight Helicopters, doing business as Carolina Life Care — conducted its AS350 B2 operations under visual flight rules. In his last U.S. Federal Aviation Regulations Part 135 competency/proficiency check, conducted in December 2008, he "satisfactorily demonstrated inadvertent IMC recovery," the NTSB said in its final report on the accident.

The pilot had worked the day shift, from 0800 to 2000, from Sept. 22–24 and switched to the night shift, from 2000 to 0800 on the day of the accident.

The helicopter was manufactured in 2000. It had 2,967 total hours of operation on Sept. 17, when its last 500-hour inspection was completed. Although it was not approved by the U.S. Federal Aviation Administration (FAA) for operations in IMC, it was equipped with instruments to operate in case of inadvertent entry into IMC. However, it did not have on-board weather radar, a night vision imaging system, an autopilot or a helicopter terrain awareness and warning system.

Omniflight's operations manual said that the pilot-in-command was responsible for obtaining weather information before any series of flights, and Omniflight pilots told accident investigators that they routinely obtained the information from a base computer at the beginning of each shift and advised the Omniflight Operations Center (OCC) of conditions during their flights. They also called the OCC before beginning a series of flights.

Accident investigators did not recover the weather data that the pilot obtained before the accident flight, but actual weather conditions reported by the pilot, as well as information associated with the operations center's approval of the flights, indicated that visual meteorological conditions had prevailed when the operation began and during the early portion of the flight.

When the operations coordinator spoke with an MUSC communications specialist at 2242, the coordinator said that if the pilot called OCC before takeoff from Charleston, they could review the weather for the return flight. The pilot did not call, and OCC did not contact him, the report said.

The Omniflight base manager at Savannah, Georgia, who also was operating a helicopter in South Carolina the night of the accident, said

that, although the weather was deteriorating, the forecast called for it to remain "well above minimums" for his return to MUSC. He said he spoke with the accident pilot, who warned him about "bad thunderstorms" near Georgetown and expressed concern that he might not be able to return that night to his base at HYW.

Witnesses who saw the helicopter shortly before the accident said it was flying northbound toward the Georgetown airport about 1,000 ft above ground level (AGL) in moderate to heavy rain, "with its searchlight turning on and off," the report said.

"Although the pilot encountered an area of deteriorating weather and IMC, this did not have to occur, as the pilot did not have to enter the weather and could have returned to Charleston Air Force Base/International Airport or landed at an alternate location," the report said. "The pilot, however, chose to enter the area of weather, despite the availability of safer options.

"Based on the pilot's statement to the Savannah-based pilot regarding bad thunderstorms in the area, he was aware of the weather and still chose to fly into it. In addition, the pilot's inability to maintain a steady state cruise altitude during the flight and the declining altitude throughout the flight likely reflected his attempt to stay below the cloud level. These cues should have indicated to the pilot that it was not safe to continue flight into IMC. This decision-making error played an important causal role in the accident."

In its final report on the accident, the NTSB noted two safety recommendations it had issued after previous crashes.

One, issued in February 2006, called on the FAA to require EMS operators to use "formalized dispatch and flight-following procedures that include up-to-date weather information and assistance in flight risk-assessment decisions." The FAA responded with a pending notice of proposed rulemaking.

The second safety recommendation, issued in September 2009, asked the FAA to require that EMS helicopters be equipped with autopilots and that pilots be trained to use them when flying without a copilot. The FAA said it would study the "feasibility and safety consequences" of requiring either an autopilot or a second pilot.

'Beat the Storm'

The second crash occurred at the end of the pilot's 12-hour overnight shift at 0600 local time March 25, 2010, near Brownsville, Tennessee. He had dropped off a patient at a hospital helipad in Jackson at 0534, and called the flight-following center MedCom and the company pilot whose shift began at 0530 — both times to ask about weather conditions, including a nearby storm system.

He told the other pilot that he was waiting on the helipad for the flight nurses to return and that he "wanted to get the helicopter out" and return to Haywood County EMS Heliport in Brownsville. The other pilot said that he checked a computer-based radar weather depiction and saw a front about 65 mi (105 km) southwest and approaching the heliport at 25 mph 40 kph).

The accident pilot told the other pilot that he believed he had "about 18 minutes to beat the storm and return to home base, so he was going to leave the flight nurses behind and bring the helicopter back," the report said.

The accident pilot ... believed he had 'about 18 minutes to beat the storm and return to home base.'

The helicopter took off from the helipad about 0551. Both flight nurses had arrived in time to board. Satellite-recorded data showed that the helicopter was flown about 1,000 ft MSL for most of the flight segment; the last recorded altitude was 752 ft MSL (about 350 ft AGL), with the helicopter flying at 105 mph (91 kt).

Arrival in 30 Seconds

After their conversation, the other pilot again checked weather radar and saw that the line of thunderstorms was about 18 mi (29 km) from the helicopter's base. When he went outside, he could not see the helicopter and telephoned one of the flight nurses, who told him that they "had the weather beat" and would arrive at the heliport in about 30 seconds.

"At the time of the conversation, the oncoming [other] pilot observed that it was raining lightly but that the wind had picked up, perhaps to about 20 kt," the report said. "Then, just after hanging up, he heard an 'immediate' loud clap of thunder and saw lightning that made him jump. He looked out, saw no helicopter and tried to call the nurse without success. He then called MedCom and ran up the hill to contact the ambulance service located there."

Rescuers found the helicopter in a field about 2.5 mi (4.0 km) east of the helicopter's base.

The pilot, 58, had a commercial pilot certificate with ratings for single-engine and multiengine land airplanes, rotorcraft helicopter, instrument airplane and instrument helicopter. He had about 4,000 flight hours in March 2009, when he received his second-class medical certificate; records indicated he had about 2,615 hours of helicopter flight time.

'The pilot made a risky decision to attempt to outrun the storm in night conditions.'

He completed his most recent airman competency/proficiency check in August 2009 and his most recent instrument competency check in February 2010.

The day before the accident, the pilot had flown 0.4 hour at night. The previous day, he had flown 0.2 hour during the day, 0.2 hour at night without night vision goggles (NVGs) and 0.5 hour at night with NVGs. He had been off duty the previous day.

The helicopter was an AS350 B3, manufactured in 2008 and delivered to the operator — Memphis Medical Center Air Ambulance Service, doing business as Hospital Wing — in May 2009; it had accumulated 248 hours total time, and the most recent 200-hour and annual inspections were performed March 1, 2010. It was equipped with NVGs and NVG-compatible lighting, an autopilot and an enhanced ground proximity warning system.

The accident investigation revealed no sign of pre-impact problems with the helicopter.

Line of Storms

Weather radar showed that, about the time of the accident, a line of thunderstorms was moving through an area that included the accident site. Radar showed IMC, heavy rain, lightning and wind gusts of up to 20 kt; the area immediately in front of the system would have been prone to extreme low-level wind shear, the report said.

Witnesses reported lightning and thunder near the accident site, along with high winds and bands of heavy rain. Information from two organizations that gathered lightning-strike data showed a number of lightning strikes from 0545 and 0615 but none within 90 seconds of the accident.

