"When the only tool you have is a hammer, every problem becomes a nail."

–Anonymous

The first iteration of CF-HFACS (figure 2) was a modification from the original framework (figure 1). It was introduced to FS investigators at the end of 2003 and used from 2004 as such until recently. Despite having been presented at an annual FS seminar back in those years, having been incorporated in the training syllabus on both the basic and advanced flight safety courses, and having been used quite extensively throughout the recent years, some difficulties in utilizing the model were highlighted by investigators at different levels of the FS organization. Key issues had to do with its relative complexity, quantitatively and qualitatively. As illustrated in figure 2, it contained more categories, or "bins", than the original framework in figure 1. With regard to the supporting text, i.e. chapter 10 of the A-GA-135-001/AA-001, Flight Safety for the Canadian Forces (henceforth referred to as A-GA-135), FS personnel

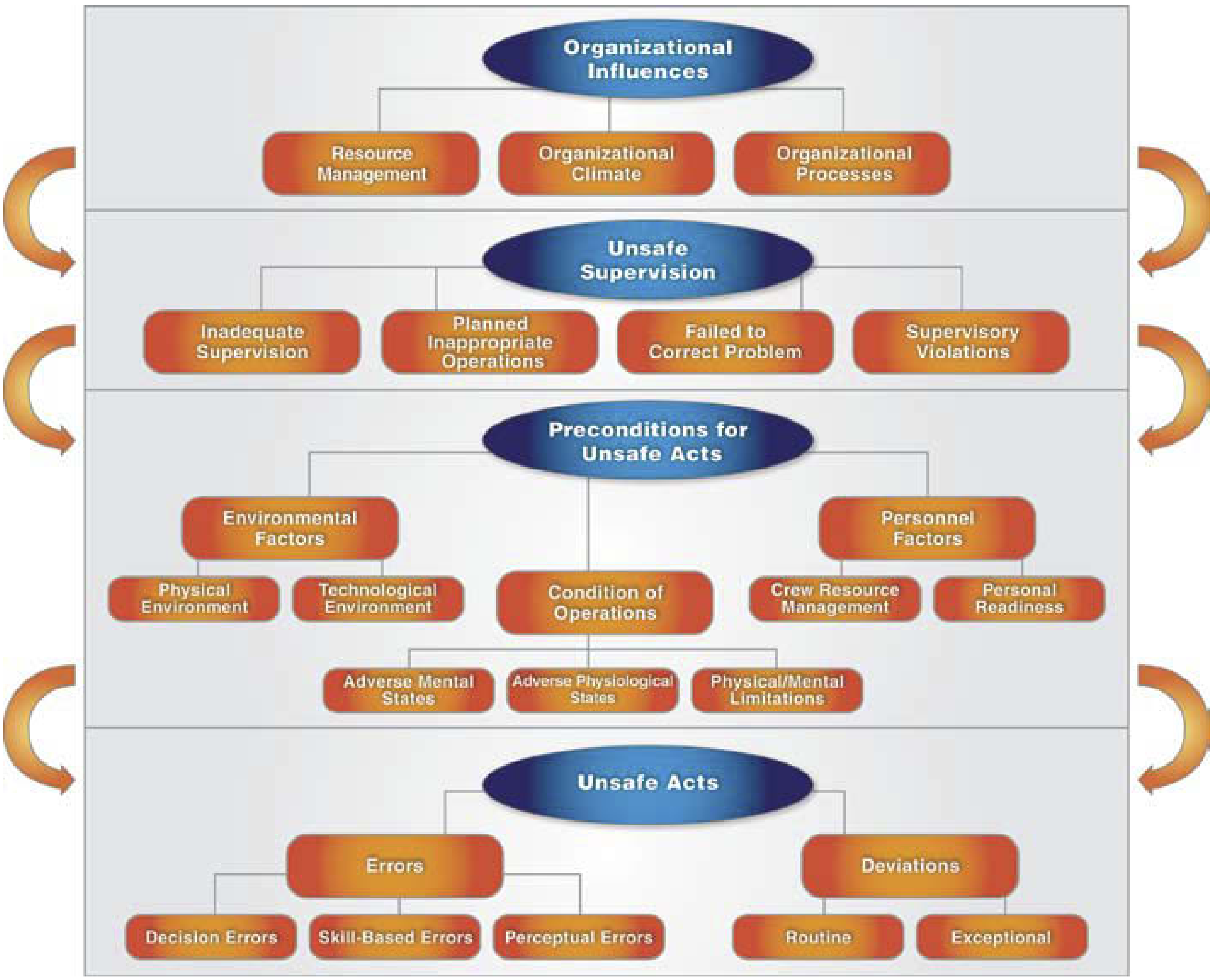


Figure 1. HFACS framework as developed by Drs. Scott Shappell and Doug Wiegmann

Flight Surgeon

> *"Insanity is doing the same thing over-and-over and expecting a different outcome."*
>
> *–Albert Einstein*

