Transport Canada Transports Canada

TP 185E
Issue 2/2010

AVIATION SAFETY LETTER

In this Issue...

Learn from the mistakes of others;
you'll not live long enough to make them all yourself...

TC-1003619

Canada

The *Aviation Safety Letter* is published quarterly by Transport Canada, Civil Aviation. It is distributed to all holders of a valid Canadian pilot licence or permit, to all holders of a valid Canadian aircraft maintenance engineer (AME) licence and to other interested individuals free of charge. The contents do not necessarily reflect official government policy and, unless stated, should not be construed as regulations or directives.

Letters with comments and suggestions are invited. All correspondence should include the author's name, address and telephone number. The editor reserves the right to edit all published articles. The author's name and address will be withheld from publication upon request.

Please address your correspondence to:

Paul Marquis, Editor
Aviation Safety Letter
Transport Canada (AARTT)
330 Sparks Street, Ottawa ON K1A 0N8
E-mail: paul.marquis@tc.gc.ca
Tel.: 613-990-1289 / Fax: 613-952-3298
Internet: www.tc.gc.ca/ASL-SAN

Change of address or format:
To notify us of a change of address, to receive the *Aviation Safety Letter* by e-Bulletin instead of a paper copy, or for any related mailing issue (i.e. duplication, request to be removed from our distribution list, language profile change, etc.), please contact:

The Order Desk
Transport Canada
Toll-free number (North America): 1-888-830-4911
Local number: 613-991-4071
E-mail: MPS@tc.gc.ca
Fax: 613-991-2081
Internet: www.tc.gc.ca/Transact

Sécurité aérienne — Nouvelles est la version française de cette publication.

ISSN: 0709-8103

TP 185E

Publication Mail Agreement Number 40063845

Table of Contents

GUEST EDITORIAL

Judy Rutherford

Management Services Branch

Have you ever gone to a restaurant on two separate occasions and had completely different dining experiences? Maybe during your first visit you had a friendly waiter and a delicious meal, while the second time perhaps you ordered the exact same dish and it arrived late and overcooked. What you might have once thought to be an excellent establishment is now tainted by this one experience. This example illustrates the importance of consistency in not only the restaurant industry but also in business in general. As Director of Management Services, I help my branch ensure consistency throughout Civil Aviation and in its processes both at headquarters and at the regional offices across Canada. Ensuring consistency and efficiency is but one of the many functions of the Management Services Branch, as it acts like a glue, holding together the various components of the Civil Aviation Program.

The Branch is responsible for developing and implementing the shared management processes and systems used by Civil Aviation staff across Canada. Management Services is essential to ensuring these shared processes not only meet the needs of the entire Civil Aviation Program but also facilitate a strong working relationship with our stakeholders and demonstrate results for Canadians. While some of you may not deal with Management Services directly, you have certainly on some level dealt with policies, frameworks or practices that have been developed and maintained by the Branch.

"Ensuring consistency and efficiency is but one of the many functions of the Management Services Branch, as it acts like a glue, holding together the various components of the Civil Aviation Program."

The Management Services Branch has a lot on its plate, which is all tied together by the *Civil Aviation Integrated Management System (IMS) Standard*. As the aviation industry moves towards fully implementing safety management systems (SMS), Transport Canada Civil Aviation (TCCA) is implementing its own accountability framework that we refer to as IMS. In many aspects, IMS mirrors SMS. Through IMS, we aim to increase communication, enhance work planning, and establish improvement processes through quality assurance and risk management. Key areas of focus in the IMS standard include: measurement and analysis, management responsibility, resources, and program design and delivery.

In the field of measurement and analysis, we have established standards for services both with fees and without—a document outlining these changes will be published in the spring of 2010. The Branch will also implement a mechanism to monitor its service delivery, allowing us to invest resources in areas that require more attention.

Communication between employees and stakeholders is a critical management responsibility and one on which we have already started to improve. One example is the Civil Aviation Issues Reporting System (CAIRS), which allows anyone to raise issues through an accessible, confidential, and timely means of direct communication. More information on CAIRS can be found at www.tc.gc.ca/CAIRS. Management Services has also launched the Online Reference Centre (www.tc.gc.ca/online-reference-centre), which houses the most up-to-date Civil Aviation documents and publications. There you will find our *Aviation Safety Program Manual*. This document is an excellent reference for Civil Aviation employees as well as industry professionals looking for a thorough overview of the Program.

"Communication between employees and stakeholders is a critical management responsibility and one on which we have already started to improve."

Resource management is a major priority for the Branch. We oversee the planning and allocation of financial resources and support managers with the most important resource: our employees. This includes designing and delivering learning activities for successful competency and career development.

One of the goals of IMS is to consider stakeholders during planning stages prior to the design and delivery of a program or service. This has led to a more robust and integrated method of business planning in the Civil Aviation Directorate as a whole, which leads to improved program delivery for all Canadians. Our new five-year strategic plan, titled *Flight 2015*, is the product of an elaborate planning process heavy on employee and stakeholder perspectives.

These are but a few examples of the crucial role the Management Services Branch plays in TCCA's continuous improvement.

Judy Rutherford
Director, Management Services Branch
Transport Canada Civil Aviation

2009 David Charles Abramson Memorial (DCAM) Flight Instructor Safety Award

The recipient of the 2009 DCAM Flight Instructor Safety Award is Harvey Penner, President and Chief Flight Instructor at Harv's Air, in Manitoba. The award was presented to Harvey on November 16, 2009, by award founders Jane and Rikki Abramson at the Air Transport Association of Canada (ATAC) Annual General Meeting and Tradeshow in Québec, Que. Mrs. Abramson was delighted to point out that this is the first DCAM award for the rotary wing community.

"Harvey's passion for aviation and for helping the younger generation of pilots have created a wonderful legacy for the future of aviation in our country. He has established a facility capable of maintaining that heritage," said Martin Eley, Director General, Civil Aviation, Transport Canada, who gave congratulatory remarks to Mr. Penner during the tradeshow dinner.

New this year, the award administrators are recognizing the achievements of a deserving nominee with a three-day instructor refresher course, courtesy of Seneca College. Deanna Wiebe, Assistant Chief Flight Instructor at Mount Royal University, is the 2009 recipient of this special recognition.

The annual DCAM Award promotes flight safety by recognizing exceptional flight instructors in Canada and has brought much recognition and awareness to the flight instructor community. Recognition of excellence within this segment of our industry upholds a safety consciousness that will hopefully be passed on for many years to come.

Update on the rudder stops for Cessna 150 and 152 series airplanes

The 1998 stall-recovery training accident that took the life of David Charles Abramson involved a locked rudder in a Cessna 152. In 2000, Transport Canada issued an airworthiness directive (AD) requiring the replacement of a number of rudder stop components in Cessna 150 and 152 series airplanes. The occurrence has not been repeated in Canada since then.

Left to right: Harvey Penner; Jane Abramson; Rikki Abramson; Wayne Gouveia, Board of Directors, ATAC

The Federal Aviation Administration (FAA) recently issued AD 2009-10-09R1, effective December 11, 2009, on the same issue. It is clear to us that Mrs. Abramson's efforts in the aftermath of this tragic accident have played a significant role in the safety actions taken by both Transport Canada and the FAA.

The deadline for nominations for the 2010 award is September 14, 2010. For details, please visit www.dcamaward.com.

An Ounce of Prevention…There Are Many Types of Measurements

by Cliff Marshall, Technical Program Manager, Technical Program Evaluation and Co-ordination, Standards, Civil Aviation, Transport Canada

There are many ways to measure performance: in school, exams are graded to establish academic abilities; in sports, time is clocked in split seconds to verify athletic prowess. Similarly, performance measurement can be used to determine how well a safety management system (SMS) is performing in an organization. SMS performance measurement is a tool that provides a method of measuring a company's progression towards achieving its established safety goals and objectives. It is a process that helps answer the question "How are you doing?"

Performance measurement is an on-going activity in any effective SMS and must be applied during all phases of SMS development. It comprises three principal activities:

1. Establishing what should be measured;
2. Determining how it will be measured; and
3. Monitoring it to ensure goals are being accomplished and the right thing is being measured.

An organization must constantly seek to identify hazards and understand the potential risks in order to focus on addressing the most critical organizational issues. This not only allows the organization to prioritize what it wants to address and measure, but it also provides a mechanism that allows the organization to demonstrate visible progress and continuous improvement to the SMS.

By using its unique hazard register and safety risk profile, the organization can adopt appropriate goals and objectives that address specific identified hazards and, at the same time, provide realistic and attainable goals. For example, if an organization were to set an objective of "zero controlled airspace violations," it might be unrealistic to expect reaching this objective in a brief time period such as a year. It would be more reasonable to set yearly goals of reduction over a longer period. An organization could overburden its system by trying to complete too many objectives at once, or by attempting to overcome objectives that are too large in scope. Performance measurements are the tools that allow management to trace their progress with regard to these safety goals.

Performance measurement can also be applied to areas of weakness identified by the quality assurance (QA) program. When there are findings identified in an area, the organization can establish performance measurements to verify the effectiveness of the corrective action. Measurement of the safety goals should be a regular part of management function. Safety goals and objectives should be reviewed on a regular basis to ensure they are still relevant. The operational environment is dynamic, not static; the goals, objectives and measures should therefore be continually reviewed and revised as the organization changes.

A management review of the SMS relies on the information collected from performance measurements in order to determine if the SMS is performing as intended. A full management review should look at all aspects of the system—including performance measurement—and, where weaknesses are detected, changes should be made. This is an on-going process that allows the SMS to continually adapt and improve.

By using these processes, an organization will become proficient in identifying and addressing the type of performance measures it needs to align with the safety objectives. It's useful to remember that before anything can be done, senior managers need to buy into the safety management philosophy and adopt performance-based management principles. There must be management endorsement at a company-wide level to ensure success. The focus should be on strategy and vision, not day-to-day operational controls. Managers should develop safety goals, ensure that each employee understands how their job fits into the strategy, and provide guidance so that departments can develop appropriate measures.

The accountability for accomplishing performance measures rests with the accountable executive. The responsibility for accomplishing goals and objectives, however, extends to all individuals in the organization. Everyone has a role to play. △

Accessing Flight Information Services via the RCO System

by Rob Bishop, Service Analyst, Level of Service and Aeronautical Studies, NAV CANADA

In 2005, NAV CANADA announced a plan—highlighted in *AIP Canada (ICAO)* Aeronautical Information Circular (AIC) 23/05—to address longstanding problems with the remote communications outlet (RCO) system. The plan, known as the RCO Redesign, involves changes in many areas of the country that affect how pilots access flight information services from flight information centres (FIC) while en route. Changes include the use of new, dedicated flight information service en route (FISE) RCO frequencies as well as the addition of new RCOs in some areas and the decommissioning of others to address coverage gaps or overlaps.

One of the RCO Redesign's key safety goals is to reduce the current congestion and interference problems resulting from the FIC's provisions of FISE and other services on 126.7 MHz. By using alternate FISE frequencies, pilots are now able to use 126.7 MHz more effectively in its primary function—as an air-to-air frequency for pilots to broadcast their intentions and their aircraft's position—thereby reducing the risk of conflict when conducting VFR and IFR flights in uncontrolled airspace.

Currently, five primary frequencies are used to provide FISE: **122.37(5) MHz, 123.27(5) MHz, 123.37(5) MHz, 123.47(5) MHz**, and **123.55 MHz**. Other frequencies are sometimes used in instances where the primary ones are not compatible with the site. In some areas where frequency congestion is not an issue, **126.7 MHz** will continue to be used by the FIC for FISE, safety message broadcasts and communication searches in addition to fulfilling its primary role of air-to-air communication.

Our experience with introducing the new FISE frequencies indicates that many pilots believe their radios are not capable of using the FISE frequencies published with three digits after the decimal. This is not the case for 760-channel radios. If the second position after the decimal can be tuned to a 2 or 7, then the radio can access frequencies with 25 KHz spacing (e.g. 123.37 = 123.375 MHz). For more information, refer to section COM 5.3 of the *Transport Canada Aeronautical Information Manual* (TC AIM).

While FICs no longer use or monitor **126.7 MHz** in most areas of the country, they are capable of selecting **126.7 MHz,** when required, to provide aeronautical broadcast service (significant meteorological information [SIGMET] and urgent pilot weather reports [PIREP]) and to conduct communication searches for overdue aircraft. This feature is indicated in aeronautical publications as **126.7 (bcst)**.

As changes are made, it is important to know where to find the most up-to-date information. Since changes reflected in aeronautical publications that are on the 56-day revision cycle are no longer published by NOTAM, pilots must use the following sources to obtain the correct FISE frequencies:

- The current edition of the *Canada Flight Supplement* (CFS) under the following FIC entries: Halifax, Québec, London, Winnipeg, Edmonton, Pacific Radio (Kamloops FIC), Whitehorse, and Arctic Radio (North Bay FIC);
- Notices published 60 days in advance of a change. These can be found under **Notice** on NAV CANADA's Web site (www.navcanada.ca) or on NAV CANADA's aviation weather Web site (www.flightplanning.navcanada.ca) via the **NOTICES** link; and
- NAV CANADA's Web site (click on Services, ANS Programs, then RCO Redesign). This site includes a brochure that describes the RCO Redesign project as well as current RCO maps for each FIC area. These maps are kept up to date as changes occur.

The redesign of the RCO system is reducing frequency congestion and allowing pilots to have better access to the services and information they need, while freeing up 126.7 MHz for its essential safety function. The project involves over 180 RCO sites and, to date, half of the sites have been completed. With changes occurring every two months, pilots must be vigilant to ensure they have the correct FISE frequencies for accessing the en route services and information they need to conduct their flight. △

Have you checked NOTAMs?

Pre-Flight

The SAC Column: A Review of Research into Avalanche Accidents and How it Might Relate to Pilot Decision Making

by Ian Oldaker, Soaring Association of Canada (SAC)

Even though people are capable of making decisions in a thorough and methodical way, it appears that most of the time they do not. A growing body of research suggests that people unconsciously use simple *rules of thumb*, or *heuristics*, to navigate the routine complexities of modern life. Pilots have to make decisions quickly and often, and may be using heuristics more frequently than we think. Heuristics give quick results because they rely on only one or two key pieces of evidence, and though they are not always right, they work often enough to guide us through routine but complex tasks such as driving or shopping.[1] Six heuristics are recognized as being widely used in our daily decision making: familiarity, consistency, acceptance, the expert halo, social facilitation, and scarcity.*

Ian McCammon reviewed 715 recreational avalanche accidents and found that there is good evidence that many avalanche victims fell prey to one or more of what are called heuristic traps.* He further explained that because these heuristics work so well and because we use them for everyday decisions, we are misled by these unconscious heuristics. He cautioned that it is not possible to establish conclusively the causes of these accidents by heuristic traps.* However, experimental results from other fields of human behaviour would support many of his findings.*

In his study, McCammon showed that many avalanche victims appeared to ignore obvious signs of danger. Almost two-thirds of the parties that were aware of the hazard still proceeded into the path of the hazard anyway.* Why? In many cases the people involved had received formal avalanche training, which included how to recognize the hazard and how to mitigate it. People at all four levels of training (none, awareness, basic and advanced) appeared equally susceptible to heuristic traps. McCammon's study gives us the basis of looking at how heuristics would apply to pilots, and what we might be able to do about improving safety through the pilots' actions.

Heuristic traps

Familiarity: Actions that do not require much thought are familiar, and we base our decision on what we did the last time we were in a similar situation. This works in most cases, but when something in the situation changes, this rule of thumb can become a trap. Pulling up sharply into a thermal works most of the time when no one else is around, and the habit is formed. However, when others are in the thermal, a different technique may be needed to avoid colliding with a glider above. Power pilots train for an engine out in the circuit and return to the field for landing. This makes it hard to resist the decision to do a 180° turn in a real engine failure on departure, despite not having enough height.

There is an apparent tendency among skiers who are highly trained (in avalanche hazards) to make riskier decisions in familiar terrain.* Remarkably, skiers with advanced training travelling in a group in familiar terrain exposed their parties to about the same hazards as parties with little or no such training.* This observation would suggest that familiarity negates the benefits of training! This also suggests that high-time or competitive glider pilots flying in familiar mountain and ridge terrain could make riskier decisions, even if they were trained in the hazards of such flying.

Consistency: In gliders on cross-country flights, deciding when to leave the last thermal for a final glide to return home, or any long glide for that matter, is usually a decision not taken lightly. However, once the decision has been made, the pilot would find it easier to stay on the glide, since it is easier to maintain consistency with the original decision. This heuristic saves time because we stick to our original assumptions.* Most of the time it is reliable, but it can become a trap when our desire to be consistent overrides critical new information about an impending hazard*, like getting low. Some pilots experience the effect of this heuristic trap when they push the weather to some poor outcome. In hindsight, it is often difficult to understand why a pilot stayed with a course of action despite worsening conditions.