At the time of the accident, Hospital Wing used a formal risk assessment program that called for an evaluation, at the beginning of a pilot's duty time, of a number of risks, including low pilot experience, inoperative aircraft equipment, poor weather and lack of night lighting. Numerical values were assigned in each area, and higher numbers indicated higher risks; a score of more than 14 meant the flight could not be conducted. The evaluation allowed for subtraction of points in acknowledgment of high levels of pilot experience, use of NVGs and other factors.

The accident pilot calculated a total risk of "3"; two points had been subtracted for pilot experience and NVG use.

The NTSB said that the encounter with deteriorating weather conditions "did not have to occur, as the pilot could have chosen to stay at the hospital helipad. … The pilot made a risky decision to attempt to outrun the storm in night conditions. … This decision-making error played an important causal role in the accident."

The report added that although the accident occurred near the end of a 12-hour overnight duty shift, accident investigators lacked complete information about the pilot's sleep and rest activities and could not determine whether fatigue contributed to his "faulty decision to attempt to outrun the storm."

This article is based on NTSB accident reports ERA-09FA537 and ERA10MA188 and accompanying documents.

BY RICK DARBY

Drawing the Line

A line operations safety audit at IranAir pinpoints safety issues and leads to solutions.

Data collected through the line operations safety audit (LOSA) process "have shown that the source of a large number of errors is the lack of efficient training" and that LOSA represents "the best information to improve training systems, crew resource management and flight proficiency checks, and to refine standard operating procedures," according to Roohollah Khoshkhoo, one of the authors of a paper presented at the 64th annual International Air Safety Seminar, held in Singapore in November 2011.[1] A flight safety and operations quality expert at IranAir, he described the first LOSA conducted at the airline in 2009, its operational findings and their application to crew training for threat and error management. A second LOSA was conducted to determine the improvement since the first.

The authors compared LOSA with other proactive safety programs, quick access recorder (QAR)/flight data recorder (FDR) analysis and line checks. "QAR/FDR [analysis] cannot identify human behavior or flight crew performance and environmental context; it also has a high cost-to-efficiency ratio," they said. "The other method is the line check to evaluate pilots' performance, and it can be punitive for pilots who fail. Therefore, pilots are under high pressure to fake qualification and capability. LOSA is non-jeopardy assurance for pilots. It avoids the weaknesses of the two other methods. LOSA is different from and complementary to other proactive safety programs."

The authors said, however, that LOSA is only a tool for collecting data, not itself a solution: "After LOSA data collection, the organization must analyze the data, find problems to investigate and react in ways that improve safety."

In the first LOSA, observed data were collected during three months. Following that, a LOSA steering committee checked the data and input them to analytical software. Based on the analysis, the committee devised goals for improving crews' ability to counter threats and avoid errors.

Threats are "uncontrollable external conditions for the flight crew and must be managed by them," the authors said. They are of two types — expected and unexpected. "Expected threats, like thunderstorms, can be anticipated by the flight crew," they said. "Unexpected threats, such as cargo loading error by ground staff, occur suddenly. The flight crew has no advance warning."

Errors are "crew actions that lead to a deviation from crew or organizational intentions or expectations." They come in three varieties: spontaneous; linked to threats; and an error chain that causes further errors. "Many errors are managed, but the others lead to another error or undesired aircraft state (UAS), possibly culminating in an accident," the authors said. UASs are either aircraft deviations or incorrect configuration.

"Threats must be recognized at the best time, because after an accident or incident it's too late to investigate threats," they said. "On the other hand, by LOSA most threats can be proactively identified."

At the time of the first LOSA, IranAir had mixed aircraft fleets including Boeing 727s and 747s, Airbus A300s, A310s and A320s, and Fokker 100s. "LOSA was undertaken on all fleets both on short-haul domestic and medium-haul international routes," the authors said. A minimum of 10 LOSA observations for each fleet were obtained in both the first and second LOSAs (Table 1).

In the first LOSA, 73 percent of flights involved at least one threat, with an average of 2.19 threats per flight. The greatest number of threats on one flight was seven.

Half the threats occurred during the preflight/taxi phase, the highest percentage (Table 2). In descending order of percentage, other threats occurred in descent/approach/

IranAir Weekly Departures During LOSA Observations

Fleet	Number of Departures	Percentage of Flights	Number of Observations, First LOSA	Number of Observations, Second LOSA
Boeing 747	34	8.59	11	10
Airbus A310	47	11.9	15	15
Airbus A300	67	16.92	21	21
Airbus A320	22	5.5	10	10
Boeing 727	27	6.82	10	10
Fokker 100	199	50.26	65	60
Total	396	100[1]	132	126

LOSA = line operations safety audit

Note:

1. Individual percentages do not equal 100 because of rounding.

Source: Roohollah Khoshkhoo et al., IranAir

Table 1

Threats in IranAir First LOSA, by Phase of Flight

Phase of Flight	Percentage of Threats
Preflight/taxi	50
Takeoff/climb	15
Cruise	8
Descent/approach/landing	19
Taxi/parking	8

LOSA = line operations safety audit

Source: Roohollah Khoshkhoo et al., IranAir

Table 2

Threats in IranAir First LOSA, by Type

Threat Type	Percentage of Threats
Environmental	**35**
Adverse weather	11.5
Air traffic control	11.5
Other	12.0
Airline	**65**
Aircraft malfunction/MEL	30.7
Ground maintenance	14.0
Dispatch/paperwork	4.4
Other	15.9

LOSA = line operations safety audit; MEL = minimum equipment list

Source: Roohollah Khoshkhoo et al., IranAir

Table 3

Errors in IranAir First LOSA	
Percentage of flights with at least one error	94
Average number of errors per flight	5.71
Most errors on one flight	20
Total number of errors	754

LOSA = line operations safety audit

Source: Roohollah Khoshkhoo et al., IranAir

Table 4

Errors in IranAir First LOSA, by Phase of Flight	
Phase of Flight	**Percentage of Errors**
Preflight/taxi	31.0
Takeoff/climb	9.0
Cruise	14.0
Descent/approach/landing	26.5
Taxi/parking	9.5

LOSA = line operations safety audit

Note: This assignment of error to phase of flight represents 90 percent of errors.

Source: Roohollah Khoshkhoo et al., IranAir

Table 5

Error Types and Outcomes in IranAir First and Second LOSAs		
Error Type	**Percentage of flight segments with at least one error, first LOSA**	**Percentage of flight segments with at least one error, second LOSA**
Technical error		
SOP cross-verification	59.0	20
Briefing	36.5	12
Sterile cockpit	23.0	15
Checklist	17.0	9
Manual flying	15.0	9
Standard callout	11.5	7
Unstable approach	11.5	5
Non-technical error		
Crew-to-crew communication	46.0	30

LOSA = line operations safety audit; SOP = standard operating procedure

Source: Roohollah Khoshkhoo et al., IranAir

Table 6

landing, takeoff/climb and cruise, which was equal to taxi/parking.