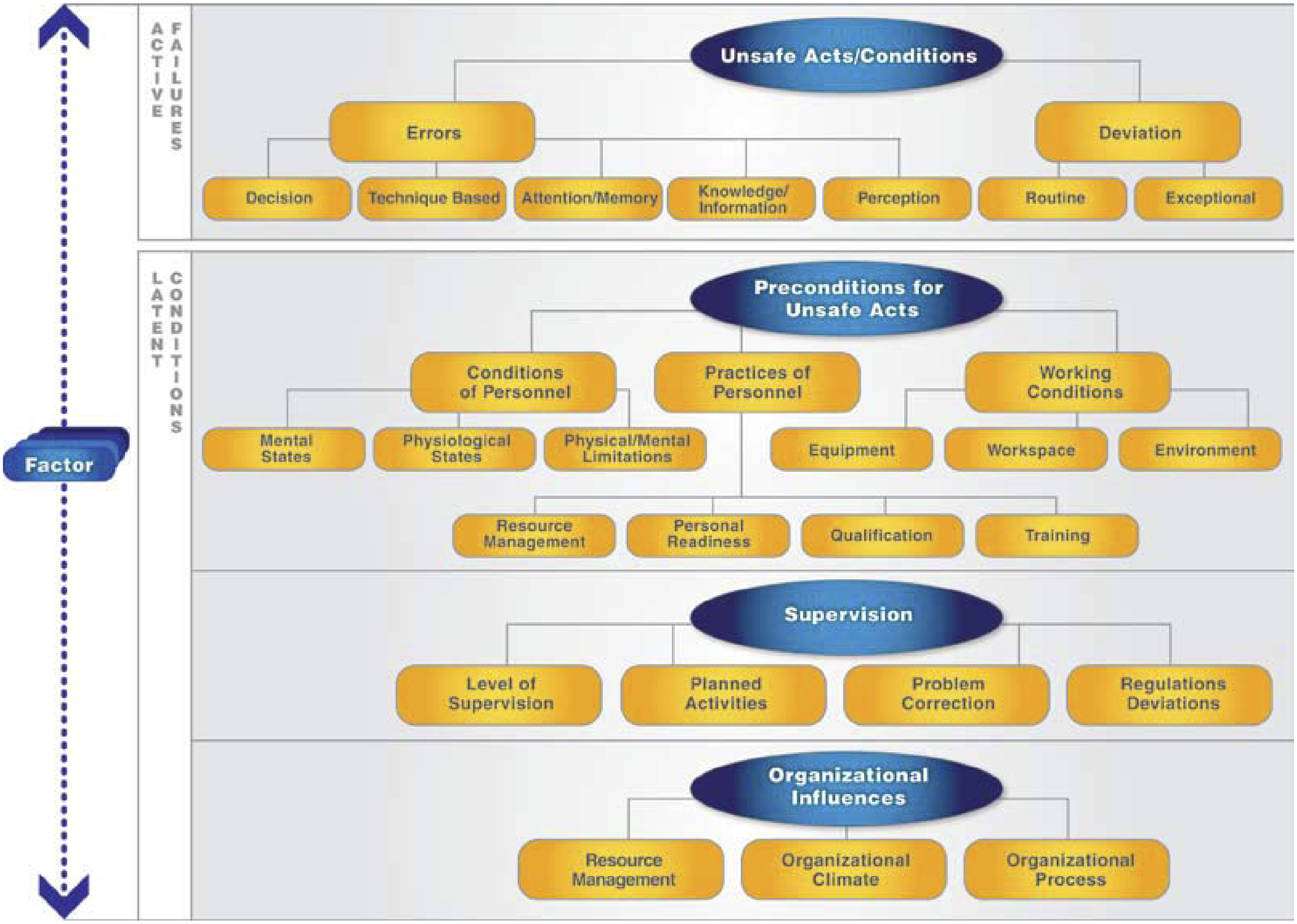


Figure 2. First version of CF-HFACS, adopted in 2004

found that examples to illustrate the concepts alluded to in the text were lacking and that the vocabulary and terminology used were at times difficult to understand.