Acceptance: This heuristic pushes us to do something or take part in an activity that we hope will get us accepted or liked by others. We are very vulnerable to this, even from an early age. Typically, in men it shows up as competitive, aggressive or risk-taking behaviour, and is more prevalent with younger men when women are involved. This would suggest that pilots at a club with mixed-gender flying activities would be more susceptible to this type of heuristic than non-mixed gender. Also, a pilot new to the group might be susceptible to this heuristic when trying to validate his acceptance by the others in the group.

The expert halo: This heuristic refers to the leader of a group—often an informal leader—who makes critical decisions for the group. Situations that can lead people into

1 Gigerenzer, et al. *Simple Heuristics That Make Us Smart*, pp. 3–34. New York, USA: Oxford University Press, 1999.

* Ian McCammon, "Heuristic Traps in Recreational Avalanche Accidents: Evidence and Implications." *Avalanche News*, No. 68, Spring 2004. The Canadian Avalanche Centre, Revelstoke, B.C.

the expert halo trap could be based on local knowledge or experience, or simply on the person's age or assertiveness. In the case of competitive gliding, it could be the assumed leader—the pilot who is followed by many because of his or her past successes or local knowledge. Another leader is the competitor who leaves first from the last thermal before the finish, whether or not he is an acknowledged *expert*.

Data in McCammon's study suggests that the expert halo heuristic may have played a role leading to avalanche accidents, particularly in large groups.* Often, decisions made by the "leader" are followed by others despite there being information available that this might not be the best course of action.

Social facilitation: When a group is involved in a decision, an individual's risk-taking will be enhanced or diminished, depending on the skills of the group as a whole. In the avalanche study, it was found that when a person had received formal avalanche training, he or she would tend to take substantially more risks after meeting others.* People with less training took fewer risks.

At a flying club, when the conditions might warrant an individual decision not to fly, a group discussion with other pilots may expose less experienced or more experienced pilots to accepting greater risk. We will normally expect less skilled pilots to take fewer risks than the more experienced in a group. In this context, by following the others (expert halo heuristic), will the less experienced take more risks than they can handle? Will this social facilitation heuristic, combined with the pilot's desire for acceptance, mean that we will inevitably have even experienced pilots exposed to more risk than when they are flying outside a group dynamic? Like other heuristic traps, social facilitation lulls its victims into a sense of feeling safe, even when dangers are obvious.

Scarcity: The scarcity heuristic is the tendency to value opportunities in proportion to the chance that the person may lose them, especially to a competitor.* In skiing situations in avalanche territory, the scarcity heuristic works exactly contrary to personal safety—it appears to become a more tempting decision-making trap as the avalanche hazard rises.* This trap requires more analysis to determine how it could apply to competitive glider pilots, for example those who may be tempted to take a difficult route in the mountains on the chance that they will gain an advantage over their competitors. In commercial flying, this might apply to self-imposed pressures and increased risk-taking to prevent the loss of business.

Conclusion

Avalanche victims fall prey to heuristic traps because they are simple to use and they have proven themselves in other areas of daily life. The challenge for avalanche educators continues to be to develop and effectively teach simple, useful decision-making tools that are viable alternatives to the heuristic traps described here. What would be needed to apply these lessons to the training of pilots? McCammon's work to analyze avalanche accidents suggests that we will not be able to influence individual pilots by training alone in the subject of heuristics. He states that effective risk management and decision-making tools need to be included in pilot training. For aviation activities, training such as pilot decision making (PDM) and single-pilot resource management (SRM) need to be used along with our knowledge of human factors.

For more information on heuristics in avalanche accidents and how they might apply to human factors in flying, go to http://avalancheinfo.net/Newsletters%20and%20Articles/Articles/McCammonHTraps.pdf. △

Jet Blast Hazard

The following is published as a result of an Aviation Safety Information letter from the Transportation Safety Board of Canada (TSB).

On June 25, 2006, a Boeing B737-600 was cleared for takeoff from the threshold of Runway 26L at the Vancouver, B.C., international airport. At the same time, a Cessna 182 was stopped at Taxiway C; once the B737 began to roll, the tower controller cleared the Cessna 182 to taxi to position on Runway 26L and wait. The Cessna 182 taxied onto the runway immediately, and as it began to turn left to line up, the left wing lifted as a result of encountering the jet blast from the departing B737. The Cessna 182 sustained damage to its right wing tip and propeller.

Recorded radar data showed that the B737 was approximately 1 200 ft down the runway when the Cessna 182 encountered the jet blast. The *Transport Canada Aeronautical Information Manual* (TC AIM) (TP 14371E), section AIR 1.7 "Jet and Propeller Blast Danger" provides guidance to pilots to help them avoid jet and propeller blasts from other aircraft. A diagram in this section identifies the potential danger areas behind three representative types of turbo-jet aircraft, namely "executive", "medium", and "jumbo" jets, based on three engine-thrust rating levels: 10 000, 25 000, and 55 000 lbs, respectively. The depicted distances show the danger zones behind the three classes with their engines at both idle and take-off power settings. For example, behind a medium jet with an engine thrust rating up to 25 000 lbs, at take-off thrust, the danger area is 150 ft wide and extends 1 200 ft behind the departing aircraft. For a jumbo jet at takeoff, the danger area is shown as 275 ft by 1 600 ft.

The performance of medium jet aircraft allows them to also operate from smaller Canadian airports, where the greater population of light airplanes and helicopters operate, providing a varied mix of aircraft operations, in both size and performance. Many of these general aviation pilots have little experience operating behind these larger jet aircraft. The information provided in the TC AIM is therefore a vital aid for these pilots.

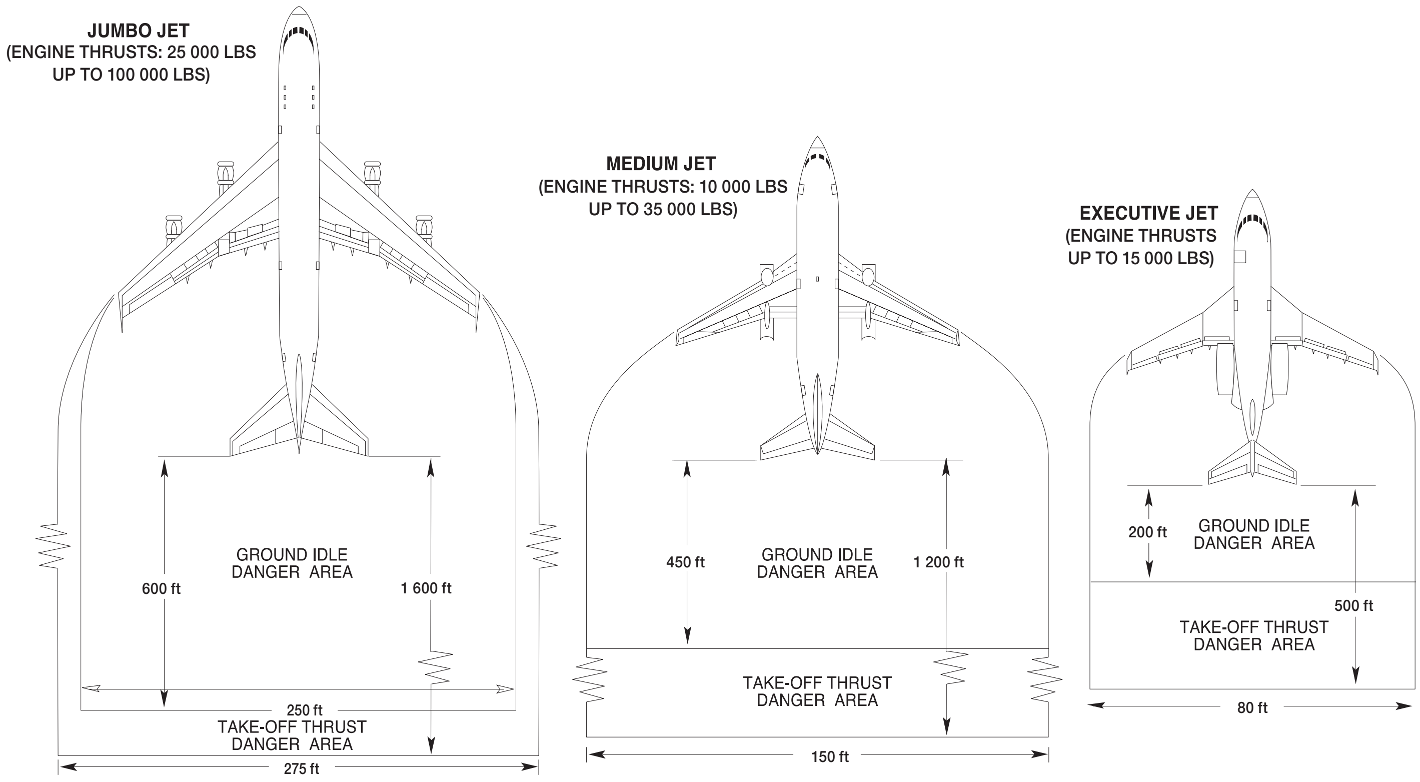
A review of engine thrust ratings for modern generation aircraft such as the Boeing B737-800, the B747-400, and the Airbus A320 shows that engine thrust has risen considerably over the years. As a result, it is not uncommon for a modern medium jet engine to produce considerably more thrust than the 25 000 lbs referenced in the TC AIM and for the heavy jumbo jet to produce thrust levels reaching 90 000 lbs. This significant increase in thrust ratings increases the danger area behind a departing modern jet. Accordingly, basing their decision on the data in TC AIM AIR 1.7, pilots entering a runway behind a medium jet, for instance, may encounter jet blast far stronger, for a longer time period, and at greater distances than depicted in the TC AIM. Therefore, there is an increased risk that a light aircraft could be damaged or upset by jet blast even though the current guidelines in the TC AIM were being followed.

Action taken by TC

As a result of this letter, the TC AIM section AIR 1.7 was updated and the following text was added:

> As newer aircraft are designed to handle more weight, larger engines are being used. Executive jets may have thrusts of up to 15 000 lbs; medium jets may have thrusts of up to 35 000 lbs; and some jumbo jets now have thrusts in excess of 100 000 lbs. Therefore, caution should be used when interpreting the danger areas for ground idle and take-off thrust settings, as some of the distances shown may need to be increased significantly.

In addition, although the danger areas depicted in the diagram have not changed, the thrust figures have been updated to reflect the revised figures above. △



Jet Blast Danger Areas (Not to scale)

Pre-Flight

The Introduction of Supplemental Briefing Cards and Other Technologies for Passengers Who Are Blind or Visually Impaired

by Erin Johnson, Civil Aviation Safety Inspector, Cabin Safety Standards, Standards, Civil Aviation, Transport Canada

Navigating an airport and travelling on board an aircraft can be very stressful experiences for many, and they are even more so for passengers with a disability. Close your eyes and imagine navigating today's chaotic world of travel without the use of your sight. Passengers who are blind or visually impaired (i.e. with partial vision) face numerous challenges when travelling by air. Not only do they have to find their way around the airport, but they must also manoeuvre in the tightly enclosed space of an aircraft cabin.

There are a number of new and innovative technologies to help these passengers overcome travel difficulties. The types of technology that help mitigate obstacles for people who are blind or visually impaired vary. Information can be disseminated to these passengers in a non-visual format via use of audible signage, audible information products, and tactile-based information, such as Braille. Types of technology that facilitate this include personal electronic travel/navigation aids (e.g. sonic devices) and GPS-based systems. These aids provide mobility assistance to persons who are blind or visually impaired. More information on this technology is available in the following Transport Canada publication on technologies for travellers with sensory or cognitive disabilities: www.tc.gc.ca/innovation/tdc/summary/13200/13247e.htm.

Safety briefings

The *Canadian Aviation Regulations* (CARs) require that air operators provide an individual safety briefing when the contents of the standard safety briefing are insufficient due to a passenger's sensory, physical or comprehension limitations, seat orientation or responsibility for another person on board the aircraft. Because of this requirement, a crew member must provide a detailed oral briefing to passengers who are blind or visually impaired. This briefing includes facilitating a tactile familiarization with the equipment that passengers may be required to use; advising them of where to stow their cane, if applicable; advising passengers of the number of seat rows between their seat and the closest exit and also of their alternate exit; providing an explanation of the features and operation of the exits; and, if requested, providing a tactile familiarization of the exit.

Braille supplemental briefing cards

Air operators must also provide each passenger at each passenger seat with a safety features card containing, in pictographic form, the information required by the *Commercial Air Service Standards* (CASS). However, until now, the regulations did not stipulate a requirement to provide passengers who are blind or visually impaired with a card to meet their needs. Recent amendments to Subpart 705 of the CARs and the accompanying Standards introduced a provision for supplemental briefing cards in Braille and large print.

Section 705.44 of the CARs introduces supplemental briefing cards along with the requirements for their visual display of information in Braille and large print. It requires that air operators provide on board every aircraft two copies of the supplemental briefing card in four formats, which may all be displayed on one or more supplemental briefing cards.

With this initiative, passengers who are blind or visually impaired are now provided the same safety information as all other passengers on board.

Service animals

In addition to travelling with a personal attendant, passengers who are blind or visually impaired may also choose to travel with a service animal. A service animal is sometimes referred to as an "assistance animal". The majority of service animals are dogs. In some cases, however, other animals—such as monkeys—have been trained to provide services for persons with a disability.

Air operators are required to permit service animals in the passenger cabin of aircraft with 30 or more passenger seats. However, the carriage of a service animal is subject to certain conditions. Firstly, the individual must require the animal for assistance. Secondly, the animal must be certified, in writing, by a professional service animal institution as having been trained to assist a person. Finally, the animal must be properly harnessed in accordance with standards established by a professional service animal institution.

For more information on the carriage of service animals, please consult Advisory Circular (AC) 700-014 at: www.tc.gc.ca/civilaviation/managementservices/referencecentre/acs/700/700-014.htm.

Things to keep in mind…

It is important to remember that good communication between passengers who are blind or visually impaired and crew members/airline personnel is essential. Good communication addresses the concerns, service, and safety needs of passengers.

It is also important to be aware that the supplemental briefing cards do not replace the requirement for the individual safety briefing. Rather, they are an effective tool for crew members to assist passengers with disabilities. With the advent of supplemental briefing cards and the use of service animals and other innovative technologies for passengers with disabilities, air travel has been made safer, easier and much more enjoyable for persons who are blind or visually impaired. △

FEATURE

Deadly Omissions

by Alan Dean and Shawn Pruchnicki. This article was originally published in the December 2008 issue of AeroSafety World *magazine and is reprinted with the permission of the Flight Safety Foundation.*

Human memory fails in predictable patterns that can be avoided by paying close attention to SOPs when distractions occur.

In August 1987, a McDonnell Douglas DC-9 flight crew taxiing to Runway 03C at Detroit Metropolitan Wayne County Airport (DTW) failed to conduct the taxi checklist. Consequently, the flaps were never set for takeoff, causing the lift-deficient aircraft to crash immediately after takeoff. As a result, 156 souls perished when the aerodynamically stalled aircraft crashed in a parking lot just off the end of the runway.

Nearly 21 years later, in January 2008, a Bombardier CRJ200 crew committed the identical checklist omission at another major U.S. Midwest airport. However, instead of the omission culminating in a fatal accident, a "config flaps" aural warning sounded, and the takeoff was safely aborted.

In the case of the DTW DC-9, the aural warning never sounded. And, although the reason for the failure of the warning system was never determined, it is important to understand that the system's failure is the only variable that separates the DC-9 crash from the CRJ aborted takeoff. Aside from this single difference, these two events are human factors equivalents of identical twins.

Alarmingly, these types of events may be more common than realized. Preliminary investigation of the August 2008 Spanair McDonnell Douglas MD-82 take-off accident in Madrid, Spain, found that the aircraft's flaps were in the retracted position. A recent study of the U.S. National Aeronautics and Space Administration's Aviation Safety Reporting System database revealed numerous reports of airline crews failing to properly configure flaps for takeoff. Seeking to understand the human factors commonalities of these types of incidents, we assembled summaries of the DC-9 and CRJ events.

Boarding of the DC-9 had been delayed by weather for nearly one hour. After passengers were boarded, the before-starting-engines checklist was accomplished, and the aircraft departed from the gate. Ground control responded to the first officer's (FO) taxi request with routing to a different runway than originally anticipated. The controller also advised the crew that the automatic terminal information service (ATIS) recording had been updated to include a warning that low-level wind shear advisories were in effect due to convective activity in the area.