Threat types in the first LOSA were analyzed according to whether they were associated with the environment or the airline (Table 3). About one-third were environmental; two-thirds were airline-associated threats. Environmental threats were more or less equally divided among adverse weather, air traffic control and "other." Airline-related threats were most often associated with aircraft malfunction or the minimum equipment list.

The first LOSA identified one or more flight crew errors on 94 percent of flights (Table 4), with as many as 20 errors on a single flight.

"It is obvious that the preflight/taxi-out and then descent/approach/landing phases [had] the most errors," the authors said (Table 5).

"Based on the first LOSA results to detect threats and errors, some changes were made for improving and enhancing operational performance and training objectives," the authors said. "[Changes were made] in standard operating procedures (SOPs) in some fleets, [and] stabilized approach and sterile cockpit policies in the operations manual. Considering the first LOSA results, related memos were sent to pilots of each fleet. Finally, useful changes were made in initial and recurrent training course syllabi, especially crew resource management and human factors."

The changes generated as a result of the first LOSA paid off in the results of the second LOSA (Table 6). Errors were categorized into technical and non-technical types, with subcategories of each. In every subcategory, the second LOSA showed improvement.

"The most frequent type of technical errors [was] SOP cross-verification, followed by briefing," the authors said. "The most frequent type of non-technical error [was] crew-to-crew communication."

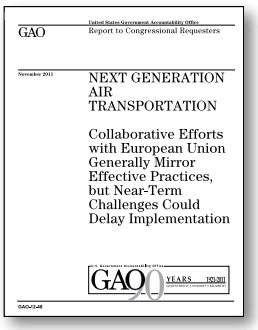
Notes

1. Khoshkhoo, R.; Goodarzi, F.; Sharafbafi, F. "Evaluation and Enhancing of Operational Performance and Training Objective in Accordance with Line Operations Safety Audit (LOSA)." *Proceedings of the 64th annual International Air Safety Seminar.* Flight Safety Foundation, November 2011.

Harmonic Convergence

The United States is collaborating with Europe on ATC modernization, but some industry skepticism remains.

BY RICK DARBY



REPORTS

Interoperability Is the Goal

Next Generation Air Transportation: Collaborative Efforts with European Union Generally Mirror Effective Practices, but Near-Term Challenges Could Delay Implementation

U.S. Government Accountability Office (GAO). GAO-12-48. Tables, figures, appendixes. November 2011. Available at <www.gao.gov/products/GAO-12-48>.

The United States and the European Union (EU) are working simultaneously on major overhauls of their air traffic control (ATC) systems, involving transition from radar-based surveillance and control to satellite-based systems. While the changes are similar, they are being carried out under separate programs: the Next Generation Air Transportation System (NextGen) in the United States and the Single European Sky Air Traffic Management Research (SESAR) program in Europe.

Hundreds of flights travel from the United States to Europe and vice versa every day, so it is important on operational — and safety — grounds that the two ATC systems be compatible for seamless transitions between U.S. and European airspace.

"FAA's [the U.S. Federal Aviation Administration's] efforts toward interoperability generally mirror effective collaborative practices, but mitigating stakeholder skepticism about NextGen/SESAR benefits will nevertheless be a challenge," the report says.

In 2006, the FAA and the European Commission signed a memorandum of understanding that led to joint meetings and interactive research. In 2011, the FAA and the EU signed a memorandum of cooperation (MOC) that formalized a "collaborative structure" for NextGen and SESAR.

This report discusses "the efforts that FAA has taken to ensure the interoperability of NextGen with SESAR and how those efforts compare with effective interagency collaboration practices." In its research, the GAO reviewed the agreements between the United States and the EU. The organization studied the academic literature about effective collaboration and "key practices that [the GAO has] previously identified in effective interagency collaborations." The GAO interviewed FAA and EU officials involved in the ATC upgrades.

Differences in how NextGen and SESAR are implemented reflect political and cultural differences between the United States and the EU. "Whereas the United States manages aviation at the federal level, the EU, with its 27 sovereign member states, and their individual regulators and service providers, must consider interoperability among its member states, as well as with NextGen," the report says. Further, NextGen and SESAR differ in management structure. NextGen is "government-centric, [with] input solicited from industry." SESAR

is "a public-private partnership, where EU government agencies and private sector entities have management roles."

"SJU [the SESAR Joint Undertaking], made up of Eurocontrol, the European Commission and 15 member organizations — including airport operators, air navigation service providers, manufacturers of ground and aerospace equipment, and aircraft manufacturers — is managing the development phase and following the master plan," the report says.

The report says that the GAO has previously identified practices that can help enhance and sustain collaborative work among U.S. agencies, which can be reasonably expected to apply to international collaboration. Some of these practices are "defining and articulating a common outcome; establishing mutually reinforcing or joint strategies to achieve the outcome and establishing compatible procedures; agreeing upon respective roles and responsibilities; [and] reinforcing individual accountability for collaborative efforts through agency performance management systems."

The trans-Atlantic connection appears to be following the proven practices, the GAO says.

"FAA and SJU officials we interviewed, as well as industry stakeholders representing organized labor, airlines, and airframe and aerospace equipment manufacturing companies, generally agreed that the 2011 MOC is a positive development toward ensuring the interoperability of NextGen and SESAR and establishes a means for FAA and SJU to operate across agency boundaries," the report says. Another promising development is that "the 2011 MOC and related documents define FAA and SJU roles and responsibilities."

In addition, "FAA's performance management system is designed to incorporate all of the responsibilities and duties of each staff member, according to FAA officials we interviewed."

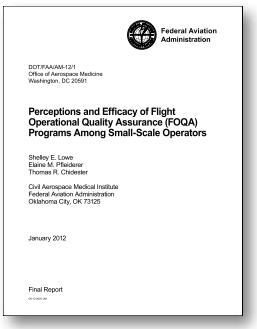
Nevertheless, some stakeholders remain partially in the dark. The report says, "FAA has not externally reported its collaborative efforts with EU entities in public documents, such as its strategic plan or performance and accountability reports. … Stakeholders representing U.S. airlines, the U.S. aviation industry and European avionics manufacturers told us that they were aware that work was progressing to ensure the interoperability of systems, but they were not aware of specific details. For example, stakeholders in the aerospace equipment industry expressed concerns about the differences in NextGen and SESAR's data comm [data communications] implementation timelines but could not say whether the collaborative structure of the 2011 MOC could help resolve these differences, because they were not familiar with the details of the MOC's structure and governance."

The lack of complete transparency about particulars of the collaboration has reinforced latent doubts about NextGen and SESAR benefits, the report says: "Some stakeholders we interviewed on both sides of the Atlantic expressed skepticism about whether or when the future benefits of NextGen and SESAR will be realized, echoing concerns that have been raised in the past. We have reported on stakeholder concerns about FAA's not following through with its NextGen efforts, which made some airlines hesitant to invest in new equipment.

"This hesitancy arose after an airline equipped some of its aircraft with a then-new data comm system, but because of funding cuts, among other things, FAA canceled the program, and the airline could not use the system. … In Europe, an air navigation service provider representative said that experiences such as FAA's canceling the earlier data comm program have led airlines to take a cynical view of promised benefits."