From our perspective at DFS, record keeping and trend analysis had been complicated by the fact that "selections" within the different categories were not necessarily "mutually exclusive" in all cases. In other words, for a given HF issue, one idea or selection could possibly fit in several "bins", thus complicating the work of investigators at times by introducing confusion and variability. This, in turn, created less than optimal levels of reliability. Revisiting the model, to alleviate the abovementioned problems and improve it, was needed. This is what we did.

We recently completed the whole process of revising the chapter on "cause factors" in the A-

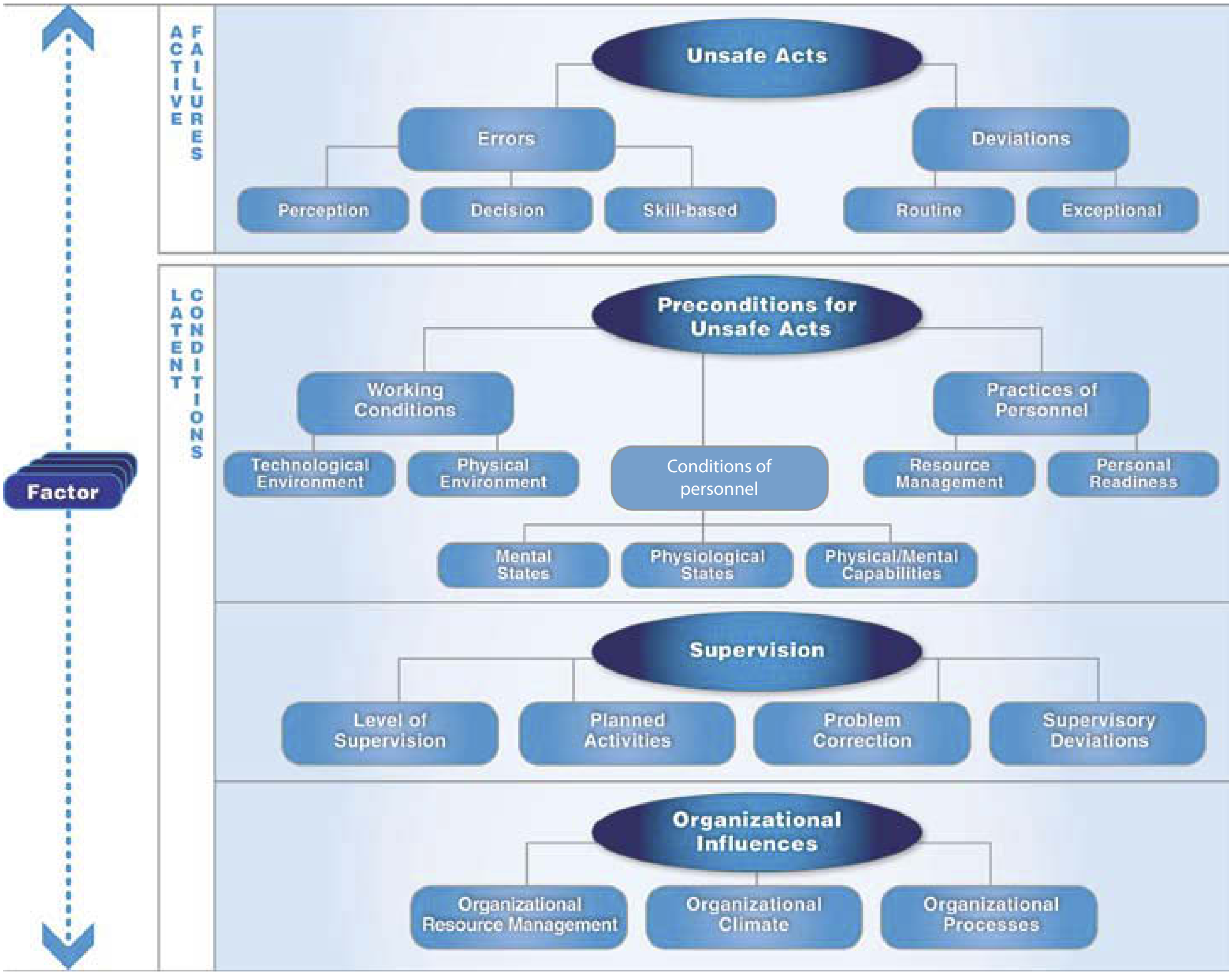


Figure 3. Amended CF-HFACS, version 2008

GA-135. As illustrated in figure 3, the CF-HFACS framework was re-designed. Most importantly, the text was entirely amended, concepts better explained, numerous examples introduced, categories and possible "selections" arranged in a step-by-step flow, and the selection ''others", appearing in just about all the "bins", removed. Those changes are now available since April 2008 in the amendment # 1 of the A-GA-135, dated March 2007.