As the captain (CA) initiated taxi, the FO obtained the new ATIS information and recalculated take-off performance numbers. While the FO was "head down," visually focused inside the cockpit, the CA passed by an assigned taxiway. Ground control redirected them, and the taxi resumed with some miscellaneous conversation regarding the earlier weather delay. This delay was significant because the crew's next flight was to an airport with an arrival curfew.

Seven minutes after leaving the gate, the DC-9 crew was cleared to taxi into position and hold on the runway. Although the CA failed to call for the before-takeoff checklist, the FO verbalized all associated items prior to receiving a take-off clearance. As the CA commenced the take-off roll, the FO was initially unable to engage the autothrottle system. This issue was resolved as the aircraft rapidly approached 100 kt. Next, the cockpit voice recorder (CVR) captured the FO verbalizing "V1," then "rotate," closely followed by the sounds of the stick shaker and subsequent ground impact.

The CRJ crew had completed the before-taxi checklist after passenger boarding and requested permission to taxi. As the CA called "flaps 20, taxi checklist," he initiated a right turn as instructed by the controller, but quickly realized that this would send them in the wrong direction. Stopping the aircraft, he interrupted the FO's checklist routine in order to seek clarification. Once that issue was resolved, they manoeuvred along a congested ramp toward their assigned runway. As soon as they reached the runway, the tower controller cleared the crew for immediate takeoff. The line-up checklist was called for, and the FO read it, concluding with "Take-off config okay…line-up check complete." Aircraft control was then transferred to the FO, who began advancing the thrust levers. The "config flaps" aural warning immediately sounded, and at approximately 30 kt the CA aborted the takeoff.

External pressure

From the narratives, it is apparent that both crews experienced external pressures to expedite their departures. For the delayed DC-9's crew, it was an airport arrival curfew, while the CRJ crew felt rushed when they were cleared for immediate takeoff.

> ***"Interruptions, distractions and deviations from standard operating procedures (SOPs) can break mental flow patterns, create false memories and even mask or eliminate initiating cues."***

Both crews likewise encountered distractions as soon as they departed from their gates. For the DC-9 crew, as the taxi began, it became necessary to obtain updated ATIS information and confirm performance data for the unexpected runway change. The CRJ crew received erroneous taxi instructions, which needed clarification. It is important to note that both crews' distractions came at the exact point when the flaps would normally be extended for takeoff according to the taxi checklist.

But to simply say these flights were plagued with errors resulting from rushing and distractions is too simplistic. Many more insidious threats were lurking on each flight deck; threats and human limitations which went untrapped—that is, undetected and unmanaged—ultimately causing both crews to skip entire checklists. Some of those threats included experience/repetition, memory problems, expectation bias and checklist discipline.

Experience and repetition threats

So, how do experienced pilots omit entire checklists? Clearly, experience has many benefits, but experience can also undermine even the most seasoned experts when they are conducting repetitive tasks such as running a checklist. The first critical concept is that, as experience is gained, repetitious tasks such as conducting checklists become cognitively ingrained as simple flow patterns. Consequently, a pilot can automatically move from checklist item "A" to item "B" to item "C" with minimal mental engagement.

The second important concept is that each subsequent checklist item (A, B, C, etc.) is mentally cued to be accomplished by the *perception* that the preceding item has been completed.

And third, initiation of a repetitious task such as a checklist must be prompted by a cue. This initiating cue can come from a verbal command ("flaps 20, taxi checklist"), a condition (engine fire) or even an environmental indicator (proximity to the runway). And here is where the threat lies. Interruptions, distractions and deviations from standard operating procedures (SOPs) can break mental flow patterns, create false memories and even mask or eliminate initiating cues. As demonstrated by the flap-setting omission by both flight crews, the end result may be a significant failure that goes untrapped.

In the DC-9 and CRJ scenarios, each crew encountered immediate interruptions as they began to taxi. This is significant because taxi initiation and proximity to the gate are typical conditional and environmental cues prompting pilots to execute the taxi checklist. In effect, the interruptions of having to obtain ATIS information and clarify taxi instructions masked those cues, leading to omission of the checklist that called for flap extension. Then, as the aircraft continued toward their departure runways, the crews continued to move even farther away from the environment, which could have reminded them to perform the taxi checklist.

Furthermore, as each crew approached the runway, new cues were encountered prompting them to execute other checklists. For the CRJ crew, nearing the runway was an environmental cue to run the before-takeoff checklist. By now the crew was mentally so far from the earlier taxi check that there was little hope that the omitted checklist would be remembered.

Memory threat

There is another elusive human factors threat associated with repetitive tasks that can harmfully influence human memory. Specifically, when presented with cues that are frequently associated with conducting a particular task—such as entering the runway cues the line-up checklist—the brain can actually plant false memories of events that never occurred. This phenomenon is especially prevalent after interruptions.

For example, it is highly likely the CRJ crew intended to perform the taxi checklist after sorting out their taxi instructions. In fact, the CA originally called for the checklist as the aircraft began to move. But then he immediately interrupted the FO from initiating the checklist to clarify the taxi routing. In interruption scenarios like this, the mind can create false memories based on previous experiences. So, later, when running the before-takeoff checklist, the errant crew may have falsely "remembered" completing the taxi checklist. That false memory was created out of the hundreds of other flights in which a checklist would have been completed at that point in the taxi.

This concept is known as *source memory confusion*. Humans are especially susceptible to source memory confusion when interrupted or rushed, variables that existed for both the CRJ and DC-9 crews.

"Another human weakness related to memory is that, generally, humans are not good at remembering to perform tasks that have been deferred for future execution."

Another human weakness related to memory is that, generally, humans are not good at remembering to perform tasks that have been deferred for future execution. Known as *prospective memory failure*, a deferred task is often forgotten until an overt indication—for example, a "config flaps" aural warning—alerts us to our omission. A simple example is when a controller requests a pilot to advise him when "proceeding direct" following a course deviation for weather. This deferred task often is forgotten until the pilot is queried by air traffic control, "Are you direct now?"

Obviously, both FOs made a decision to delay extending the flaps; clearly, the deferred task was not remembered. The CRJ crew received an overt indication of their omission when the "config flaps" aural warning sounded; the DC-9 crew was less fortunate.

Expectation bias threat

Another threat that lurked on both the CRJ and DC-9 flight decks is known as expectation bias. In simple terms, expectation bias is "seeing" what you expect to see even when it is not there. In the case of the CRJ departure, the final item on the line-up checklist is verifying that the "T/O CONFIG OK" advisory message is posted on the electronic display. Among other things, the message confirms that flap settings are appropriate for takeoff. Even though it was not posted, the FO revealed in a post-incident debrief that he "thought" he saw the message.

Understanding such an aberration is difficult, but one explanation provides a plausible answer. Experience conditioned the FO because he always saw "T/O CONFIG OK" displayed when taking the active runway. With an established 100 percent success rate of always seeing the message, expectation bias may have led him to believe that it was present. Perhaps a casual glance at the electronic display was adequate for expectation bias to take place—the FO "saw" the message he was expecting to see.

Checklist discipline threat

Aircraft and procedures are designed with multiple layers of defences to prevent errors from developing into accidents. The DC-9 CVR recording concludes with the sound of the stick shaker, another layer of defence. Under normal circumstances, a crew receiving a stick-shaker warning would decrease pitch and increase thrust to rectify a slow-speed encounter. However, not realizing the aircraft's insufficient lifting capabilities, the DC-9 CA increased the pitch angle, assuming the reason for the stick shaker was a wind shear encounter. His decision in a time-critical environment was not unfounded, as the ATIS noted that low-level wind shear advisories were in effect. However, post-accident investigation revealed no wind shear involvement.

So, although the aircraft's stall warning system functioned properly, the captain's misperception of a wind shear event negated the aircraft's built-in defences. This outcome highlights the extreme importance of the layer of defence existing just prior to the aircraft's defences—the human layer. It also exposes how human error and limitations can readily defeat multiple, robust layers of defence.

And, like aircraft defensive systems, human defensive systems function through sophisticated algorithms. On the flight deck, one of those algorithms is the checklist.

From the narrative, it is apparent that the DC-9 CA never requested the taxi or before-takeoff checklists in accordance with SOPs. By not following standard checklist protocols, the CA became reliant upon the FO to ensure that necessary procedures were accomplished. Because of this SOP deviation, it is conceivable that the FO was task-saturated, having to obtain the new ATIS information, confirm take-off data, perform his normal functions and anticipate checklists the CA failed to request.

Additionally, the CA's reliance on the FO to conduct checklists on his own accord negates a critical two-pronged safety factor associated with checklist design. When correctly applied, the proper method is for a pilot to call for a checklist based upon the flight phase and which pilot is flying the aircraft. As a backup, if the designated pilot fails to call for a checklist, the other pilot should issue a challenge. By transferring checklist initiation to one pilot, that critical safety backup is nullified.

A CA can transfer responsibility for checklist initiation passively or actively. He or she can actively promote the transfer by telling the FO to "run the checklists at your leisure." Alternatively, the CA can passively transfer checklist responsibility by allowing an overly assertive FO to simply run checklists without being commanded. Either way, the practice is not acceptable because it greatly undermines a critical layer of defence. Both pilots must retain their shared responsibility to ensure that checklists are completed.

Cognitive saturation

Maintaining a "sterile cockpit" merits discussion here as well. The human brain has amazing capabilities. But, like a computer, each task accomplished and each variable assessed places cognitive demands on the brain. When these demands exceed an individual's capacity, newly presented information may not be perceived or understood.

This situation is referred to as *cognitive saturation* and its occurrence prevents the accomplishment of further tasks. Even the act of ignoring nonpertinent conversation requires mental effort, which may compromise safety. For example, while listening to a CA speak about his weekend plans, an FO may fall victim to source memory confusion, causing him to incorrectly believe he's completed a checklist.

Some argue that light conversation serves to facilitate crew bonding. While this is true, the timing of such conversation must respect cognitive limitations and the safety advantages of adhering to sterile-cockpit regulations.

Mitigation strategies

These threats represent inherent weaknesses associated with the flight deck environment and the professionals who strive to perform flawlessly within it. Unfortunately, a minor slip or deviation from SOPs can put crew and passengers in harm's way. Individually, some violations are seemingly inconsequential—an incomplete taxi briefing or a minor violation of the sterile cockpit rule. But when combined with other lost layers of protection, sometimes unknown to the crew, the margin of safety can rapidly erode, causing the flight to slip closer to an accident.

When presented with threats, professional pilots want to know how to counter them. The following mitigation strategies outline proven techniques to overcome normal human limitations that may erode safety margins:

- Recognize that interruptions can alter human behaviour and seriously erode safety margins. Interruptions are threats and should be regarded as accident precursors. Treat any interruption with caution.
- Overcome prospective memory failure by clearly informing your flying partner if interruptions or operational necessity dictate delaying a checklist. When doing so, also verbalize a specific plan detailing when the delayed task will be accomplished. This can enable the other crew member to confirm that the task will be performed.
- Understand that memory is heavily influenced by cues. A memory aid recognized by both crew members can serve as a reminder to perform a delayed task.
- If interrupted while performing a checklist, re-run the entire checklist. Doing so greatly reduces the probability of succumbing to source memory confusion.
- To overcome expectation bias, use the say-look-touch confirmation technique. For example, when confirming proper flap settings while conducting a checklist, say what the setting should be, look at the flap position indicator and touch the flap handle. By incorporating multiple sensory inputs, a higher level of task attentiveness is achieved.
- Slow down. Rushing is a primary initiator of human factors-related failures, including those associated with repetitive tasks.
- Checklists should be specifically called for by the appropriate pilot in accordance with SOPs. Doing so ensures that the check-and-balance philosophy built into them remains intact. It also enhances situational awareness, as both pilots can remain apprised of the aircraft's status. Do not advocate the idea of executing checklists "at your leisure."

Alan Dean is Chief of Safety for a large corporate aviation flight department. He also has extensive air carrier experience as an airline captain, line check airman and flight safety manager. For nearly a decade, Dean served as a flight safety investigator for the Air Line Pilots Association, International (ALPA).

Shawn Pruchnicki, a CRJ200 captain with Comair Airlines, is a former accident investigator and director of human factors for ALPA and has participated in numerous accident investigations. He teaches classes related to system safety, human factors and accident investigation at Ohio State University.

References:

1. U.S. National Transportation Safety Board. Aircraft accident report: *Northwest Airlines, Inc., McDonnell Douglas DC-9-82, N312RC, Detroit Metropolitan Wayne County Airport, Romulus, Michigan, August 16,1987*. NTSB/AAR-07/05.
2. Dismukes, R.K.; Berman, A.B.; Loukopoulos, L.D. *The Limits of Expertise*. Aldershot, Hampshire, England: Ashgate Publishing.
3. Pruchnicki, S. "Raising Awareness for All." *Professional Pilot*. Volume 42, no. 4 (2008) 72–74. △

Area Navigation in Canada

by Ian Johnson, Civil Aviation Safety Inspector, Aerodromes and Airspace Standards, Standards, Civil Aviation, Transport Canada

Airborne navigation has progressed from maps, watches and sextants, to ground-based navigation aids (NAVAID) (non-directional beacons [NDB] and VHF omnidirectional ranges [VOR]), to self-contained navigation systems such as inertial navigation systems (INS) and space-based systems (e.g. GPS). A minimum navigation performance specification (MNPS) for the North Atlantic was published in 1979 by the International Civil Aviation Organization (ICAO), marking the beginning of navigation harmonization. The intent was to standardize the navigation performance of aircraft crossing the Atlantic from North America to Europe in order to manage air traffic in a safe and efficient manner and increase safety. By using managed Mach cruise speeds and specifying a level of navigation-system accuracy (initially, the required position accuracy allowed a 60-NM across-track by 60-NM along-track spacing between aircraft), aircraft could be spaced more effectively, thereby saving air operators time and fuel. As the skies became more crowded over the years and the distances travelled increased, greater accuracy in navigation became necessary not only for oceanic airspace but also for domestic airspace. The earlier tolerance for navigation error gave way to the "be exactly at this position, at this time" necessity of today's busy airspace. This has led to the development of additional navigation specifications for specific types of airspace.

Initially, civil aviation authorities regulated aircraft navigation capability by requiring the carriage of specific navigation units (e.g. VOR or distance-measuring equipment [DME]). Then area navigation (RNAV) system use became commonplace in the 1970s. These early units used input from long-range systems (OMEGA, LORAN) and ground-based NAVAIDs to fix positions. As costs decreased, stand-alone inertial navigation systems (INS) began to be widely utilized and positional accuracy increased significantly. With this greater level of accuracy and reliability, highly sensitive systems utilizing multiple sensor inputs were developed and put into service. Satellite navigation constellations, inertial reference platforms, and ground-based NAVAIDs are all integrated by flight management systems (FMS) today to determine the position of an aircraft. An example of a stand-alone sensor with integrated capabilities available would be a combination GPS-inertial reference unit (IRU).

Early navigation practices meant an aircraft's position could be in error literally by miles. Today's systems can establish a position to significantly less than a mile. These technological advances have created many different levels of possible system accuracy, redundancy, and performance monitoring. RNAV progressed to required navigation performance (RNP), which has now evolved into the ICAO performance-based navigation (PBN) concept. RNP and RNAV are sub-specifications of PBN; RNP has additional technical requirements above and beyond RNAV. In order to have a consistent global approach to navigation, standards are being harmonized through PBN. Rather than specifying the exact navigation equipment aircraft need to carry, ICAO has created PBN specifications. This means that a navigation specification will state the accuracy, integrity, continuity, performance monitoring and alerting, and signal in space required. The system accuracy required is stated after the type of specification, for example, RNP 4, RNAV 5. The 4 and 5 represent the +/- NM along-/across-track accuracy performance the aircraft's navigation system must meet. An RNP-type navigation system will continuously monitor its position and alert crew members if the aircraft has the potential to stray outside of allowable airspace boundaries. The airspace boundary is an area equivalent to twice the RNP value. For example, the RNP-4 lateral boundary is a corridor 8 NM in width.

The basic navigation categories are as follows:

Area navigation (RNAV)—A method of navigation that permits aircraft operation on any desired flight path within the coverage of station-referenced NAVAIDs, within the limits of the capability of self-contained aids, or a combination of both.

Required navigation performance (RNP) system—An RNAV system that supports on-board performance monitoring and alerting.

Performance-based navigation (PBN)—RNAV based on performance requirements for aircraft operating along an air traffic system route, on an instrument approach procedure, or in a designated airspace.