The airlines' "show me" attitude results in their hesitancy to equip their airplanes with NextGen/SESAR technologies because "some of the key benefits, such as increased capacity and more direct, fuel-saving routing, will not be realized until a critical mass of equipped aircraft exists," the report says. There will be no first-mover advantage. "It is difficult for an airline to make a business case showing that the

The trans-Atlantic connection appears to be following proven practices, the GAO says.



near-term benefits of equipping [their airplanes] will outweigh the cost," the report says.

Influencing the unpredictability of NextGen/SESAR harmonization are possible FAA budget cuts, according to the report, which cites already-existing restrictions on travel for meetings. "To reduce travel costs, action plan teams have endeavored to schedule their meetings to coincide with other meetings, and officials are making use of technological substitutes for travel," the report says. "However, a Eurocontrol official said that he does not consider these virtual meetings to be as effective as face-to-face interactions, and an official representing European air navigation service providers told us that overuse of this technology could impede harmonization and result in higher costs over the long run."

The 2011 MOC is still in the early stages of implementation. "Because the components of the MOC have not yet been put into action, we were unable to judge its effectiveness in facilitating collaboration toward interoperability," the report says. "The real test of the MOC's effectiveness will come when NextGen and SESAR move toward final decisions about implementing solutions and system components. In the past, FAA and Europe jointly developed systems that were either not implemented or were implemented differently by each side … . The structure of the 2011 MOC is designed to prevent such results in the future. However, the absence of effective collaborative practices does not guarantee failure, nor does their presence ensure success."

In its conclusion, the report recommends that the FAA provide the industry with more specific information about its efforts and the provisions of the MOC. "These details could allow stakeholders to judge for themselves whether interoperability efforts are moving ahead deliberately, as planned, and provide assurance that FAA is serious about collaborating on interoperability and implementing NextGen." It reiterated an earlier recommendation that FAA provide current information about how budget decisions will affect the progress of NextGen.

FOQA Writ Small

Perceptions and Efficacy of Flight Operational Quality Assurance (FOQA) Programs Among Small-Scale Operators

Lowe, Shelley E.; Pfleiderer, Elaine M.; Chidester, Thomas R. U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute. DOT/FAA/AM-12/1. January 2012. 22 pp. Tables, figures, references.

"Despite safety and economic advantages, as well as endorsements by the International Civil Aviation Organization, the FAA, the National Transportation Safety Board and Congress, not all U.S. operators have chosen to participate in FOQA programs," the report says. "Participation in FOQA is particularly low among small operators." A recent report by the U.S. Government Accountability Office (GAO) said that the majority of U.S. Federal Aviation Regulations Part 121 flights are currently operated by airlines with FAA-approved FOQA programs, but only 17 percent of smaller carriers have them.

The report cites the Flight Safety Foundation (FSF) FOQA task force's efforts to identify issues that might discourage FOQA adoption among operators. "Recognizing that data security was critical, a special working group was created from within the FOQA task force to concentrate on these issues," the report says. "The working group identified two main areas of concern: that data in the possession of the federal government could be released in response to Freedom of Information Act requests or through civil litigation, and that information from FOQA data could be used in enforcement or disciplinary actions against pilots."

Since FOQA's early days, "the combined efforts of the FAA and the airline industry have produced procedural guidelines for protecting FOQA data and engendering trust in the program," the report says. Nevertheless, "according to [the GAO] report, pilots' concern about data misuse continues to be one of the primary factors that prevent their participation in voluntary safety programs. … Considered in conjunction with pilots' attitudes and pressure from pilot unions, airlines might find it difficult to justify the cost of implementing and maintaining a FOQA program if they are dubious about its

benefits or concerned about its risks. Increased FOQA participation among small-scale air carriers might depend on demonstrating that significant safety benefits can be gained, and positive perceptions of the program sustained, with minimal cost to the operator."

The report describes two experiments about FOQA in connection with small-scale flight operations:

- "Experiment 1 evaluates pilots' perceptions of a FOQA program maintained by a small-scale government operator. The [FAA] Office of Aviation System Standards (AJW) employs approximately 180 pilots and operates within strict budgetary constraints. As such, this organization faces many of the same challenges as comparable small-scale commercial operators. The FOQA program at AJW has been fully operational since 2006, and so pilots' experience and attitudes about FOQA should be well developed in this group."

- "Experiment 2 examines operational efficacy using time series analysis. Trends suggesting improved pilot performance may simply be a function of monitoring alone, or might represent a natural progression over the course of time. Time series analysis removes systematic trends so the actual effects of interventions may be evaluated. Time series analysis of FOQA event rates should determine whether quarterly reports providing feedback to pilots (a cost-effective intervention method) can produce significant safety benefits."

In experiment 1, the researchers used a previously validated survey instrument called the Perceptions of Flight Operations Quality Assurance Questionnaire (PFOQA). "Questionnaire items were based on the concerns and recommendations proposed by the FSF FOQA task force created to identify issues that might hinder or prevent the implementation of FOQA programs in this country," the report says. Included in the PFOQA were 16 items in which the respondent chose a number on a scale representing agreement or disagreement with a statement. In this experiment, statements of both positive and negative attitudes toward FOQA were included — for example, "I expect FOQA data to be used to take action to correct safety problems" and "I worry that FOQA data will be used for disciplinary actions."

"Disappointingly, approximately 83 percent of the pilots with high negative perceptions scale scores (45 percent of the total sample) worried that FOQA data will be used for enforcement actions," the report says. "This is an area where the FAA has perhaps taken its strongest stand and for which an industry history of honoring those protections has been clearly demonstrated. This signals that the issue is so important that organizations should strive to consistently remind pilots of regulatory protections and make sure that every demonstration of compliance is communicated to them."

Experiment 2 involved feedback reports to AJW pilots based on FOQA data. Analysis found that these "interventions" were correlated with reductions in the rate of exceedances — in which aircraft are operated beyond established normal parameters.

"The overwhelming reduction trend in exceedance rates of these events over the course of the time series was impressive," the report says. "Simply by measuring selected flight parameters, informing pilots what had been observed, explaining why exceedances represented an unacceptable risk, and recommending strategies for avoiding these circumstances, AJW pilots were able to profoundly and quickly reduce the frequency of these events. This is remarkable because it only required measurement and feedback (i.e., issues endorsed by pilots in the positive perceptions scale). It did *not* require identification of individual pilots, disciplinary action or public disclosure of findings (i.e., concerns reported by pilots on the negative perceptions scale) to bring about this change. This accomplishment should motivate other small operators to consider FOQA programs."

'The issue is so important that organizations should strive to consistently remind pilots of regulatory protections.'