CF-HFACS, since its adoption in 2004, has helped greatly better understand, document and analyze the HF aspects at the root of FS accidents and incidents. In order to support FS investigators, to further improve their awareness and understanding of the revised model and refine their skills at investigating HF issues embedded in FS occurrences, a new edition of the "On Target" magazine is currently under construction, and will be issued in the near future, dedicated to the specific subject of human factors. Happy reading! ◆

I'm OUTTA HERE!

Riding the Rocket Seat

By Capt Stéphane Paquet, Editor of Flight Comment, Directorate of Flight Safety, Ottawa

So you're a rocket seat rider, eh? We all agree that, in terms of thrill rides, ejecting out of an aircraft probably scores 15 on a scale of 1 to 10. Yet, over the last 5 decades, ejection seat technology has greatly evolved to effect ever greater survival rates, fewer injuries, and within a wider operating envelope, from 0 to 600 knots, and from ground level to the stratosphere.

Just to give you an example, the venerable F86 Sabre's ejection seat (figure 1, left) was of little use below 1000 feet above ground, and did little else than push the seat and pilot out of the aircraft with a catapult. The pilot had to manually eject the canopy and manually lock his harness prior to ejection. He also had to remember to bring his feet back and place them on the seat's footrests, and brace his arms on the armrests. Post ejection, he had to unstrap himself manually from the harness and quick away from the seat, and had to manually open the main parachute, which was directly attached to the pilot, and had to be carried in and out of the aircraft for each flight. Talk about a busy egress drill! Needless to say, the confidence in such a system was limited at best.

Now, compare this to the Mk 14 NACES seat (figure 1, right), which is scheduled to upgrade the CF188 Hornet escape system next year. The NACES uses a digital electronic sequencer along with airspeed sensors and electrically-fired systems on the seat to allow for five separate modes of operation depending on the sensed conditions at ejection. The pilot's legs are automatically reeled in and held in place, and the seat harness automatically retracts and locks the pilot firmly in place. The seat is pushed out of the aircraft via a multi-stage catapult system, followed by a powerful underseat rocket. Immediately upon leaving the aircraft, the seat deploys a rocket propelled multi-point attachment drogue chute which slows the seat down prior to the main parachute deployment and keeps it stabilized in the airflow (see figure 1a, next page). Needless to say, the main parachute (also rocket-deployed) opens automatically, along with seat-man separation. The NACES' ejection envelope goes from zero airspeed and zero altitude, all the way to 600 knots and 50,000 feet.

As mentioned by Col Shelley in his From the Director article on page 4, this type of progress means that crews are increasingly confident in their escape systems, which in turn may at times translate to a certain degree of complacency, and pushing of the limits.

I like to compare this to driving in a snowstorm in Canada. If you're going to attempt this with a 15 year old beater, with worn brakes and bald tires, you'll get acquainted with your limits quickly and clearly. Consequently, you'll be very alert, your driving speed will be slow, and you'll approach every curve with a sense of impending doom (you'd think I've been there…). Now, fed up with this, you go and buy a Hummer (first generation, please). How do you think your attention, speed and curve handling may vary? Will you not be tempted to drive faster, defy the elements, and go into curves without slowing down? Believe me, I've seen many, many people fall for this over the years. The problem in doing so is of course, that this nice layer of added safety you dearly purchased is all but useless. You find yourself upside down in a snowbank, and another dude with his old beater slowly passes you by and waves through frosty windows.

You get my point…

Now, let us see what we've learned in the past few years following our own ejections. This article will depict the Canadian Forces' last 8 ejections, from May 2003 to April 2008.

CF188 Hornet, 188732, May 26th, 2003

Following a severe flight control malfunction during a low level, air-to-surface mission, the pilot ejected at approximately 1250 feet AGL, 465 kias, with the aircraft in a negative 2.5 G rolling motion, and approximately 76 degrees of right bank. The pilot was fatally injured during the egress process.