Certain levels of navigation performance are infrastructure-based, meaning the number of DME or

VOR/DME facilities available affects the aircraft system's ability to resolve its location. A navigation system may be capable of an accuracy level of only 2 NM, due to the number and proximity of facilities. Yet given enough facilities, the same system may provide an accuracy level of 1 NM. For example, because the RNAV-1 and RNAV-2 specifications can be dependent on infrastructure, the two specifications are combined into one by ICAO and the Federal Aviation Administration (FAA): RNAV 1/2. The use of satellite systems provides a unique capability independent of ground-based infrastructure. RNAV or RNP arrivals or departures can be implemented at airports that have either minimal or non-existent ground-based NAVAIDs—potentially a much more cost-effective way to provide approach services.

With the advent of reliable and accurate navigation systems for commercial and private aircraft, operators can now take advantage of these capabilities in certain en-route and terminal airspaces. Specifications currently in place or being developed are:

Area of application	Navigation accuracy (NM)	Designation of navigation standard (current)	Designation of navigation standard (new)	Requirement for performance monitoring and alerting	GNSS required
Oceanic/Remote*	10	RNP 10	RNAV 10 (RNP 10 label)	No	No
Oceanic/Remote	4	RNP 4	RNP 4	Yes	Yes
En-route-Continental	5	B-RNAV	RNAV 5	No	No
En-route-Continental and Terminal**	2	US RNAV "A"	RNAV 2	No	No
Terminal**	1	US RNAV "B" P-RNAV	RNAV 1	No	No
Terminal	1	Basic RNP 1		Yes	Yes
Terminal	1	Advanced RNP 1		Yes	Yes
Terminal/Approach	1/0.3	RNP APCH		Yes	Yes
Terminal/Approach	1/0.3 or less	RNP AR APCH		Yes	Yes

* Time limits apply to certain DME/DME/IRU systems.
** RNAV 1/2 can be infrastructure-based.

RNAV and GPS procedures have been in effect in Canada for some time now, and operators are aware of their benefits. Operators are currently using PBN arrivals, approaches, and departures at various airports to reduce flight time, fuel burn, carbon emissions, and noise footprints. RNP procedures into mountainous airports have the potential to enable lower weather minima than those possible with traditional NAVAIDs.

In the future, PBN will enable continuous descent arrivals (CDA) and required time of arrival (RTA) approaches (i.e. the flight will be cleared to arrive at the runway threshold within a specific window of time). It has the potential to increase efficiencies at high-volume airports and provide better access to smaller airfields. Combined with automatic dependent surveillance-broadcast or -contract (ADS-B and ADS-C, respectively) and controller-pilot data link communications (CPDLC), PBN specifications could allow higher traffic densities on oceanic or remote routes. PBN's inherent potential to optimize flight routes, improve flight safety, and also reduce emissions makes it an attractive tool for aviators in Canada.

References:

1. *ICAO Performance-Based Navigation Manual*, ICAO Doc 9613
2. TC Advisory Circular (AC) 123R "Use of Global Positioning System for Instrument Approaches"
3. FAA AC 90-105 "Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System"
4. FAA AC 90-101 "Approval Guidance for RNP Procedures with SAAAR"

Other information:

1. *Transport Canada Aeronautical Information Manual* (TC AIM)
2. *AIP Canada (ICAO)* COM section. △

EMS Helicopter Crew Caught by Black Hole Illusion

On February 8, 2008, a Sikorsky S-76A MEDEVAC helicopter departed Sudbury, Ont., for Temagami, Ont., to meet a land ambulance. At approximately 22:02 Eastern Standard Time (EST), while on final approach to the Temagami Snake Lake Helipad in night visual meteorological conditions (VMC), the helicopter crashed in the forested area at the edge of the lake. The helicopter came to rest on its left side and was substantially damaged. Three of the four occupants received serious injuries and were transported to the hospital. This article is based on the Transportation Safety Board of Canada (TSB) Final Report A08O0029.

The entire region was experiencing localized light to moderate snowfall on the evening of the occurrence and it was uncertain as to whether the flight would be able to land in Temagami.

The captain was the pilot flying (PF) and was certified and qualified for the flight in accordance with existing regulations. He had approximately 3 107 hr total flying time and 2 267 hr on the Sikorsky S-76A. Records indicate that he had received all of the company's required training, including night visual flight rules (VFR)/ instrument flight rules (IFR) and controlled flight into terrain (CFIT) with specific training for black hole approaches (visual spatial disorientation). The captain had been to this location once in the past, on a day VFR flight.

The first officer was the pilot not flying (PNF) and was certified and qualified for the flight in accordance with existing regulations. The first officer was hired in July 2007, and had all the required training. He was fairly new to emergency medical services (EMS) operations and had never been to this location.

On the night of the occurrence, the helicopter departed Sudbury at approximately 21:40 EST on a short flight to the Snake Lake Helipad in the town of Temagami, located approximately 60 NM to the northeast. The helicopter climbed to 2 500 ft and proceeded to Temagami. Throughout the initial portion of the flight, the visibility was found to be no less than 4 to 5 SM and improved as the flight progressed. The flight was uneventful and both pilots spent most of the time discussing procedures and co-ordinating the patient pick-up with dispatch. During the last 1.5 min of the approach, the PF was explaining to the PNF what he was doing, step by step, and what to watch for during night approaches, including black hole illusions.

The Snake Lake Helipad is located on the northeast edge of town. According to the operator's landing site directory for the Sudbury/Moosonee district, the Snake Lake Helipad is at a field elevation of 997 ft above sea level (ASL) and has a 100 by 100 ft asphalt-surfaced pad with retro-reflective cones around the perimeter and with lead-in cones at 220° magnetic (M) from the pad. Four of the perimeter cones can be equipped with e-flares to aid in visibility. These must be requested by the flight crew and are placed and activated by ground EMS personnel. They were not requested on the night of the occurrence.

The directory cautions of the following hazards:

- wires under, along east and north sides of the approach/departure sector;
- large hills south, east, and north of the site;
- tower west and fire tower south of the site;
- ball park east of helipad.

Additionally, there is a single house located beside the ball diamond, which has typical outside door entrance lights.

The helicopter approached the helipad from the southwest on a heading of approximately 048°M and entered the trees near the edge of the lake approximately 814 ft horizontally from the helipad.

The trees on the approach averaged 40 ft in height. The helicopter impacted trees that were located on the downward slope of the hill, at approximately 70 ft horizontally from the shore, where the height of the hill is approximately 10 ft higher than the helipad. As such, the average tree tops were approximately 50 ft higher than the helipad. The descent into the trees was near vertical with very little horizontal momentum and the nose of the helicopter came to rest approximately 15 ft from the shore. The helicopter's rotor diameter was 44 ft and the damage to the trees was mostly within this diameter. The rotor blades were completely destroyed. During the descent, a tree passed through the left landing gear bay, the main battery, and continued through the engine deck and exhaust collector of the right engine. There was evidence of heat and scorching on the tree consistent with the heat of a running engine, but no post-crash fire.

Snake Lake Helipad

A detailed examination of the helicopter revealed no discrepancies that would have affected its flying characteristics. No damage was found that would have prevented the engine from running.

The helicopter was equipped with an enhanced ground proximity warning system (EGPWS), dual Garmin GNS 530 global positioning system (GPS)/Navigation/Communication units, a Latitude Technologies SkyNode satellite tracking system, and a cockpit voice recorder (CVR). These components were removed and analyzed. There were no operating abnormalities with the helicopter or engines prior to impact, and the helicopter was on the proper descent profile until it reached 500 ft above ground level (AGL) and 0.5 NM from the helipad, 21.5 s before impact. The PF perceived that the helicopter was too high and corrected accordingly. Simultaneously, the cockpit area microphone picked up the sound of the rotor RPM increasing slightly, then decreasing just prior to impact. The rotor RPM recording also confirmed an increase and decrease in rotor RPM just prior to impact. The PNF did not question the PF's deviation from the proper descent profile, nor did he make any further speed or altitude calls after the deviation.

According to a study by the United States Air Force, titled *Running Head: BLACK HOLE ILLUSION*, spatial disorientation is defined by Gillingham as: "an erroneous sense of one's position and motion relative to the plane of the earth's surface." The study also states:

> Visual spatial disorientation (SD) is often cited as a contributor to aviation accidents. The black hole illusion (BHI), a specific type of featureless terrain illusion, is a leading type of visual SD experienced by pilots. A BHI environment refers not to the landing runway but the environment surrounding the runway and the lack of ecological cues for a pilot to proceed visually. The problem is that pilots, despite the lack of visual cues, confidently proceed with a visual approach. The featureless landing environment may induce a pilot into feeling steep (above the correct glide path) and over-estimate their perceived angle of descent (PAD) to the runway. Consequently, a pilot may initiate an unnecessary and aggressive descent resulting in an approach angle far too shallow (below the correct glide path to landing) to guarantee obstacle clearance.

Analysis

There were no anomalies found with the helicopter that would have contributed to the accident. Therefore, this analysis focuses on the operation of the helicopter.

The Snake Lake Helipad is a classic black hole approach helipad. Temagami itself is a small community and the helipad is on the northeast edge of town. The approach is flown over the town and past all the lights with a relatively featureless landscape forward. The only visible lights are those of the house beside the ball diamond. On the terrain along the approach path, a small hill begins to rise approximately 2 430 ft horizontally from the helipad. The maximum rise is approximately 20 ft, which then gently slopes back down to the lake surface 723 ft horizontally from the helipad. The mature trees along the flight path would further increase the obstacle height another 40 ft. However, the steep approach angle of 8° into the landing site would have provided for adequate clearance above the trees to land safely.

The black hole approach requires diligent monitoring of the helicopter's instruments. The flight crew followed most of the standard operating procedures (SOPs) during the approach and appropriate calls were made. In this case, the PNF was monitoring the airspeed, altitude and distance to the helipad. He relayed this information to the PF regularly. The PF, flying a visual approach, utilized the information from the PNF in addition to the visual cues for reference. However, the PF's radar altimeter was not set to 150 ft as called for by the operations manual. This would have provided an additional cue to the flight crew that the helicopter was approaching the ground too soon during the descent into the helipad. Meanwhile, the helicopter was on a stabilized approach with the proper 8° descent profile, as required by the operations manual and the SOP.

During the 1.5 min of the approach, the PF's attention was split between flying the approach and explaining why things were happening and what to watch for during a black hole approach. This likely distracted the pilots from the task at hand. In this case, the PF acknowledged a 0.5 NM and 500-ft call, an on-profile condition, but visually perceived that the helicopter was too high and, therefore, increased the rate of descent. This coincides with the increase in the rotor RPM—an indication that the collective is being lowered, decreasing the load on the rotor blades and increasing the descent rate. This was followed by a decrease in rotor RPM as the collective was raised, increasing the load on the rotor blades and decreasing the descent rate just prior to impact. At no time did the PNF question the PF's deviation from the proper descent profile nor did he make any further speed or altitude calls after the deviation.

Based on the available information, a descent from 500 ft to impact in less then 21.5 s equates to a descent rate of more than 1 400 ft/min—well in excess of the recommended maximum descent rate of 750 ft/min. The increased descent rate caused the helicopter to descend into the trees before either crew member realized what was happening.

Findings as to causes and contributing factors

1. The PF was likely affected by visual spatial disorientation and perceived the approach height of the helicopter to be too high. While correcting for this misconception, the helicopter descended into trees 814 ft short of the helipad.
2. The pilots were likely distracted during the critical phase of the approach and did not identify that the helicopter had deviated from the intended approach profile and recommended descent rates.

Findings as to risk

1. The right rear aft-facing paramedic seat lap belt attachment barrel nut was worn in the groove where the seat belt attaches, weakening the barrel nut's structural integrity, thereby increasing the risk of failure.
2. The helicopter crashed on its side, placing an abnormal side load on the right rear aft-facing paramedic seat lap belt attachment barrel nut, thereby causing it to fail.

Safety action taken

Following the occurrence, the supplemental type certificate (STC) holder for the EMS interior utilized in the S-76, issued Service Bulletin No. SB-EMS76-1. This service bulletin identified the affected helicopters and called for the replacement of the existing lap belt attachment barrel nut with a steel shackle. All affected helicopters have complied with the service bulletin. △

Helicopter Safety Helmets—A Hard S(h)ell

by Rob Freeman, Program Manager, Rotorcraft Standards, Operational Standards, Standards, Civil Aviation, Transport Canada

In 1913, two American Army Signal Corps aviators were involved in a crash of their aircraft. It was later determined that the use of a steel helmet prevented one of them from suffering serious injuries. The investigation team recognized the potential of safety helmets for aviators, and ran with it. In fact, a steel helmet was designed for experimental use in aircraft near the end of World War I. From that uncertain genesis, you never see a military helicopter pilot anywhere in the world today without a helmet.

In the intervening years, we have seen many different types of helmets designed, developed, and accepted as an effective preventative measure. The list is long and inclusive of almost all activities where the participant is exposed to head injury—from construction workers and hockey players, to Formula One drivers, and many others. Why? Helmets work. They save heads and, subsequently, lives. And yet, their overall use by commercial and private helicopter pilots in the civilian market is conspicuously low, as verified by surveys and accident statistics. Agreed, there are some pockets of usage and acceptance in Canada—such as for aerial work, and by police and EMS operators, government pilots, heliskiing operators and individual, progressive companies—but for many Canadian operators and their pilots, helmet use is still rare.

As noted above, helmets, and the official recognition of their contribution to aviation safety originally occurred almost 100 years ago. There are light-weight, high-tech helmets specifically developed for helicopter use on the market now, incorporating active noise suppression, superior communications, and other desirable innovations that contribute to physical health and comfort, as well as accident protection. Availability and technology are not the issue. So what gives? Why are so many of our associates still flying around with semi-naked heads? The traditional list of excuses for not wearing helmets includes, but is not limited to, the following:

- Peer pressure. You start in a new company and are anxious to fit in, and no one else wears a helmet. I was once asked disdainfully by a group of grizzled veterans when I showed up on the job site with a helmet if I was a rookie or an ex-military pilot. Although no explanation for these two unrelated categories was offered, apparently neither group was desirable in a real man's operation. Does this sound familiar? How are helmets perceived in your company? Is the safety culture supportive or dismissive?

- Company pressure. More than one operations or marketing manager has suggested that their pilots not wear helmets, as it frightens the passengers by implying that helicopter flight is a high-risk activity and is therefore bad for business.
- Comfort, fit, and helmet weight. These complaints often stem from the fact that used helmets were purchased from various sources such as military surplus and were never properly fitted for the current user. Pressure, hot spots, and neck pain resulted. And earlier designs were heavy.
- Feeling of restriction. Some pilots genuinely suffer claustrophobia when wearing helmets. Luckily, they are few in number, but their dilemma is legitimate. (There are a few newer models of light-weight helmets with less side-panel coverage that might provide a solution for these folks.)
- Feeling of invincibility. No one takes off in the morning planning to have an accident. If you are involved in the same work, in the same helicopter type for a long period of time, you may develop a sense of complacency and invincibility. One day is pretty much the same as the next. If you are never going to crash, why bother with a helmet?
- Cost. Depending on the model and installed equipment, a well-equipped helmet can exceed $3000, whereas a good-quality headset, complete with designer sunglasses and a snazzy baseball cap with your favourite team logo is less than a grand. Simply put, what is more important: your head or your "look"?
- Conventional wisdom states that aerial work and remote operations conducted by single-engined helicopters pose the greatest risks to their pilots for mishaps, and those are the areas where helmets should be employed. Medium and large twins, used more for pure transport, are statistically less likely to end up in an accident. Therefore, helmet usage is a lesser concern for these pilots.

The reality: In the past three years, at least one of each of the latest generation of medium to large twin-engined helicopters, with all the latest technology, has suffered a serious or fatal accident somewhere in the world. Although the traditional wisdom would seem to indicate otherwise, there is no "pass" to helmet usage just because you fly a large twin mostly in cruise flight at altitude. If you lose control of the helicopter for whatever reason, you are subject to the same forces on impact as the pilot in the smallest single. One study conducted by the U.S. Army concluded that head injuries occurred in approximately 70 percent of helicopter accidents. And many of these accidents occur at relatively slow speeds, meaning that they are probably survivable, if the crew is properly protected.

It is the secondary impact that causes head trauma and kills. The primary impact is the airframe striking the terrain or water. The secondary impact results from inertia, causing the crew to strike hard fixed objects within the cockpit. Instantaneous, momentary impact forces can easily exceed 50 g—50 times the force of gravity. Without a helmet, no matter how strong you are, or how you brace yourself you cannot avoid the hard secondary impact with your head. Transport Canada (TC) *Canadian Aviation Regulations* (CARs) mandate seat belts and shoulder harnesses to hold you in your seat. This has greatly reduced chest and limb injuries. Unfortunately, without a helmet, your head is left unprotected and flailing about during an accident sequence.