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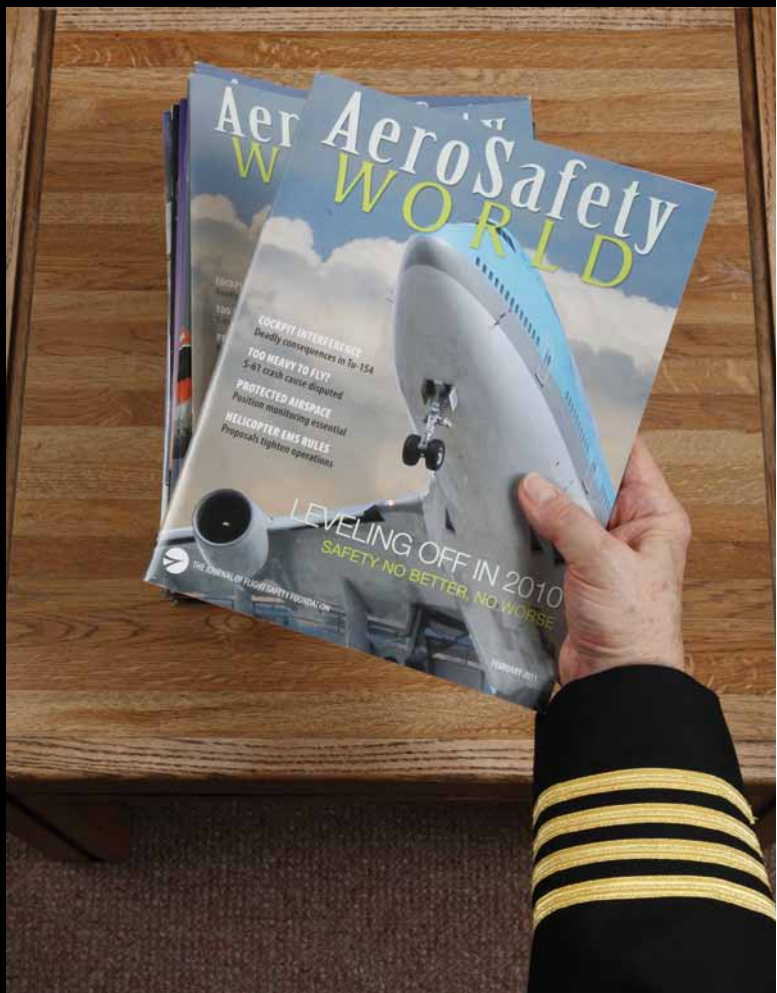

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Taxiway Takeoff

Pilots were distracted by a 'sudden surge in cockpit workload' during line-up.

BY MARK LACAGNINA

The following information provides an awareness of problems that might be avoided in the future. The information is based on final reports by official investigative authorities on aircraft accidents and incidents.

JETS

Controller Called for Abort

Airbus A340-300. No damage. No injuries.

The flight crew had been instructed by air traffic control (ATC) to expedite their departure and were completing a variety of tasks when they inadvertently turned onto a parallel taxiway and began a rolling takeoff. The A340 was accelerating through 75 kt when the air movements controller told the crew to stop. The pilots rejected the takeoff and, after waiting for the brakes to cool, departed without further incident.

The serious incident occurred at Hong Kong International Airport the night of Nov. 27, 2010. The final report by the Accident Investigation Division of the Hong Kong Civil Aviation Department said that a causal factor was "a combination of a sudden surge in cockpit workload and the difficulties experienced by both the captain and the first officer in stowing the EFB [electronic flight bag] computers at a critical point of taxiing shortly before takeoff, [which] distracted their attention from the external environment [and] resulted in a momentary degradation of situation awareness."

The report also faulted company standard operating procedures (SOPs) that delegated responsibility for taxiing solely to pilots-in-command and "did not provide a sufficiently robust process for the verification of the departure runway before commencement of the takeoff roll."

The passenger terminal is on the east side of the Hong Kong airport and between parallel east-west runways, both 3,800 m (12,467 ft) long and 60 m (197 ft) wide. The south runway was closed for scheduled maintenance, and the A340 flight crew was told to taxi to Runway 07L for their departure to Helsinki, Finland. Visual meteorological conditions (VMC) prevailed, with 10 km (6 mi) visibility. The report did not specify the number of people aboard the A340.

The aircraft was about 1,400 m (4,593 ft) from the end of the outer parallel taxiway, Taxiway B, when the air movements controller confirmed that the crew was ready for departure and asked them to expedite their taxi and to line up on Runway 07. Another aircraft was on an 18-nm (33-km) final approach to Runway 07L, and the controller planned for the A340 to depart before the other aircraft landed. The A340 was nearing the end of Taxiway B when the controller cleared the crew for takeoff.

When the aircraft reached the end of Taxiway B, the captain made a right turn onto Taxiway A1, which crosses the inner taxiway, Taxiway A, and leads to Runway 07L. Instead of taxiing the aircraft onto Runway 07L, however, the captain turned onto Taxiway A and

transferred control to the first officer, who began a rolling takeoff, per company procedure.

"This abnormal maneuver was detected by the ground movements controller on the advanced surface movement guidance and control system," the report said. The ground controller alerted the air movements controller, who radioed the crew to "stop rolling."

The crew brought the aircraft to a stop 1,400 m from the west end of the taxiway at 0124 local time, or about 14 seconds after initiating the rejected takeoff. After waiting about 50 minutes for the wheel brakes to cool, the crew departed from Runway 07L.

Investigators found that neither the captain, the first officer nor the relief pilot stationed in an observer's seat realized until the controller's call that the takeoff had been initiated on the taxiway. While turning the aircraft onto the taxiway, the captain had made a public-address announcement for the flight attendants to be seated, activated the weather radar system and transferred control to the first officer. Both pilots completed the "Line-Up Checklist," and both had difficulty stowing their EFBs. During the turn, the first officer disengaged the air-conditioning packs and checked the fuel load just before setting thrust for the company-preferred rolling takeoff. The relief pilot was looking down during the turn, trying to make sure that his EFB was stowed and that there were no loose items on his tabletop.

'No queries were ever raised among the three pilots concerning the correct positioning of the aircraft.'

"Both [operating] pilots stated that they saw the red stop bar lights perpendicular to the centerline but dismissed them as part of the lighting system leading to the displaced runway threshold," the report said. "No queries were ever raised among the three pilots concerning the correct positioning of the aircraft."

Taxiway A1 was a known hot spot. Prior to the incident, three other flight crews had initiated takeoffs on Taxiway A, rather than on Runway 07L. These incidents also had occurred after midnight, with good visibility and light traffic, and after the crews were cleared for takeoff before reaching Taxiway A1. The previous incidents had led to several changes in the lighting, marking and signage at the hot spot.

The report noted that information in the Hong Kong *Aeronautical Information Publication* about the hot spot had not been incorporated in the A340 operator's airport briefing. Among the recommendations generated by the investigation were that the operator ensure that safety-significant information is incorporated in airport briefings in a timely manner and that Hong Kong ATC managers ensure that clearance for takeoff on Runway 07L is not issued at night until ensuring that the aircraft has passed Taxiway A or has entered the runway.

Approach to a Closed Runway

Boeing 777-300. No damage. No injuries.

En route from Narita, Japan, with 117 passengers and seven crewmembers, for a 50-minute flight to Kansai International Airport the night of Aug. 30, 2010, the flight crew had briefed for the instrument landing system (ILS) approach to Runway 24L. Nearing Kansai, however, the crew accepted an offer by ATC to expect a visual approach to the runway.

The report by the Japan Transport Safety Board said that although VMC prevailed, "a visual approach to the airport is very difficult at night due to a lack of light in the vicinity." The longer, parallel runway, 24R, was closed for maintenance, but its approach lights and precision approach path indicator (PAPI) lights were on.

Soon after the approach controller issued a heading of 100 degrees, a vector to establish the 777 on a right downwind leg for Runway 24L, the crew reported that the runway was in sight. The approach controller cleared the crew for a visual approach and instructed them to establish radio communication with the airport traffic controller.

When the crew reported that the aircraft was established on downwind, they were cleared to land on Runway 24L. The first officer, the pilot flying, disengaged the autopilot, turned onto a right base leg and told the captain to perform the landing checklist. He then saw runway and

PAPI lights, and turned onto final approach to what he thought was Runway 24L.

Both pilots noticed that their navigation displays showed abnormal indications for the ILS approach to Runway 24L and realized that they were on final approach to Runway 24R. Almost simultaneously, at 2155 local time, the airport traffic controller advised the crew that they were approaching the closed runway and asked if they could make a left turn to align the aircraft to land on 24L.

At the time, the 777 was about 3 nm (6 km) from Runway 24R, and the crew decided that side-stepping to Runway 24L would be difficult. They conducted a go-around and subsequently landed the aircraft on Runway 24L without further incident. During the go-around, the lights for Runway 24R were turned off.

'Electrical Anomaly' Ignites Fire

Bombardier CRJ200. Substantial damage. No injuries.

Shortly after external electrical power was applied to the CRJ in preparation for its departure from Tallahassee (Florida, U.S.) Regional Airport the morning of Feb. 28, 2009, the captain and a flight attendant, the only people aboard the airplane, heard a hissing sound and detected smoke and signs of a fire. They evacuated through the cabin door.

"Evidence suggests that the fire initiated as a result of an electrical anomaly in the top portion of the JB-1 junction box, near bus bar and contactor components," said the report by the U.S. National Transportation Safety Board (NTSB). The junction box, located in the upper fuselage between the cockpit and cabin door, contains components associated with the distribution of electrical current from the auxiliary power unit and external power sources.

"The fire ignited combustible materials, including insulation blankets, and spread upwards toward a flexible oxygen line mounted above the JB-1 junction box," the report said. "The flexible oxygen line ignited when exposed to the fire, and the fire burned through the aircraft's fuselage" before it was extinguished by fire fighters.

Transport Canada subsequently issued an airworthiness directive requiring compliance with a Bombardier service bulletin that informed CRJ operators about the accident and recommended replacement and rerouting of the oxygen line.

Gust Spoils Landing

Dassault Falcon 10. Substantial damage. No injuries.

The flight crew had to circumnavigate several thunderstorms during the flight to Sellersburg, Indiana, U.S., the night of March 23, 2011. The airport's automated weather observation system was reporting VMC, with surface winds from 310 degrees at 19 kt, gusting to 27 kt. Nearing the airport, the crew canceled their instrument flight plan and conducted a visual approach to Runway 36, which was 5,500 ft (1,676 m) long and 100 ft (30 m) wide.

"The captain [the pilot flying] reported that the landing reference speed (V_{REF}) was 110 kt, which included a 5-kt gust factor," the NTSB report said. "As the airplane touched down on its main landing gear, it encountered a wind gust that raised the left wing. The captain corrected with a left roll input as he simultaneously reduced the airplane's pitch in an attempt to place the nosewheel onto the runway, but the airplane became airborne and drifted off the runway.

"The airplane touched down for the second time in the grassy area alongside the runway, where the subsequent landing roll was completed without further incident."

The pilots and their passenger were not injured, but the Falcon's right main landing gear, right wing spars and forward pressure bulkhead were substantially damaged. Additionally, "both engines appeared to have ingested foreign object debris past their first compressor stages," the report said.

Turbulence Triggers Control Loss

Cessna Citation 680. Substantial damage. No injuries.

The flight crew did not obtain forecasts or recent pilot reports of moderate or greater turbulence along the route before departing

Both pilots noticed abnormal indications for the ILS approach to Runway 24L and realized that they were on final approach to Runway 24R.

from Denver for a positioning flight to Eagle, Colorado, U.S., the morning of Feb. 13, 2010.

The Citation encountered extreme mountain-wave turbulence after leveling at 18,000 ft. "The extreme-turbulence encounter caused a brief loss of control that lasted less than a minute," said the NTSB report. "The airplane then made an uneventful descent and landing.

"A postflight inspection of the airplane revealed overstress damage that caused wrinkling and debonding of portions of the top skin on both wings."

Unsecured Tow Bar Separates

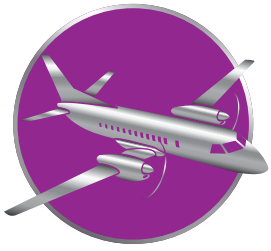
Boeing 737-800. Minor damage. No injuries.

A tractor was pushing the 737 from the gate at Dallas–Fort Worth International Airport when the tow bar separated from the airplane's nose landing gear the evening of Feb. 20, 2011. The 737 then rolled backward, and its right wing struck the nose of a parked McDonnell Douglas MD-82.

The communications cord between the tractor and the 737's flight deck had been severed, and "the captain and first officer, who were in the process of starting the engines, were unaware that the airplane was rolling freely," the NTSB report said.

None of the 145 people aboard the 737 was injured, and damage was minor. However, damage to the unoccupied MD-82, which was operated by the same airline, was substantial.

The airline examined the tow bar and found no mechanical failures or abnormalities. NTSB concluded that the tractor driver had not confirmed that the tow bar was secured properly to the airplane before beginning the push-back.



TURBOPROPS

Connector Ignites Cabin Fire

Beech King Air 200. Substantial damage. No injuries.

The flight crew was conducting an emergency medical services (EMS) flight from La Romaine to Sept-Îsles in Quebec, Canada, the afternoon of Jan. 2, 2010, when one of the medical technicians aboard informed them that there was smoke in the cabin. At the time, the King Air was in instrument meteorological conditions (IMC) about 5 nm (9 km) from the runway at Sept-Îsles Airport, which had 2 mi (3,200 m) visibility in freezing drizzle and fog, and broken ceilings at 900 ft and 2,000 ft.

"The crew had little time to assess the situation and take appropriate action," said the report by the Transportation Safety Board of Canada. They did not declare an emergency or conduct the "Smoke and Fume Elimination" checklist, which requires in part the donning of oxygen masks. However, the captain did turn off the switches for the fluorescent cabin reading lights and the "No Smoking" and "Fasten Seat Belts" signs, and closed the engine bleed air valves. He did not pull any circuit breakers.

The first officer, the pilot flying, transferred control to the captain and went to the cabin, where "he observed the presence of gray smoke, which appeared to be dissipating," the report said. The first officer then returned to the cockpit and briefed the captain on what he saw.

The King Air was landed without further incident. After taxiing to the company's facility, however, the crew again saw smoke but were unable to determine the source. While the three medical technicians exited the aircraft and the stretcher patient was removed by ambulance attendants, the first officer used his cellphone to advise the airport's flight service specialists of the situation and to request the assistance of municipal fire fighters.