The Transportation Safety Board of Canada (TSB) Aviation Safety Advisory which follows this article advises that you are six times more likely to suffer a fatal injury if you crash without a helmet. A 1998 Flight Safety Foundation (FSF) study on helmet-visor usage further suggests that, in 25 percent of helicopter accidents where a helmet is worn with the visor down, the visor will significantly reduce facial and—of particular importance to pilots—eye injuries resulting from those secondary collisions. Visors aren't just for bird strikes. In researching this article, I realized that I personally knew several skilled pilots over the years who died in helicopter accidents, primarily due to unprotected head trauma. How about you? Uncomfortable memories too? These statistics aren't just for others.

U.S. military services train helicopter crew members to use aviation life-support equipment (ALSE) on every flight and include, minimally, a Nomex flight suit, fire-and chemical-resistant gloves, leather boots, and a helmet with visor. The helmet and visor are considered the most critical because numerous studies show that head injuries are the leading cause of death in U.S. Army helicopter accidents. Although an argument might be made that military missions are different from civilian flying, military accidents that do not involve weapons fire are surprisingly similar to those of their civilian brethren in root causes. There are certainly more similarities than differences.

If an accident occurs and you are unconscious or badly injured, you are of no help to your passengers and significantly reduce their chances for survival. Passengers look to their pilot(s) for leadership and direction after a crash, and they are far less likely to do as well without you. After all, you are the activity authority (flight) figure, you have the survival training knowledge, and you are familiar with the emergency gear, the emergency locator transmitter (ELT), and rescue protocols. An unconscious pilot is just one more demanding burden on the survivors, who may have limited abilities or knowledge and are probably dealing with shock, confusion, and trauma themselves. Your need to perform and provide leadership after an accident has occurred should not be underestimated. Your own survival, as well as theirs, could depend on it.

The fact is, all helicopter pilots should be wearing helmets—with visors installed and selected down, whenever possible. The numbers speak for themselves. So what is the answer? How do we get a buy-in and get Canadian heads and helmets together? When motorcycle head injuries spiked some years ago and large numbers of injured riders suddenly needed expensive, continuous, and high-tech medical care, provincial transportation authorities introduced mandatory helmet regulations. The loss of individual freedom of choice was considered less important than the soaring medical costs of treating severe, chronic injuries on a lifetime basis. Remember: unlike other injuries, brain trauma may be irreversible. The injury and its consequences may be with you for the rest of your life, provided that you survive to begin with.

Should TC introduce regulations for mandatory helmet usage? Under the current government's Cabinet Directive on Streamlining Regulations, TC may consider regulatory action only when absolutely necessary. Other alternatives must be considered first. In this case, with relatively low numbers of pilots affected, a more consultative approach with industry in accordance with the Canadian Aviation Regulation Advisory Council (CARAC) Charter is mandated before any regulatory action can be undertaken. However, when Safety Management Systems (SMS) arrive, individual operators will be required to do operational risk assessments to identify existing hazards and mitigate them. And this is definitely a hazard. In the meantime:

- Various associations such as the Helicopter Association of Canada (HAC), Air Transport Association of Canada (ATAC), Association québécoise des transporteurs aériens (AQTA), and others such as the insurance industry could act as champions for this safety initiative, particularly if identified as a best practice by the associations' memberships.
- Individual operators and their safety managers can encourage or underwrite the time-payment purchase of helmets. In fact, a single paragraph inserted in the company operations manual—mandating the use of helmets by all company pilots—would suffice, provided that the operator were willing to underwrite or otherwise assist in their purchase.
- Alternatively, each pilot can take responsibility for his or her own well-being. Nothing prevents individuals from purchasing and using helmets themselves, without official action at any level. You might even be able to negotiate a deal if several pilots in the same organization place a bulk order!

This is one proven but overlooked safety innovation that greatly increases accident survivability and resulting quality of life, and it is fully supported by TC. To paraphrase those quirky television credit-card commercials: "What's on your head?"

Source: Flight Safety Foundation, Helicopter Safety, *Volume 24, Number 6, November–December 1998.*
Article: Helmets with Visors Protect Helicopter Crews, Reduce Injuries
Authors: Clarence E. Rash, Barbara S. Reynolds, Melissa Ledford, Everette McGowin, III, John C. Mora, U.S. Army Aeromedical Research Laboratory, Fort Rucker, Alabama △

Low Usage of Head Protection by Helicopter Pilots

The following is an Aviation Safety Advisory from the Transportation Safety Board of Canada (TSB).

On March 12, 2009, a Sikorsky S-92A helicopter with 16 passengers and 2 flight crew on board was en route from St. John's, N.L., to the Hibernia oil production platform when, 20 min after departure from St. John's, the flight crew noticed an indication of low oil pressure to the main gearbox. The crew declared an emergency and diverted the flight back to St. John's. Approximately 30 NM from St. John's, the helicopter impacted the water and sank in 178 m of water. There was one survivor and 17 fatalities. Although not fatally injured during the impact sequence, both pilots received severe injuries due in part to striking their heads/faces against the instrument panel. Neither pilot on the occurrence flight was wearing head protection.[1] The TSB investigation into this occurrence (A09A0016) is ongoing.

While the *Canadian Aviation Regulations* (CARs) do not require that helicopter pilots wear head protection, approximately 10 percent of the operator's pilots were routinely wearing head protection at the time of the occurrence. Whether or not this percentage represents an industry-wide norm for head protection usage is unknown. However, the majority of pilots surveyed during the A09A0016 investigation cited discomfort as the reason they did not wear head protection. In addition, very few pilots had fully considered that

[1] TSB defines head protection as the use of an approved helmet, complete with visor.

partial incapacitation due to a head or face injury could compromise their ability to help their passengers after an accident. On May 8, 2009, the operator implemented a cost-sharing program aimed at increasing the use of head protection. Management agreed to cover a portion of the cost for any pilot wishing to purchase a prescribed make and model of head protection. The operator stated that approximately 50 percent of its pilots have participated thus far, and it anticipates 75 percent participation.

According to U.S. military research[2], the risk of fatal head injuries can be as high as six times greater for helicopter occupants not wearing head protection. In addition, the second most frequently injured body region in survivable crashes is the head.[3] The effects of non-fatal head injuries range from momentary confusion and inability to concentrate, to a full loss of consciousness[4]; these outcomes can effectively incapacitate pilots. Incapacitation can compromise a pilot's ability to quickly escape from a helicopter and assist passengers in an emergency evacuation.

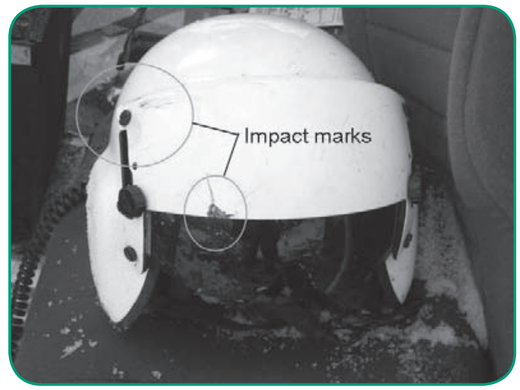
The U.S. National Transportation Safety Board (NTSB) has acknowledged that the use of head protection can reduce the risk of injury and death. A review of 59 emergency medical services accidents that occurred between May 11, 1978, and December 3, 1986, was completed in 1988. This review resulted in recommendations to the Federal Aviation Administration (FAA) (# A-88-009) and to the American Society of Hospital-Based Emergency Aeromedical Services (# A-88-014) to require and encourage, respectively, that crew members and medical personnel wear protective helmets to reduce the risk of injury and death.

Transport Canada (TC) also acknowledged the safety benefits of head protection use in its 1998 Safety of Air Taxi Operations Task Force (SATOPS) report[5], in which it committed to implementing the following recommendation:

- That TC continue to promote in the *Aviation Safety Vortex* newsletter the safety benefits of helicopter pilots wearing helmets, especially in aerial work operations, and promote flight training units (FTU) to encourage student pilots to wear helmets.

In addition, SATOPS directed the following recommendation to air operators:

- That helicopter air operators, especially aerial work operators, encourage their pilots to wear helmets, that commercial helicopter pilots wear helmets, and that FTU encourage student helicopter pilots to wear helmets.



This helmet was retrieved from an AS350 accident in Atlantic Region (TSB File A07A0007). The other pilot was not wearing his helmet and suffered serious head injuries.

The TSB has documented a number of occurrences where the use of head protection likely would have reduced or prevented the injuries sustained by the pilot. Similarly, the TSB has documented occurrences in which the use of head protection reduced or prevented injuries sustained by the pilot. Despite the well-documented safety benefits of head protection, the majority of helicopter pilots continue to fly without it. Likewise, most Canadian helicopter operators do not actively promote head protection use amongst their pilots. The low frequency of head protection use within the helicopter industry is perplexing, given the nature of helicopter flying and the known benefits of head protection.

As shown in this occurrence, without ongoing and accurate communication of the benefits of head protection usage, helicopter pilots will continue to operate without head protection, thereby increasing the risk of head injury to the pilot and consequent inability to provide necessary assistance to crew or passengers. Therefore, TC and the Helicopter Association of Canada (HAC) may wish to consider creating an advocacy program designed to substantially increase head protection use amongst helicopter pilots. Such a program could include, but is not limited to, initiatives that: ensure that helicopter-pilot training curricula highlight head protection use, promote the advantages of cost-sharing programs between operators and pilots, and encourage informed debate by publishing articles that promote head protection use in publications such as the TC *Aviation Safety Letter* (ASL) and HAC newsletters. △

[2] Crowley, J.S. (1991) "Should Helicopter Frequent Flyers Wear Head Protection? A Study of Helmet Effectiveness." *Journal of Occupational and Environmental Medicine*, 33(7), 766-769.

[3] Shanahan, D., Shanahan, M. (1989) "Injury in U.S. Army Helicopter Crashes October 1979–September 1985." *The Journal of Trauma*, 29(4), 415-423.

[4] Retrieved on 31 August 2009 from www.braininjury.com/injured.html.

[5] Transport Canada publication, TP 13158.

Sharing Best Practices—Managing the Risk of Maintenance Error

by Alan Hobbs, Ph.D., Australian Transport Safety Bureau

The following is an excerpt from "An Overview of Human Factors in Aviation Maintenance" in the Aviation Research and Analysis Report—*AR-2008-055, which is published by the Australian Transport Safety Bureau. It is reprinted with permission. To read the complete report, visit* www.atsb.gov.au.

Organisational influences on maintenance error

Although maintenance occurrences usually involve errors made by technicians, investigations of airline maintenance events also identify organisational-level factors such as: training and qualification systems, the allocation of resources, and the cultural or value systems that permeate the organisation. For example, a maintenance violation—such as using an incorrect tool—may occur because the correct tool was not available, which in turn may reflect equipment acquisition policies or financial constraints. One of the most common reasons given for maintenance violations is time pressure, and this in turn may be symptomatic of organisational conditions such as planning, staffing levels or work scheduling.

An acknowledgement of the organisational influences on maintenance error is sometimes misconstrued as an attempt to absolve maintenance technicians of responsibility for their work, or to shift blame from workers to management. Yet just as positive outcomes such as profitability, on-time performance, and customer satisfaction are indicative of the performance of the entire organisation, so too, negative events such as maintenance lapses are often a product of organizational processes.

"While all involved in aviation safety must be prepared to take responsibility for their actions, a punitive response to genuine errors is ultimately counterproductive."

Although human factors problems in maintenance are usually revealed through the actions of technicians, the solutions to these problems usually require system-level solutions, as described in the next section.

Managing the risk of maintenance error—Error management systems

Within airline maintenance, there is an increasing emphasis on error management as an integral part of an organisation's safety management system (SMS). An SMS is a coordinated approach to the management of safety that goes beyond regulatory compliance. According to the International Civil Aviation Organization (ICAO), an effective SMS requires strong management commitment and attention to concerns ranging from corporate culture to event investigation and human factors training.[1]

A significant problem facing maintenance organisations is how to encourage the disclosure of maintenance incidents that would otherwise remain unknown to management. Despite the extensive documentation that accompanies maintenance, the day-to-day work of maintainers may be less visible to management than the work of pilots or controllers. Pilots work under the constant scrutiny of quick access recorders, cockpit voice recorders and flight data recorders, not to mention passengers and the public. The performance of air traffic controllers is carefully monitored, and their errors tend to become immediately apparent to either fellow controllers or pilots. In contrast, if a maintenance engineer has a difficulty with a maintenance procedure at 3 a.m. in a remote hangar, the problem may remain unknown to the organisation unless the engineer chooses to disclose the issue. Once a maintenance error has been made, years may elapse before it becomes apparent, by which time it may be difficult to establish how it occurred.

Incident reports are one of the few channels for organisations to identify organisational problems in maintenance, yet the culture of maintenance around the world has tended to discourage the open reporting of maintenance incidents. This is because the response to errors has frequently been punitive. In some companies, common errors such as leaving oil filler caps unsecured will result in several days without pay or even instant dismissal. It is hardly surprising that many minor maintenance incidents are never officially reported. When Australian maintenance engineers were surveyed in 1998, over 60 percent reported having corrected an error made by another engineer without documenting their action, to avoid potential disciplinary action against the colleague.[2]

[1] International Civil Aviation Organization (2008). *Safety Management Manual* (SMM). 2nd ed. (Doc 9859).

[2] National Transportation Safety Board (1992). *Continental Express, Embraer 120.* Aircraft Accident Report 92/04.

While all involved in aviation safety must be prepared to take responsibility for their actions, a punitive response to genuine errors is ultimately counterproductive. Some in the aviation industry have proposed that a "blame free" culture is necessary to encourage reporting. This could imply that no-one would ever be held responsible for their actions. More recently, the concept of "just culture" has been promoted, in which some extreme violations will result in discipline; however, most will not.

Incident reporting programs in maintenance

Progress is slowly being made towards error reporting systems that enable maintenance engineers to disclose genuine mistakes without fear of punishment. Part 145 of the European Aviation Safety Agency (EASA) regulations requires maintenance organisations to have an internal occurrence reporting scheme that enables occurrences, including those related to human error, to be reported and analysed. In 2001, prior to the release of the EASA requirements, the UK Civil Aviation Authority released Airworthiness Notice 71, outlining best practices on maintenance error management. These included corporate commitment, a clear discipline policy, and an event investigation process. Transport Canada has also promulgated regulations requiring safety management systems for airlines. This requirement includes the reporting of errors and other problems, and the internal investigation and analysis of such events.

"To arrive at the organisational root causes of a mishap involving human performance, we need to ask 'Why?' repeatedly: Why did the behaviour occur?"

In the United States, the Federal Aviation Administration (FAA) encourages airlines and repair stations to introduce Aviation Safety Action Programs (ASAP) that allow employees to report safety issues with an emphasis on corrective action rather than discipline. Incident reports are passed to an event review committee comprising representatives of the FAA, management and the union.[3] Despite the advantages that these programs offer, they have been adopted more widely for flight crews than for maintenance personnel. Not all incidents are accepted into ASAP programs. Some of the key conditions for accepting a report are as follows:

1. The report must be submitted in a timely manner, generally within 24 hours of the reporter becoming aware of the problem.
2. The incident must not involve criminal activity or substance abuse.
3. The incident must not involve intentional falsification.
4. The incident must not involve intentional violations or actions that reflect "intentional disregard for safety".

The first three of these criteria are unlikely to pose a problem in most cases. However, when it comes to violations or actions that involve an "intentional disregard for safety", the matter becomes more subjective. Many routine violations in maintenance could fit this criterion.

The issues of blame and justice apply to more than just maintenance personnel on the hangar floor. Managers and supervisors are also responsible for the performance of the personnel who report to them. It has been proposed that when workplace violations occur, there should be consequences not only for the individuals directly involved but also for managers. For example, if an incident involved a routine rule violation, managers should be called to account for their failure to ensure compliance or their failure to change the rule if it was an unnecessary one.[4]

Human factors training

From the 1970s onwards, airlines around the world began to provide human factors awareness training for flight crews. Until relatively recently, human factors training was rarely provided to maintenance personnel.

In the 1990s, an initial wave of maintenance human factors training courses began in the U.S., modelled on successful cockpit resource management training. This early training was typically referred to as maintenance resource management (MRM) and focused on topics such as: assertiveness, stress management, decision making, awareness of norms, communication skills, and conflict resolution. Courses typically aimed not only to change attitudes among maintenance personnel but also to provide them with practical skills that could be applied in the workplace, such as assertiveness skills and conflict resolution techniques.

A second wave of maintenance human factors training has been generated by new requirements from ICAO, EASA, and Transport Canada that call for maintenance staff to have knowledge of human factors principles. EASA Regulation 66 lists human factors knowledge among the basic initial knowledge requirements for certifying maintenance staff on commercial air transport aircraft. The recommended syllabus includes teamwork, working with time pressure and deadlines, communication, and the management of human error. Although these syllabus items are listed in the appendix to the regulation as an "acceptable means of compliance," EASA has not listed alternative

[3] Federal Aviation Administration, Advisory Circular (AC) 120-66B.