An examination of the aircraft revealed that paint on the upper left fuselage was burning. "The crew again opened the main [cabin] door and discharged three portable fire extinguishers," the report said. "When the Sept-Îsles municipal fire fighters arrived, the fire was under control."

The aircraft was manufactured in 1976 and had more than 19,300 flight hours. The

source of the fire was traced to arcing between an electric power supply and connector for the fluorescent lights in an upper cabin panel. The arcing had ignited a strip of fabric. Components damaged by the fire included two interior panels and a portion of the fuselage skin. Repairs included replacement of cabin insulation material and installation of newer fluorescent lighting power supplies.

The report noted that, based on several similar occurrences, the manufacturer had issued recommendations in 2002 that the fluorescent light power connectors "be thoroughly cleaned and not be handled with bare hands in order to avoid contaminating them, and the electrical plug that fits the connector be tight and free of dirt." The manufacturer also had advised that loose or contaminated connectors can increase electrical resistance "that could produce sufficient heat to damage the connector and power supply."

Icing Factors in Approach Stall

Beech C-99. Substantial damage. No injuries.

The pilot was conducting a cargo flight the morning of Jan. 6, 2010, to Kearney, Nebraska, U.S., which had 1/2 mi (800 m) visibility in freezing fog, a 200-ft overcast and surface winds from 130 degrees at 4 kt. He said that the C-99 accumulated light to moderate icing during the ILS approach, and he cycled the wing deicing boots once before reaching the final approach fix.

Indicated airspeed was 120 kt, and the C-99 was configured with the landing gear and 30 percent flaps extended, when the pilot gained visual contact with Runway 36 about 250 ft above ground level. He made a slight left turn and a right turn to align the airplane with the runway centerline.

"When the airplane was wings-level and about 25 ft above the runway, the left wing stalled, and the airplane landed hard on the left main landing gear, bending the rear spar of the left wing," said the NTSB report.

Examination of the airplane revealed 3/8 to 1/2 in (1 to 1 1/4 cm) of ice on portions of the wings and deicing boots. NTSB concluded that the probable cause of the accident was "the failure of the pilot to maintain adequate airspeed during the approach, resulting in a stall" and that a contributing factor was "the accumulation of structural icing during the flight."

Seized Gearbox Forces Deadstick Landing

Pilatus PC-12/45. Substantial damage. No injuries.

The PC-12 was climbing through 18,000 ft during an EMS flight with four people aboard from Derby to Kununurra, Western Australia, the night of Jan. 29, 2010, when the pilot felt the airframe shudder significantly and heard a loud humming and whining noise. "Seconds later the engine 'CHIP' caution light illuminated, indicating the detection of metal chips in the engine oil," the Australian Transport Safety Bureau report said.

Components damaged by the fire included two interior panels and a portion of the fuselage skin.

The pilot declared an urgency and turned back toward Derby, which was about 56 km (30 nm) away. Shortly thereafter, engine oil pressure and torque decreased, and the inter-turbine temperature increased.

The aircraft was about 11 km (6 nm) from Derby when the low oil quantity caution light illuminated. The pilot shut down the engine, and the propeller feathered and stopped rotating immediately. The pilot declared an emergency and glided the PC-12 to a landing at the airport.

Examination of the engine revealed that the propeller reduction gearbox had seized. "The investigation found that four of the six first-stage reduction gearbox bolts had failed due to fatigue cracking," the report said, noting that another bolt had fractured due to overstress. "Debris from the failed bolts was released into the first-stage sun and planet gears, causing significant damage."

Pratt & Whitney found that a number of reduction gearbox bolts for PT6A-67 series engines had not been "cold-rolled" during manufacture by the supplier to increase their hardness and strength. The company subsequently issued two service bulletins recommending replacement of the bolts.

Overrun on a Short, Icy Runway

Cessna 208B Caravan. Substantial damage. No injuries.

The Caravan was on a scheduled flight to Kipnuk, Alaska, U.S., the afternoon of Jan. 6, 2011. Surface winds at the airport were from the northeast at 10 kt, and the captain said that he landed long on Runway 33 to avoid a bump on the 2,120-ft (646-m) runway.

"As the airplane touched down on the runway, he applied brakes and moved the propeller into beta," the NTSB report said. "During the landing roll, he realized the airplane was still traveling too fast on the snow- and ice-covered runway to stop, and he did not have enough area to abort the landing."

With maximum wheel braking applied, the Caravan overran the runway and struck a ditch. Damage was substantial, but the four passengers, the first officer and the captain escaped injury.

'Unsuitable Weather' for a Check Ride

Fairchild Merlin. Destroyed. Three fatalities.

The English summary of an accident report issued by the Norwegian Accident Investigation Board in December 2011 said that weather conditions were "not suited" for a check ride administered in June 2008 to a newly hired airline first officer. A "low ceiling, rain showers, winds up to 40 kt and turbulence" prevailed in the area of Bergen Airport Flesland, the report said.

On the first day of the check ride, June 19, "turbulence caused the stick pusher to activate during the demonstration of slow flight," the report said. "The commander decided to pull the circuit breaker for the stall avoidance and stability augmentation system (SAS), presumably to avoid nuisance activations of the stick pusher."

The candidate found the next task, a stall demonstration, "frightening" and "experienced great difficulties, having to use all her available physical strength to remain in normal flight with the engines on full power and [the aircraft] in IMC," the report said.

The examiner required the same tasks to be performed the next day, which had even stronger winds than the day before. "However, when it came to demonstrating stalls, the examiner asked for slow flight up to the first indication of stall and not an actual stall," the report said. "He asked for call-outs and a minimum loss of altitude [in the] recovery."

The SAS circuit breaker, apparently intentionally, was not reset before the flight began. "The commander undertook the tasks of adding power and retracting gear and flaps on the candidate's request," the report said. "During this exercise [in IMC], the crew lost control of attitude and airspeed." Radar data showed that the Merlin climbed about 400 ft before descending at up to 10,000 fpm into the North Sea. The candidate, commander and examiner were killed.

"This accident highlights the need for a change in the current training on initial stall-recovery techniques, especially the focus on minimum loss of altitude at the expense of breaking the stall by lowering the nose and, thus, reducing the angle-of-attack," the report said.

PISTON AIRPLANES

Airspeed Anomaly Cited in Overrun

Cessna 402C. Substantial damage. No injuries.

The commuter airplane was descending to join the landing pattern at Watertown, New York, U.S., the afternoon of Feb. 1, 2010, when the pilot noticed the indicated airspeed decrease from 145 kt to 85 kt. He applied full power and lowered the airplane's nose, but the indicated airspeed did not change.

Weather conditions were deteriorating, with low clouds and snow squalls near the airport. The pilot "considered climbing to a higher altitude in order to troubleshoot the airspeed anomaly; however, due to the weather conditions, he decided to land as soon as possible," the NTSB report said.

The pilot perceived that the 402's groundspeed was higher than the 85-kt indicated airspeed, but he did not cross-reference the airspeed indicator on the right side of the instrument panel. He extended the landing gear and 20 degrees of flap on final approach to the

5,000-ft (1,524-m) runway, which was covered with 1/2 in (13 mm) of snow.

"The airplane touched down about 1,000 ft [305 m] beyond the threshold of the runway and bounced slightly," the report said. "The nose landing gear made runway contact about mid-field. … The pilot applied the brakes but observed the braking action to be nil."

The landing gear collapsed and all the propeller blades were bent when the 402 overran the runway onto snow-covered terrain. The six passengers and the pilot were not injured.

"Post-accident testing revealed that the pitot tubes were warm to the touch when the pitot heat switch was turned on," the report said. "Unregulated air pressure was applied to the [pitot system]. The corresponding airspeed indicators displayed needle movement, with no leaks detected. Since no further examination of the pitot-static system was conducted, the cause of the airspeed anomaly could not be determined."

HELICOPTERS

Wire Strike in a River Valley

Bell 206B. Substantial damage. Four fatalities.

The JetRanger was two hours into a public-use deer-surveying mission and was being flown along a river valley near Auberry, California, U.S., when the main rotor struck a power-transmission cable, or skyline, the afternoon of Jan. 5, 2010. The helicopter descended to the ground, killing the pilot and the three passengers, who were employees of the state's wildlife department.

The NTSB report said that the helicopter was being flown southbound, and the position of the sun would have hindered the pilot's ability to see the skyline and four other cables strung between towers about 1,300 ft (396 m) above the valley. The cables were depicted on a sectional aeronautical chart and on a survey map found in the wreckage.

However, another set of power lines about 200 ft (61 m) below the cables was not depicted on the maps. "As such, it is possible that the pilot misidentified these as the lines depicted on the maps," the report said. "Neither of the sets of power lines [was] equipped with spherical visibility markers or similar identification devices."

Department employees who had flown with the pilot on previous deer-surveying missions told investigators that during his preflight briefing, he had asked the passengers to watch for obstructions. However, the report said, "At the time of the accident, the state agency did not have any formal safety or operational training systems in place for passengers who fly on surveying missions."

Collective Mistaken for Brake

Sikorsky S-92A. Substantial damage. No injuries.

A marshaller was guiding the commander in ground-taxiing the helicopter to a stand at Scatsta Airport in the Shetland Islands the morning of March 30, 2011. "When the helicopter reached the parking position, [the marshaller] signaled the pilot to stop," said the report by the U.K. Air Accidents Investigation Branch. "In accordance with [SOPs], the copilot in the left seat stated 'disc, brakes, lights.' The commander leveled the [rotor] disc, exerted toe pressure on the foot brakes and then intended to raise the parking brake handle."

Instead, the commander inadvertently raised the collective control lever, the hand grip of which is located just to the right of the parking brake handle between the crew seats. "The helicopter lifted approximately 6 ft [2 m] into the air, with a slight roll to the left, and the commander instinctively released the collective lever," the report said. "The helicopter immediately descended and landed heavily."

Examination of the S-92 revealed fuselage deformations in two places and a cracked main landing gear wheel rim.

"As a result of this occurrence, the operator promptly issued a flying staff instruction to ensure that the pilot flying or the pilot monitoring has control of the flying controls during critical phases of flight or when on the ground, rotors running," the report said.

Preliminary Reports, January 2012

Date	Location	Aircraft Type	Loss Type	Injuries
Jan. 5	Steen River, Alberta, Canada	Eurocopter AS 350	major	1 minor/none
The helicopter was being landed at a logging staging area when the external long line struck the tail boom, tail rotor and horizontal stabilizer.				
Jan. 7	Sampit, Indonesia	Xian MA60	minor	68 minor/none
The flight crew was attempting to turn around after landing when the left main landing gear ran off the side of the runway and sank into soft ground.				
Jan. 8	Barrancabermeja, Colombia	Bell 412	total	4 minor/none
Day visual meteorological conditions (VMC) prevailed when the helicopter crashed on a rooftop in a petroleum refinery.				
Jan. 9	Guayaramerín, Bolivia	Xian MA60	major	21 minor/none
The fight crew landed the twin-turboprop on its belly after attempting unsuccessfully to extend the landing gear.				
Jan. 10	Salisbury, Wiltshire, England	Eurocopter Gazelle	total	3 minor/none
The pilot apparently lost control of the helicopter while making a 180-degree turn at low altitude.				
Jan. 15	Timmins, Ontario, Canada	Pilatus PC-12	major	3 none
The engine malfunctioned during cruise, but the pilot decided to continue the flight to Timmins, using a higher-than-normal approach speed. The PC-12 overran the runway into snow-covered terrain. Preliminary examination of the engine revealed a leaking oil line attachment.				
Jan. 15	Raipur, India	Hindustan Aeronautics Dhruv	total	1 serious, 4 minor/none
Witnesses said that the helicopter, which was on a test flight, descended from a height of 100 ft to a hard landing.				
Jan. 15	Fairbanks, Alaska, U.S.	PZL Swidnik SW-4	major	3 none
The helicopter struck the runway under unknown circumstances while maneuvering during cold-weather testing at the airport.				
Jan. 16	Nad Ali, Afghanistan	Bell 214	total	3 fatal
The helicopter, operated by the U.S. Department of Defense, crashed under unknown circumstances in a remote area.				
Jan. 17	Chilliwack, British Colombia, Canada	Eurocopter AS 350	total	1 fatal
The helicopter, operated by the Royal Canadian Mounted Police, emitted smoke while hovering during a training flight and then descended into a wooded area.				
Jan. 18	Auyantepui, Venezuela	Bell 206	total	5 fatal
Bad weather was reported in the area when the 206 struck the tabletop mountain.				
Jan. 19	Puerto Montt, Chile	Piper Cheyenne	major	8 none
After the right engine malfunctioned during a night approach, the pilot landed the airplane with the landing gear retracted on open ground near the airport.				
Jan. 22	Rio de Janeiro, Brazil	Eurocopter AS 350	major	1 minor/none
The engine lost power during cruise flight, and the pilot landed the helicopter in a rugged area near a beach.				
Jan. 22	Dallas, Texas, U.S.	Bell 206	major	4 none
The tail boom was damaged when the pilot landed the helicopter on a golf course after the engine lost power.				
Jan. 24	Orange, Texas, U.S.	Cessna Citation V	major	8 none
The nose landing gear collapsed when the Citation veered off the runway while landing in strong winds and heavy rain.				
Jan. 28	Shishmaref, Alaska, U.S.	Reims-Cessna 406 Caravan II	major	7 minor/none
A main landing gear collapsed as the twin-turboprop was rolling out on landing.				
Jan. 30	Baltimore, Maryland, U.S.	Gulfstream G150	major	2 minor/none
The nose landing gear collapsed when the airplane veered off the runway onto soft ground during a night landing.				
Jan. 30	McBride, British Columbia, Canada	Bell 212	major	1 minor
After dropping off skiers, the pilot landed at a staging area at the bottom of the hill. He was shutting down the engine when the helicopter was struck by an avalanche.				

This information is subject to change as the investigations of the accidents and incidents are completed.

Source: Ascend

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