[4] Hudson, P. (2000). Safety culture and human error in the aviation industry: In search of perfection. In B. Hayward & A. Lowe (Eds). *Aviation Resource Management*. Ashgate: Aldershot.

means of compliance, so this syllabus effectively has the force of a regulatory requirement.

The related EASA-145 contains extensive human factors requirements for maintenance organisations. Among the requirements in these regulations and the associated support documents, are that personnel receive training in human factors principles. This training is required not only for certifying staff, engineers and technicians but also for managers, supervisors, quality control staff, store personnel and others. Human factors continuation training must occur every two years. Over 60 human factors topics are listed in the guidance material associated with EASA-145, including violations, peer pressure, memory limitations, workload management, teamwork, assertiveness, and disciplinary policies. The Civil Aviation Safety Authority has indicated that similar regulations will apply to maintenance organisations and personnel in Australia in the future when *Civil Aviation Safety Regulation* (CASR) Part 145 is introduced.[5]

Learning from incidents

In most cases, the immediate circumstances of a mishap are symptoms of deeper, fundamental problems. Treating the symptoms of a problem will rarely lead to adequate solutions and may even make things worse. For example, enforcing compliance with a routinely ignored procedure may cause more harm than good if the procedure is unnecessary or poorly conceived. To make lasting improvements, we need to identify and treat the underlying fundamental origins, or root causes, of mishaps.

To arrive at the organisational root causes of a mishap involving human performance, we need to ask "Why?" repeatedly: Why did the behaviour occur? Why did risk controls fail? Why did the contributing factors exist? Repeatedly asking "Why?" eventually leads us to fundamental aspects of the organisation that can have powerful and wide-ranging influences on safety and quality.

Incident investigation systems

Incident reports provide valuable raw material from which safety lessons can be extracted. In recent years, several investigation techniques have been developed specifically for airline maintenance.

The oldest of these, Boeing's Maintenance Error Decision Aid (MEDA) presents a comprehensive list of error descriptions, such as "access panel not closed", and then guides the investigator in identifying the contributing factors that led to the error. Over 70 contributing factors are listed, including fatigue, inadequate knowledge, and time constraints.[6] The system, however, does not include psychological descriptions of errors.

The Aircraft Dispatch and Maintenance Safety System (ADAMS) was developed in Europe by a team based at the Psychology Department of Trinity College Dublin. In common with MEDA, ADAMS includes a range of maintenance errors but also enables the investigator to describe the psychological form of the error using a large range of descriptions such as habit capture and memory failure. The investigator is provided with a choice of approximately 100 performance influencing factors covering the task, the work environment, the organisation, and the error-maker's physical and mental state.[7]

The Human Factors Analysis and Classification System (HFACS) is based on the Reason model and was originally developed to assist in the investigation of mishaps in the U.S. military. A maintenance extension of this methodology (HFACS-ME) was developed by the U.S. Navy to analyse aviation incidents.[8] HFACS-ME assists the investigator in identifying maintenance actions using a taxonomy based on that of Reason, and provides 25 potential latent conditions that contribute to maintainer errors. Perhaps due to their military origins, HFACS and HFACS-ME emphasise supervisory factors.

There are two key advantages of using a structured and systematic error investigation system such as those described above. First, structured investigation systems have been shown to improve the effectiveness of investigations. Structured systems serve as prompts or checklists that assist the investigator with uncovering relevant issues during the investigation process. Second, once the system has been in use over time, a bank of incident data becomes available in a standard form that is suitable for statistical analysis. It then becomes possible to search for trends and associations in the data that may not otherwise have been identifiable.

[5] Civil Aviation Safety Authority (2006). *Notice of Proposed Rule Making. A Proposal to Modernise and Harmonise Rules for the Maintenance of Australian Aircraft and Licensing of Aircraft Maintenance Personnel*. (Document NPRM 0604MS). Canberra: Author.

[6] Rankin, B. & Allen. J, (1996). Boeing introduces MEDA, Maintenance Error Decision Aid. *Airliner*, April–June, 20-27.

[7] Russell, S., Bacchi, M., Perassi, A., & Cromie, S. (1998). Aircraft Dispatch And Maintenance Safety (ADAMS) reporting form and end-user manual. (European Community, Brite-EURAM III report. BRPR-CT95-0038, BE95-1732.) Dublin, Ireland: Trinity College.

[8] Schmidt, J. K., Schmorrow, D. & Hardee, M. (1998). *A preliminary human factors analysis of naval aviation maintenance related mishaps*. SAE Technical Paper 983111. Warrendale, PA: Society of Automotive Engineers.

Repair and Overhaul Challenges

by Brad Taylor, Civil Aviation Safety Inspector, Maintenance and Manufacturing, Standards, Civil Aviation, Transport Canada

The majority of aircraft owners and operators currently enjoy an established product support base that includes the original equipment manufacturer (OEM) as well as distributors and maintenance, repair or overhaul (MRO) facilities. When they require services or spares, aircraft owners and operators have many options to choose from and rarely need to concern themselves with the acceptability of the products or services they receive. Not everyone is so lucky!

During the design and conception phase of new aircraft development, the manufacturer attempts to determine the anticipated service life of new models, including variants thereof, in order to build an airframe capable of lasting that duration. In many cases, aircraft have found niche markets where they are utilized far longer than anticipated and in unpredictable ways. Operators with businesses founded on satisfying these market needs with unique aircraft—which sometimes operate far past any projections—are faced with a unique challenge in keeping their aircraft in the sky and their business afloat. In many cases, the established support industries are long gone or exist in parts of the world where the aircraft is still found in numbers sufficient to warrant their existence.

What would you do if the support network for your aircraft started to shrink as the aircraft model aged and was slowly removed from service? Perhaps, through word of mouth and the Internet, you might discover that the parts and/or services you need are available in another country. You do the research by reviewing Airworthiness Notice (AN) B073 and the *Canadian Aviation Regulations* (CARs) and by consulting your principal maintenance inspector (PMI) or local Transport Canada office. Through your research, you discover that Transport Canada Civil Aviation (TCCA) doesn't have an agreement to allow for acceptance of parts manufactured or repaired in the country you identified. You're stuck in a situation where it appears that you cannot maintain your aircraft due to regulatory barriers. Have you exhausted all your options within the boundaries of the regulatory system, or could you have done more? You have four real options that should allow you to achieve acceptable results:

- Locate a Canadian approved maintenance organization (AMO) capable of performing the work required or willing to add the ability to their existing capabilities list.
- Locate a foreign MRO facility that is acceptable within the scope of TCCA's international agreements.
- Consider modifying your aircraft with newer equipment through one-off approvals or supplemental type certificates (STC).
- Contact TCCA to discuss other possibilities as a last resort.

When you have exhausted all domestic options and begin to look at foreign sources, you will find that TCCA doesn't currently have any Foreign Approved Maintenance Organizations (FAMO) outside of the current international agreements. Therefore, a search in this genre should start and end within the current list of countries with which Canada has developed agreements. Companies within the scope of the agreements must also have CAR 573 approval, unless they are Federal Aviation Administration (FAA)-approved repair stations. The bilateral agreement between Canada and the United States is different from the agreements with the European Aviation Safety Agency (EASA) and other countries in this regard. In fact, each agreement is different, which means that you must familiarize yourself with the details of the relevant agreement before doing business in that country.

Another common misconception is that foreign OEMs are automatically granted the ability to maintain their product because it has been approved for use in Canada. The distinction between manufacturing and maintenance approvals becomes blurred by the fact that you are dealing directly with an OEM. The person signing the maintenance release assumes complete responsibility for the work performed and the parts used during maintenance under CAR 571.10. Therefore, it is their responsibility to ascertain whether the maintainer of the product is acceptable under the CARs. The origin, condition and supporting documentation that accompanied the product must be evaluated prior to deciding whether or not you will install it on an aircraft. This holds true even if you're releasing an aircraft with your Aircraft Certification Authority (ACA) approval granted by an AMO. In this particular situation, you must be certain that the MRO side of the OEM has received Canadian approval to maintain the product and that they certify it in accordance with the terms of the applicable international agreement.

Many people believe that simply having a completed Authorized Release Certificate in hand makes the identified part acceptable for installation. In reality, the document must be reviewed closely to ensure that it is completed properly, is actually for the part in question, and has been issued by an acceptable facility. There are many FAA-approved repair stations capable of issuing 8130-3 repair certificates that TCCA does not recognize, simply because they are located outside of the United States. Aeronautical products maintained and certified by these facilities are not acceptable for installation on Canadian aircraft, despite the fact that they have what appears to be acceptable documentation. The reason for this is really quite simple and is explained thoroughly in AN B073, but it bears repeating here. Our bilateral agreement with the United States extends only to the parts of the industry over which the FAA exercises direct oversight. When the FAA enters into an agreement with another country and that country has agreed to perform oversight on behalf of the FAA, the FAA no longer exercises direct oversight with the repair stations located there. The same is true for EASA and any countries with which it has additional agreements.

In reality, the onus is on you to stay abreast of the changes and keep current in your understanding of how to conduct business. It would be convenient if there were a system to throw up red flags anytime changes that affect you and your organization occur, but that just isn't the case. A keen eye on industry publications will generally assist you in this effort; monthly review of the CARs revisions and international agreements applicable to your operation should do the rest. Only you know where your liabilities lie, and only you can be held accountable in the end for compliance with regulations. You are expected to manage your risk and proactively deal with the challenges of repairing and overhauling your aeronautical products by staying informed. △

ACCIDENT SYNOPSES

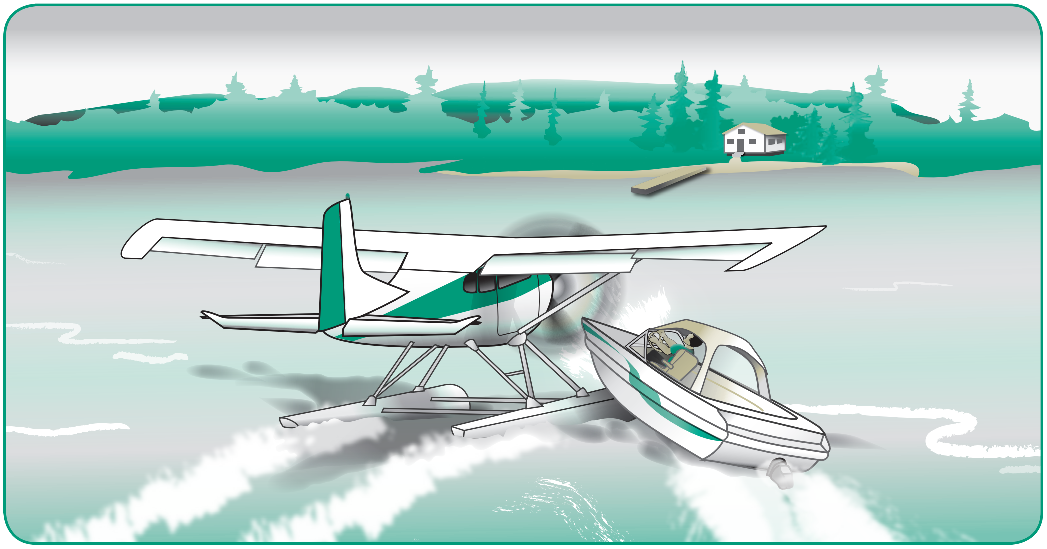
Note: All reported aviation occurrences are assessed by the Transportation Safety Board of Canada (TSB). Each occurrence is assigned a class, from 1 to 5, which indicates the depth of investigation. A Class 5 consists of data collection pertaining to occurrences that do not meet the criteria of classes 1 through 4, and will be recorded for possible safety analysis, statistical reporting, or archival purposes. The narratives below, which occurred between August 1, 2009, and October 31, 2009, are all "Class 5," and are unlikely to be followed by a TSB Final Report.

— On August 1, 2009, a **float-equipped, advanced ultralight Quad City Challenger II** was taking off from Lac à la Truite, Que., with the pilot/owner and one passenger on board. During the initial climb, the wind blew the aircraft toward the forest. The aircraft hit the trees and crashed. The aircraft's two occupants sustained minor injuries. Only the pilot/owner was wearing a seat belt. *TSB File A09Q0126.*

— On August 2, 2009, an **ultralight Aérocruiser** was conducting a flight from the St-Cœur-de-Marie marina to Alma, Que. During the initial climb, the wind blew the aircraft back down and the pilot was unable to regain control of the aircraft in time. The aircraft crashed and sank upside down. The pilot was able to egress and sustained minor injuries. He was wearing a seat belt and a flotation device. The aircraft was heavily damaged. *TSB File A09Q0128.*

— On August 2, 2009, a **Jodel D11 amateur-built** aircraft was en route from Delta Airpark, B.C., to Courtenay Airpark, B.C., when structural failure occurred in the circuit at Courtenay. Portions of the right wing were found 500 m from the crash site. The pilot was fatally injured. There was no fire. *TSB File A09P0231.*

— On August 3, 2009, a **Cessna 185 on Edo 3430 floats** had just landed near the centre of the northeast arm of Lake Temagami, Ont. The aircraft had slowed to a slow taxi speed of approximately 10 mph and was headed to the pilot's dock. As the aircraft was taxiing, a 16-ft boat traveling down the lake with only one person on board collided with the right float. The bow of the boat bounced into the idling propeller. Both the aircraft and the boat sustained substantial damage; however, neither sank. There were no injuries. *TSB File A09O0158.*



Artist's impression of the collision between the boat and the Cessna 185

— On August 5, 2009, a privately-owned **Smith Miniplane powered paraglider** took off 4 NM northwest of the Sept-Îles, Que., airport for a local flight. Witnesses observed the parachute losing volume and then crashing to the ground. The pilot sustained serious injuries and was transported to the hospital. At the time of the accident, winds were gusting from the west between 10 and 20 kt. *TSB File A09Q0133*.

— On August 5, 2009, a **Piper PA28-151** with a student-pilot on board was conducting a solo cross-country training route between Quebec City, Que., and Trois-Rivières, Que. While backtracking on Runway 23 after landing at the Trois-Rivières airport (CYRQ), the pilot noticed an aircraft that was preparing to land on the runway. The pilot moved the aircraft to the northern edge of the runway to avoid the landing aircraft. The aircraft's left wing hit a metal marker board signalling construction being carried out north of the runway. The left wing sustained considerable damage. The pilot was not injured. *TSB File A09Q0138*.

— On August 7, 2009, a privately-owned **Beech E-90** was conducting an instrument flight rules (IFR) flight from Peterborough, Ont., to Quebec City, Que., with only the pilot on board. Immediately after takeoff, the No. 2 engine cowl detached and hit the leading edge of the right wing before falling on the runway. The aircraft returned to Peterborough and landed without incident. No one was injured. *TSB File A09Q0139*.

— On August 16, 2009, a privately-owned, **amphibian Wagaero DARO-01** took off from Lac William, Que., for a local flight. The pilot was the aircraft's only occupant. During the take-off run, the floatplane nosed over after one of its floats hit a wave created by a boat. The pilot, who was wearing his seat belt and flotation device, left the aircraft unharmed. *TSB File A09Q0142*.

— On August 24, 2009, the pilot of a privately-owned **Piper PA23-250** arriving from the United States stopped in Brantford, Ont., to clear customs before continuing to his private strip. When the pilot was preparing to depart Brantford, he was unable to start the right engine. The pilot elected to attempt a single-engine takeoff from Runway 23. During the take-off roll, the pilot was unable to maintain directional control; the aircraft departed the right side of the runway just before the intersection of Taxiway Echo and Runway 23. The aircraft struck a taxiway light and continued across the taxiway before becoming airborne. The aircraft began a slow climb but was unable to clear trees at the edge of the airport property. The aircraft's right wing struck a tree approximately 20 ft off the ground, severing the outboard portion of the right wing. The aircraft crashed into a cornfield approximately 300 ft beyond the tree and sustained substantial damage. The pilot was the only occupant on board and received minor injuries. *TSB File A09O0179*.

— On September 5, 2009, during a fly-in on Île Ronde near St-Sulpice, Que., a **Taylorcraft BC-12-65** and a **basic ultralight Voyageur II 912S** collided. The collision occurred when the two aircraft were conducting their flare for landing on Runway 06. While he was conducting the flare and his aircraft was slowing down, the pilot of the ultralight noticed the nose of the Taylorcraft appear below him to the front and right. At that moment, he hit the tail of the Taylorcraft, which nosed up and ended its run upside down. The two occupants of the Taylorcraft and the pilot of the ultralight, who was alone on board the aircraft, sustained minor injuries. The two aircraft sustained considerable damage but did not catch fire. *TSB File A09Q0162*.

— On September 9, 2009, a **Mooney M20J** was conducting a local visual flight rules (VFR) flight in the Ste-Anne-des-Monts, Que., area. While the aircraft was on approach for landing on Runway 14, the landing gear did not drop and the aircraft landed on its belly. The pilot, who was the aircraft's only occupant, was not injured. The aircraft's propeller and ventral skin panels sustained considerable damage. *TSB File A09Q0163*.

— On September 9, 2009, the pilot of a **Beech 77** was conducting a run-up when his brakes failed. The aircraft hit a parked **Cessna 172M**. The Beech 77 sustained damage to its propeller, while the Cessna 172 sustained damage to a wing. The pilot, who was the only occupant on board the Beech 77, was not injured. *TSB File A09Q0164*.

— On September 13, 2009, a **Bell 214B-1 helicopter** was bucketing near Clinton, B.C., topping up water storage tanks at 6 000 ft above sea level (ASL). While flying over a tank, there was a loud bang and a reduction in power. The aircraft reached a nearby pad but landed heavily, spreading the skid gear. There were no injuries. The long line had not been released. *TSB File A09P0310*.

— On September 29, 2009, a **Zenair Zodiac CH601** was turning on final approach to conduct touch-and-goes at the Lachute, Que., airport when the aircraft crashed. The aircraft was destroyed by the impact but did not catch fire. The pilot—the aircraft's only occupant—sustained fatal injuries. TSB investigators were dispatched to the scene of the accident and will collect data to support the coroner's investigation. *TSB File A09Q0177*.

— On October 2, 2009, an **R44 II helicopter** took off for a visual flight rules (VFR) flight from the Mascouche, Que., airport to Bagotville, Que. The pilot and one passenger were on board the helicopter. Near

Mont Apica, the pilot conducted a 180° turn after hitting fog. During the turn, the pilot lost his visual references with the ground and started climbing. During the climb, the aircraft slowed down. The pilot pushed on the cyclic control stick to increase the speed. During this manoeuvre, the main rotor partially cut off the tail boom. The blade did not sever the tail rotor drive shaft. However, the aircraft became unstable and the pilot began an autorotation. The pilot regained visual contact with the ground and landed without further incident on a logging road. Search and rescue (SAR) services were notified and went to the scene of the accident that same day. Neither the pilot nor the passenger was injured. *TSB File A09Q0179*.

— On October 8, 2009, a privately-owned, **canard-type Velocity XL RG** aircraft was on short final when the gull-wing-type door unexpectedly popped open. Directional control was difficult to maintain, but the pilot continued with the landing. After touchdown and approximately 200 ft from the threshold, the aircraft began to ground loop—damaging the landing gear and wing—and came to a stop on the grass infield. The aircraft sustained substantial damage, but the pilot was not injured. Reportedly, the gull-wing door was not properly latched prior to the flight and popped open when the aircraft encountered minor turbulence on final. *TSB File A09O0216*.

— On October 10, 2009, a **basic ultralight Sauterelle** was climbing at approximately 400 ft above ground level (AGL) after a takeoff from the Mascouche ,Que., airport, when the pilot lost control of the aircraft. The ultralight aircraft then crashed on Route 25. The aircraft sustained considerable damage and caught fire. The pilot—the aircraft's only occupant—died from his injuries a few days later in the hospital. *TSB File A09Q0182*.

— On October 14, 2009, a **Piper PA-24** departed Smith Falls, Ont., en route to Rockcliffe, Ont. The aircraft was in the circuit prior to landing when the engine lost power. The pilot attempted to land on Runway 27, but the aircraft did not make it to the runway. The aircraft impacted the airport's perimeter fence and sustained substantial damage. The pilot, who was the aircraft's sole occupant, was not injured. When examined after the accident, the right fuel tank was empty. There was some useable fuel in the left tank. *TSB File A09O0220*.

— On October 16, 2009, a **Eurocopter EC130B helicopter** was performing power-line and sock-line stringing operations in Manuel Canyon, B.C., when the main rotor struck a steel tower. The pilot immediately flew away to the west of the power line and, when clear of all ground crew, operated the emergency mechanical hook release. He then made a precautionary landing on a nearby road. The helicopter sustained substantial damage. The pilot was not injured. *TSB File A09P0353*.

— On October 31, 2009, a **Eurocopter EC120B helicopter** was at idle power on the ground in Port Huron, Mich. When the pilot opened the door to latch it a second time in preparation for lift-off, a gust of wind caught the door and opened it fully. The top of the door hit the main rotor system, causing damage to all three rotor blades and to the door. The door strut had been removed previously due to a malfunction. *TSB File A09F0153*. △

Important Editorial Note: Article deleted from ASL 1/2010

In *Aviation Safety Letter* (ASL) 1/2010, Transport Canada (TC) published an article which reproduced a Transportation Safety Board of Canada (TSB) Aviation Safety Advisory titled "Major Modifications to Amateur-Built Aircraft". Some aircraft referred to in the article were incorrectly identified as Bush Caddy aircraft. It has since been determined that none of the aircraft mentioned in the subject article were Bush Caddy aircraft. Consequently, the article has been removed from all online versions of ASL 1/2010. With this notice, TC also retracts the article from the printed version of ASL 1/2010. Further, the aircraft type in the June 28, 2009 occurrence listed in the section entitled 'Accident Synopses' on page 31 of ASL 1/2010 should read "C.A.D.I. L-160", and not "Bush Caddy". The ASL apologizes to Canadian Light Aircraft Sales and Services Inc. (CLASS) Bush Caddy, and to owners and operators of CLASS Bush Caddy aircraft for this error.

The following summaries are extracted from Final Reports issued by the Transportation Safety Board of Canada (TSB). They have been de-identified and include the TSB's synopsis and selected findings. Some excerpts from the analysis section may be included, where needed, to better understand the findings. We encourage our readers to read the complete reports on the TSB Web site. For more information, contact the TSB or visit their Web site at www.tsb.gc.ca. *—Ed.*

TSB Final Report A06O0231—Collision with Terrain

On September 4, 2006, the pilot of an amateur-built Pitts S1S aerobatic biplane was on a local flight from his private grass airstrip in Melancthon, Ont., when the aircraft struck the ground following a low-level roll. The impact and post-crash fire destroyed the aircraft. The pilot, the only person on board, received fatal injuries. The accident happened at 19:59 Eastern Daylight Time (EDT) during twilight hours.

Analysis

The pilot had extensive flight experience and had flown the Pitts S1S for 160 hr over the previous seven years. He was also experienced at flying low-level aerobatics. There was no indication that the roll was anything other than an intentional aerobatic manoeuvre. The fact that the aircraft struck the ground in a wings-level attitude immediately following the completion of a roll indicates that the pilot was probably controlling the aircraft throughout the manoeuvre and that the rudder and aileron control systems were functional.

It could not be determined why the aircraft struck the ground. There were no identifiable problems with the aircraft, the pilot was fit for the intended flight, and the autopsy did not reveal any pre-existing medical conditions that would have contributed to the accident. As well, it was considered that weather did not play a part in the accident. The analysis will therefore focus on physiological aspects of this flight.

The setting sun to the west was bright and would tend to illuminate the countryside in that direction. It was significantly darker to the east, which would make the horizon more difficult to distinguish in that direction.

The pilot departed to the west and completed at least one turn to the east and two 360° turns before beginning the roll manoeuvre on an easterly heading. Each time the pilot turned past the setting sun, his eyes would have been subjected to the bright light of the sun, and each time he headed in an easterly direction, he would have been looking at a relatively dark horizon. Each time the pilot's eyes were exposed to the bright light, the process of dark adaptation would have had to begin again. Since there is no way to determine where the pilot was looking as he turned toward the setting sun, the amount of dark adaptation required cannot be quantified. However, each time the aircraft turned from west to east, the eastern horizon would have been more difficult to pick up.

Two factors that likely contributed to the accident were the light conditions and the low altitude at which the roll manoeuvre was initiated. The low light conditions would have made it more difficult for the pilot to identify the exact attitude of the aircraft in a dynamic manoeuvre such as a roll. The horizon to the east was darker than the horizon to the north or south. Thus, while it would have been relatively easy to identify that the wings were level, it would have been more difficult to identify whether the nose was in a level-flight attitude. The low altitude is significant because it minimized the amount of time that the pilot had to recognize and correct any errors as he completed the roll. It is probable that the pilot did not recognize that the aircraft was descending and flew it into the ground.

Findings as to causes and contributing factors

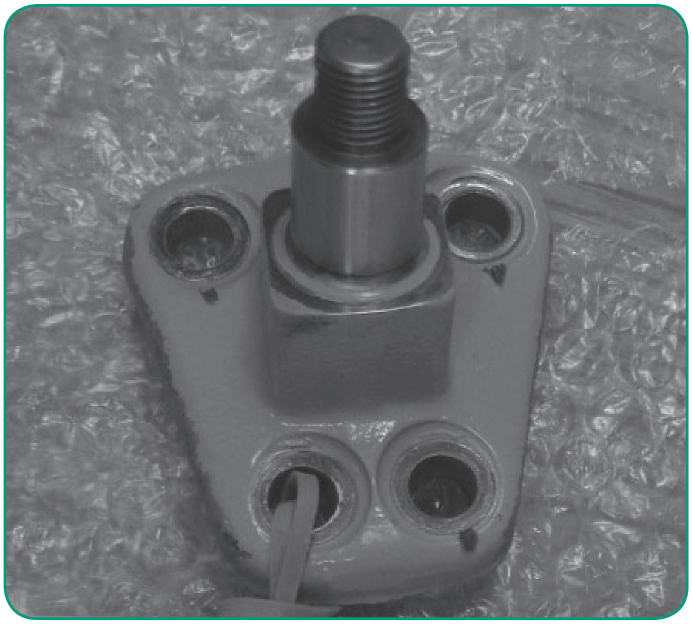
1. As the pilot was completing a roll at low altitude, the aircraft descended. It is probable that the pilot did not recognize that the aircraft was descending and flew it into the ground.
2. The varying light conditions during manoeuvring could have made it difficult for the pilot to detect that the aircraft was descending.

Finding as to risk

1. The pilot of the Pitts aircraft flew in close proximity to another aircraft without having discussed his plans with the other pilot.

TSB Final Report A06P0190—Loss of Control—Transmission Pylon Support Spindle Fracture

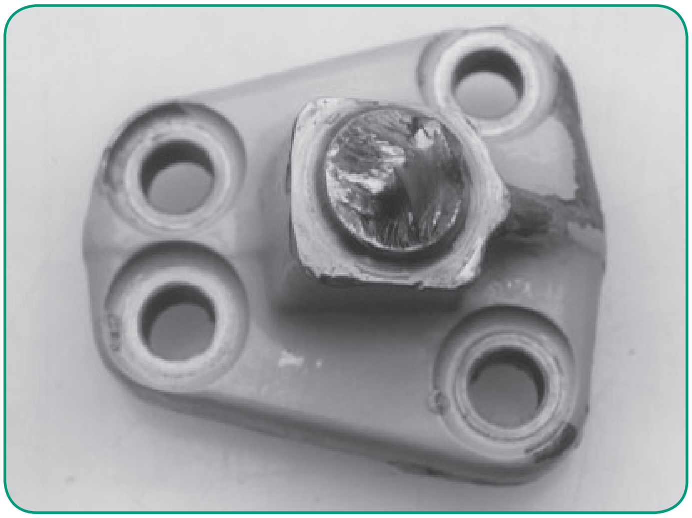
On September 19, 2006, at about 07:10 Pacific Daylight Time (PDT), a Bell 206B helicopter, with one pilot and two passengers on board, departed from a service landing area about 0.5 NM from the village of Alice Arm, B.C. The flight was conducted under visual meteorological conditions (VMC). This was the first flight of the day, and the pilot was conducting a crew change at a resource-exploration drill site about 6 NM to the north. The flight departed on a northeast heading across the tidal estuary in front of the village and crashed in the estuary 0.5 NM from the departure point. It was low tide at the time. The helicopter was destroyed, and all three persons on board were fatally injured. There were indications of a small post-impact fire that self-extinguished. There were no eyewitnesses.



Exemplar pylon support spindle

Analysis

Examination of the ground scars and photographs taken before the wreckage was moved revealed a wreckage distribution pattern associated with a condition of high deceleration forces and a steep angle of descent to the level ground, which are consistent with a loss of control. Weather, pilot incapacitation, and engine failure were assessed as unlikely contributors; the investigation focused on flight control malfunction/failure.



Exemplar pylon support spindle

The observations made during testing with the Bell 206B static display demonstrated that damage around the main transmission was consistent with the misalignment of the pylon assembly in flight. Although the main driveshaft and pylon assembly were misaligned, the main rotor and tail rotor were still being driven by the engine until the time of impact.

The right-hand pylon support spindle was found fractured at the root end of the journal section, yet the spherical bearing supporting the spindle did not display impact-related damage. This indicates that the right-hand pylon support spindle was not in the spherical bearing at the time of impact. A fatigue fracture is not consistent with an impact force. The dimensional restoration repair of the spindle journal introduced a stress concentration feature at the location of the subsurface radius, which was responsible for the formation of the fatigue crack and subsequent failure of the right-hand pylon support spindle.

Testing with the Bell 206B static aircraft also demonstrated that the cyclic and collective control linkages could partially support the fuselage from the swash plate assembly, and this condition would render the helicopter uncontrollable in flight, regardless of pilot inputs. It is likely that the time between the spindle failure and ground impact could be measured in seconds. If the helicopter had flown for any longer, any uncontrolled gyrations that may have occurred would likely have resulted in the helicopter breaking apart in flight. Since the accident site was compact, it is more likely that the helicopter was at a low altitude and collided with the ground before time allowed it to break up in flight.

Findings as to causes and contributing factors

1. The dimensional restoration repair of the spindle journal introduced a stress concentration feature at the location of the subsurface radius, which was responsible for the formation of the fatigue crack and subsequent failure of the right-hand pylon support spindle.
2. Failure of the right-hand pylon support spindle in flight caused the helicopter to become uncontrollable and collide with the level ground.

Findings as to risk

1. It is likely that the pylon-support-spindle repair process was designed without the benefit of all original design data. It could not be shown that tests, stress analyses or other techniques were used to ensure that the repair maintained the strength and other properties assumed in the original design data.
2. There is a risk that repair designs for parts identified as critical may have been approved before the definition of critical parts, applicable to normal category rotorcraft, was adopted by Transport Canada (TC). Such repair schemes may not ensure that critical parts maintain the critical characteristics on which certification is based.
3. TC made inquiries regarding approved spindle repair procedures following the release of Bell Helicopter Textron Inc. (BHTI) Operational Safety Notice (OSN) 206-99-35 Revision A, but it closed the file without formally reviewing or cancelling the two approved repair certificates, thus allowing the repair to continue in its original form.

Safety action taken

On February 6, 2007, the TSB issued Occurrence Bulletin OB-A06P0190-1 addressed to TC. The Occurrence Bulletin provided a factual description of the failure mode of the pylon support spindle.

On February 27, 2007, TC issued Airworthiness Directive (AD) CF-2007-02, which mandated removal of all affected Bell 206B pylon support spindles and mandated that maintenance records be annotated accordingly.

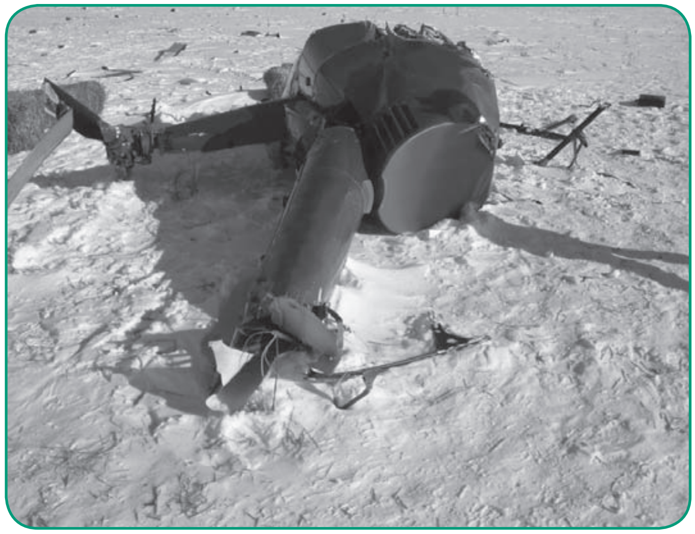
On March 9, 2007, BHTI issued OSN 206-99-35 Revision B. This document is a revision of the previous version (Revision A) and reinforces BHTI's opposition to dimensional restoration repairs of Bell 206B pylon support spindles.

On August 23, 2007, AD CF-2007-02 was superseded and CF-2007-02R1 was issued by TC. The revision included serial numbers of pylon support spindles, which incorporated a similar repair performed by another company.

TSB Final Report A07O0030—Uncontrolled Flight into Terrain

On February 2, 2007, the crew of a Robinson R44 II helicopter was conducting a series of maintenance check flights following a change of the aircraft's main rotor blades. The pilot and aircraft maintenance engineer (AME) were tasked with "blade tracking", and the engineer had made pitch link adjustments on the main rotor blades based on the results of two earlier flights. The occurrence flight was conducted with the intention of blade tracking and checking the rotor RPM during an autorotation procedure.

At approximately 17:28 Eastern Standard Time (EST), in low light conditions, the aircraft entered the autorotation at 2 400 ft above sea level (ASL) and continued its descent until it impacted the snow-covered frozen field. The emergency locator transmitter (ELT) activated, and rescue and fire-fighting teams responded. Both occupants suffered serious injuries and were ejected from the cockpit when the seat-belt attachments failed. The aircraft was destroyed.



Analysis

The helicopter departed from Cambridge, Ont., on a maintenance test flight. The purpose of the flight was twofold. First, the AME was attempting to track the main rotor blades while the helicopter was in an autorotation and, second, he wanted to check the autorotational RPM. There is a specific procedure in the maintenance manual for checking the autorotational RPM, though it was not reviewed before the flight and was not being followed. Tracking the main rotor blades in an autorotation is not a procedure that is described in the helicopter maintenance manual.

Without a detailed pre-flight briefing, the pilot might not have been fully aware of what to expect during this maintenance test flight. The consequences of not reviewing the autorotational RPM adjustment procedure prior to the flight included not having enough altitude to properly conduct the test and not being aware that, at its current weight, the target rotor RPM was above the main rotor RPM red line.

The flight was normal up to the point where the autorotation was initiated. At some point during the autorotation, the pilot allowed the rotor RPM to drop to approximately 80 percent and was unable to recover before the helicopter hit the ground. The upward bending of the rotor blade confirms that, at some point in the autorotation, the rotor RPM was low. Losing rotor RPM could be the result of incorrect technique when initiating the autorotation, or it could have resulted from a failure to continually monitor the RPM throughout the autorotation.

When the helicopter struck the ground, the rotor tachometer was indicating 98 percent, the rate of descent was 800 ft/min, and the helicopter had very little forward speed. All of this indicates that although full throttle had been reapplied during descent, there was insufficient altitude and time to arrest the descent prior to impact.

Findings as to causes and contributing factors

1. The AME was attempting to track the main rotor blades while the helicopter was in an autorotation. This procedure was not described in the helicopter maintenance manual. Attempting to combine these two activities likely interfered with the pilot's ability to monitor aircraft performance during the autorotation.
2. The gross weight of the helicopter exceeded the maximum specified by the manufacturer for checking rotor RPM in autorotation.
3. During the autorotation, the rotor RPM decayed to approximately 80 percent and, although full throttle had likely been reapplied, there was insufficient altitude and time remaining to arrest the rate of descent prior to impact.

TSB Final Report A07O0124—Hard Landing and Main Landing Gear Collapse

On May 20, 2007, a Bombardier CL-600-2B19 Regional Jet with 3 crew members and 37 passengers on board, was operating on a flight from Moncton, N.B., to Toronto/Lester B. Pearson International Airport, Ont. At 12:35 Eastern Daylight Time (EDT), the aircraft landed on Runway 06R with a 90° crosswind from the left, gusting from 13 to 23 kt. The aircraft first contacted the runway in a left-wing-down sideslip. The left main landing gear struck the runway first, and the aircraft sustained a sharp lateral side load before bouncing. Once airborne again, the flight and ground spoilers deployed and the aircraft landed hard. Both main landing-gear trunnion fittings failed, and the landing gear collapsed. The aircraft remained upright, supported by the landing gear struts and wheels. The aircraft slid down the runway and exited via a taxiway, where the passengers deplaned. There was no fire. There were no injuries to the crew; some passengers reported minor injuries as a result of the hard landing.

Findings as to causes and contributing factors

1. On final approach, the captain diverted his attention from monitoring the flight, leaving most of the decision making and control of the aircraft to the first officer, who was significantly less experienced on the aircraft type. As a result, the first officer was not fully supervised during the late stages of the approach.
2. The first officer did not adhere to the operator's standard operating procedures (SOPs) in the handling of the autopilot and thrust levers on short final, which left the aircraft highly susceptible to a bounce and without the bounce protection normally provided by the ground lift dump (GLD) system.
3. Neither the aircraft operating manual nor the training that both pilots had received mentioned the importance of conducting a balked or rejected landing when the aircraft bounces. Given the low-energy state of the aircraft at the time of the bounce, the first officer attempted to salvage the landing.
4. When the thrust levers were reduced to idle after the bounce, the GLD system activated. The resultant sink rate after the GLD system deployed was beyond the certification standard for the landing gear and resulted in the landing-gear trunnion fitting failures.
5. There was insufficient quality control at the landing gear overhaul facility, which allowed non-airworthy equipment to enter into service. The condition of the shock struts would have contributed to the bounce.

Safety action taken

On September 26, 2006, the operator sent an e-mail to all of its simulator and line training instructors to raise awareness about the dangers of landing the CRJ-series aircraft with residual thrust, reminding them that it could contribute to a bounced landing. This information was officially incorporated into the October 1, 2007, update of its line indoctrination guide, which provides guidance on administering line training.

TSB Final Report A07Q0213—Loss of Control and Collision with Terrain

On October 25, 2007, a Beechcraft A100 was conducting an instrument flight rules (IFR) flight between Val-d'Or, Que., and Chibougamau/Chapais, Que., with two pilots on board. The aircraft flew a non-precision approach on Runway 05 at the Chibougamau/Chapais Airport, followed by a go-around. On the second approach, the aircraft descended below the cloud cover to the left of the runway centreline. A right turn was made to direct the aircraft towards the runway, followed by a steep left turn to line up with the runway centreline. Following this last turn, the aircraft struck the runway at about 500 ft from the threshold. A fire broke out when the impact occurred, and the aircraft continued for almost 400 ft before stopping about 50 ft north of the runway. The first responders tried to control the fire using portable fire extinguishers but were not successful. The Chibougamau and Chapais fire departments arrived on the scene at about 09:26 Eastern Daylight Time (EDT)—approximately 26 min after the crash. The aircraft was destroyed by the fire. The two pilots suffered fatal injuries.

Findings as to causes and contributing factors

1. The aircraft was configured late for the approach, resulting in an unstable approach condition.
2. The pilot flying carried out a steep turn at a low altitude, thereby increasing the load factor. Consequently, the aircraft stalled at an altitude that was too low to allow the pilot to carry out a stall recovery procedure.

Findings as to risk

1. The time spent programming the GPS reduced the time available to manage the flight. Consequently, the crew did not make the required radio communications on the mandatory frequency (MF), did not activate the aircraft radio control of aerodrome lighting (ARCAL), did not make the verbal calls specified in the standard operating procedures (SOPs), and configured the aircraft for the approach and landing too late.
2. During the second approach, the aircraft did a race-track pattern and descended below the safe obstacle clearance altitude (OCA), thereby increasing the risk of a controlled flight into terrain (CFIT). The crew's limited instrument flight rules (IFR) experience could have contributed to poor interpretation of the IFR procedures.

3. Non-compliance with communications procedures in an MF area created a situation in which the pilots of both aircraft had poor knowledge of their respective positions, thereby increasing the risk of collision (see the full TSB Final Report for the analysis on this finding.)
4. The pilot-in-command monitored approach (PICMA) procedure requires calls by the pilot not flying when the aircraft deviates from pre-established acceptable tolerances. However, no call is required to warn the pilot flying of an approaching steep bank.
5. The transfer of controls was not carried out as required by the PICMA procedure described in the SOPs. The transfer of controls at the co-pilot's request could have taken the pilot-in-command by surprise, leaving little time to choose the best option. △

Flight 2015—Letting Our Collective Ideas Take Flight

by Richard Berg, Senior Risk Assessment Advisor, Policy and Regulatory Services, Civil Aviation, Transport Canada

This is a follow-up to an article published in *Aviation Safety Letter* (ASL) 4/2009 on the development of Transport Canada Civil Aviation's (TCCA) strategic framework, *Flight 2015*. That article, titled "Transport Canada Civil Aviation Kicks Off the Development of a New Strategic Plan," provided an overview of Transport Canada's six-step strategic plan. TCCA is well into the planning process for its new strategic plan, *Flight 2015*, which will be underpinned by the important philosophy of continuous improvement.

Feedback from employees and industry representatives over the past few months has allowed us to learn much about the Civil Aviation Directorate, and indeed about its stakeholders—both internal and external. The insights we've gained from our consultations are helping us focus the Directorate's next strategic plan on some key areas to ultimately deliver an effective aviation safety regulatory program to Canadians.

This next plan will represent a collage of ideas from our employees, aviation industry executives, special-interest groups, and other government officials. The general philosophy of this initiative has been to:

1. Ask questions to gain a multitude of perspectives from stakeholders;
2. Gather feedback from stakeholders to find out how Civil Aviation should proceed and gain knowledge; and
3. Use that knowledge effectively.

Here are some of the questions that were asked:

1. For TCCA to be accountable and achieve its mission, what must TCCA focus on?
2. How should TCCA sustain its ability to change and keep improving?
3. To satisfy stakeholders, which operational processes must TCCA excel at?
4. How will TCCA sustain its ability to change and improve?[1]

TCCA management created the Strategic Planning Committee to provide a framework for informed decision-making. This committee, which comprises representatives from all TCCA branches at Headquarters and in the Regions, sorted and prioritized information gathered to align initiatives with Transport Canada's mandate and other government priorities. This exercise helped formulate TCCA's new platform for change: *Flight 2015*. The strategic framework will:

1. reflect TCCA's vision—what it wants to achieve;
2. provide a platform for necessary skills, incentives and resources; and
3. support an action plan to efficiently co-ordinate TCCA's activities.

The committee is now in the final stages of determining the necessary steps for implementing the strategy and measuring and controlling its performance. It has consulted with Civil Aviation employees across the country to identify and develop performance measurements, controls, data sources, and targets so TCCA can demonstrate its accountability to Canadians and the travelling public.

Flight 2015 is expected to generate an organizational synergy to make air transportation safer and improve TCCA's Aviation Safety Program. Watch for updates in future issues of the ASL and on Transport Canada's Web site as everyone's ideas take flight with the upcoming launch of the next strategic direction. △

[1] *Questions were derived from the* Balanced Scorecard *by Robert S Kaplan and David P Norton, Harvard Business School Press, 1996*

Invest a few minutes into your safe return home this summer...

...by reviewing your fuel requirements in Section RAC 3.13 of the *Transport Canada Aeronautical Information Manual* (TC AIM).

Stick to the Basics: Stable Approach and Sterile Cockpit

by Mike Treskin, Civil Aviation Safety Inspector, System Safety, Ontario Region, Civil Aviation, Transport Canada

I recently gave a safety seminar to a large group of general aviation (GA) pilots. A few of the subjects that generated some serious discussions were go-arounds, overshoots and missed approaches. Another one was the (lack of) seriousness of a sterile cockpit while on final approach and on departure.

There are a number of standard operating procedures (SOPs) used by major airlines that can be implemented by GA pilots into their own personal operating procedures (POP). One of them is the stabilized approach. Typically, an airliner on approach under instrument meteorological conditions (IMC) will need to be stabilized prior to going below 1 000 ft as a minimum, or by the final approach fix (FAF), whichever occurs first. Under visual meteorological conditions (VMC), 500 ft is the minimum. If the aircraft is not stabilized on approach by then, the pilot must conduct a go-around and try again, if fuel permits.

What is meant by a stable approach? Stable means that the aircraft is fully configured and is at the right reference speed (V_{ref}) for the approach and landing. Now, to apply this to a GA setting, you need to establish a minimum altitude where your aircraft is wings-level, all lift/drag devices are out, and you have the approach speed pegged. That altitude should be the minimum for your comfort zone. If you are not stabilized by the time you reach that altitude on approach, you should go around.

Give yourself a margin for a small altitude loss and to allow for a successful go around. Remember that when going around, you will be busy trimming and reconfiguring the aircraft, and communicating with air traffic services or others in the traffic. You will need to stop the descent and start climbing to a safe altitude. Can you remember the last time you needed to go around, or the last time you practiced one?

We sometimes tend to push the safe envelope when we come in for landing. You only need to observe aircraft on final to see if they are stable and ready for landing. Many are making noticeable power changes, pitch changes and heading corrections. Some descend below the ideal approach path and then drag the aircraft in. A go-around after an unstabilized approach is usually safer than trying to "squeeze on in."

Another topic we discussed at the safety seminar was sterile cockpits. Any distractions during a critical phase of flight, such as takeoff and landing, could be disastrous. All large commercial aircraft will have an SOP stating that all non-flying-related conversation will cease once flying through 10 000 ft in descent. The cockpit will be quiet unless it has a bearing on the flight. Again, this SOP can easily be adapted to the GA pilot who regularly flies with passengers.

This is best done during the pre-flight safety briefing to the passengers. Advise them that you would appreciate the cockpit to be silent for the take-off, climb, descent and landing portions of the trip. Still, they should be encouraged to point out safety items, such as nearby traffic or any warning light on the instrument panel.

Once you have flown in a sterile cockpit, you will notice how it can reduce the stress of flying with passengers on board. △

"Blackfly Air" Loses a Friend

It is with great sadness that we inform our readers of the passing of Marc Guertin, our *Aviation Safety Letter* (ASL) illustrator for the past 10 years. Among his favourite assignments were all 19 episodes of "Blackfly Air", which started as a simple way to introduce safety management system (SMS) concepts, and evolved into the peculiar saga of a fictitious grumpy 703 operator and his business-savvy wife. Marc also created a number of civil aviation classics, such as all six "Runway Incursions Are Real!" posters and the "Cats Can See in the Dark. You Can't!" night VFR poster. Over the years, he created nearly 100 custom illustrations for the articles and tear-outs in our newsletters. We extend our condolences to Marc's family and many friends.

Watch for the return of "Blackfly Air" in a future issue of the ASL.


FINAL APPROACH
ALL CLEAR? BE SURE!
RUNWAY INCURSIONS
ARE REAL!
Transport Canada
Transports Canada
NAV CANADA
alpa
ATAC
C.A.C.
CATCA/ACCTA
CAW/TCA 5454
FSS
CANADIAN OWNERS AND PILOTS ASSOCIATION
TP 14007E
(10/2002)
Canada

Transport Canada Transports Canada

TP 2228E-18
(04/2003)

TAKE FIVE...

for safety

Five minutes reading could save a life

Underwater Egress

Although the odds of experiencing a ditching event are extremely low, pre-flight preparation and knowledge are paramount to survival should it happen.

The following items will enhance your chance of a successful egress.

1. Pre-flight Preparation

Ensure the pilot-in-command demonstrates the location and use of the emergency exits, life preservers, emergency equipment, life raft, and the proper brace position—before the flight. For extended over-water flights, consider wearing your life preserver. Make sure all baggage and cargo is secured so it does not block access to the emergency exits.

2. In-flight Preparation

If you are aware that you are about to ditch, do the following:

- Put on your life preserver, but DO NOT INFLATE IT.
- Locate all emergency exits, note where they are in relation to your right or left hand, and visualize how to open them.
- Assume the proper brace position for your seat, as briefed by the crew.
- Follow the instructions given by the pilot-in-command.

3. Underwater Egress Procedure

- **Try to remain calm!**
- Take a deep breath prior to being submersed under water.
- OPEN YOUR EYES.
- Orient yourself in relation to your selected emergency exit.
- Get a firm grip on a fixed reference point.
- ***If you are seated right next to your emergency exit:***
  - Wait until the water has filled three quarters of the cabin before you fully open the exit, then open it.
  - Release your safety harness.
  - Pull yourself free from the cabin.
  - Inflate your life preserver after exiting the aircraft.
- ***If you are NOT seated right next to the emergency exit:***
  - Release your safety harness and proceed toward your emergency exit.
  - Wait until the water has filled three quarters of the cabin before you fully open the exit, then open it.
  - Pull yourself free from the cabin.
  - Inflate your life preserver after exiting the aircraft.

Some of the difficulties during underwater egress include lack of oxygen; disorientation; in-rushing water; obscured vision; and floating debris. ***Don't panic***. You know you can hold your breath, so relax for a moment; open your eyes; find the exit; and egress. These are basic guidelines only, and your best defence is underwater egress training.

Canada