The investigation revealed that the mechanism of the fatal injury was a sudden and large sideways force applied

Figure 1. F86 Sabre (left) versus CF188 NACES (right)

to the pilot when the main parachute opened at high velocity. The pilot's head was forced through the shoulder harness to the left.

The SJU 9/10 seat (otherwise know as Martin-Baker Mk 10L) which was used in this ejection uses a single point drogue chute for initial seat aerodynamic stabilization, deceleration and to extract the main parachute from the headbox. However, at low altitudes (below 7500' ASL), this drogue chute will only be in action for about 1 second prior to extracting the main parachute. Thus, during a low level, high speed ejection, a large deceleration force will be imparted to the pilot during the main parachute opening phase. In this case, it was estimated at approximately 25 G's. This large force was applied sideways because the seat was not properly aligned with the airflow at the time of main parachute opening (see figure 2).

Figure 1a. NACES ejection test showing the multi-point attachment drogue chute

Here is a breakdown of the main deficiencies highlighted by this accident:

Procedural Deficiencies

The strap in procedures employed by many aircrew (including the accident pilot) at the time of the accident were incorrect. The full procedure, as mandated by the manufacturer, was not fully accomplished, and resulted in the pilot being improperly restrained during ejection. Notably, the simplified combined harness (SCH) was not sufficiently tightened, resulting in the so-called "triangular void" above the pilot's shoulders (figure 3). Tests demonstrated that this gap can be in the order of 7 inches when the pilot is suspended. The investigation also revealed that many aircrew felt "nice and snug" in the harness when in the seating position in the cockpit, even when it was improperly adjusted. Also, an improper tightening of the leg restraint snubber lines resulted in the pilot's right leg going outside of the seat bucket during ejection, adding to the seat's instability. AOI's were subsequently modified to enforce the correct strap-in procedures.

Several deficiencies were noted with the training that technicians and pilots receive with respect to duties associated with the CF188 ejection system. Although the training syllabus was improved since then, some variances still exist between Wings and fleets on the scope and depth of egress training. This is currently being addressed via the ALSE working group in an effort to standardize egress training across the CF. Amongst many items, the importance of annual recurrent training, with a full suspension test every time, must be emphasised.

Figure 2. Extraction of main parachute by drogue chute; approximation of misalignment of seat/pilot with main chute axis on inflation

Material Deficiencies

Following this accident, a fleet-wide special inspection revealed 52 unserviceable harness or ejection seat straps, as well as improper routing of the emergency oxygen hose fitting through the rigid seat survival kit (RSSK). As well, the RSSK attachment straps were incorrectly routed through the lower lock harness webbing. These last two deficiencies contributed to the failure of the lower harness lock, which in turn worsened the pilot's restraint further during the ejection.

Other ALSE problems were noted. Most notably, the life preserver survival vest (LPSV) had inflated from windblast, destroying the floatation bladder. The LPSV contents had been dumped out of the pockets, some of which hit the pilot forcefully, and the helmet visor was torn off when exposed to the windblast. As a result, a new LPSV was designed and implemented (the MSV 875). A solution to the visor retention problem is still pending.

Following this accident, a CF188 ejection system risk assessment was conducted in light of accident findings and recommendations, as

Figure 3. Suspension test showing excessive triangular void above the shoulders

well as the introduction of the CF188 joint helmet mounted cueing system (JHMCS). The need to increase the seat's inherent aerodynamic stability, and to reduce the main parachute opening shock were, amongst other parameters, clearly identified. As a result, the procurement of the NACES ejection seat described earlier in this article was approved in early 2006, with a forecast implementation during 2009. In the meantime, a revised escape system modernization provided for the replacement of the SCH with a PCU-56 torso harness, an improved seat cushion, the new LPSV, as well as a revised placement of the oxygen regulator.

CT155 Hawk, 155202, May 14th, 2004

Following a touch and go as part of a training mission, at about 70 feet AGL and accelerating through 239 kias, the aircraft was hit by a bird, which was ingested in the engine intake, causing an immediate loss of power. The instructor pilot (IP), flying from the backseat, initiated a climb to trade airspeed for altitude, and told the student to prepare to abandon the aircraft. This is an important positive point to emphasize, as the front seater of a training aircraft is usually a student, most of which having a low level of flying experience. An early warning may greatly help in preparing the student pilot (SP) for a successful ejection.

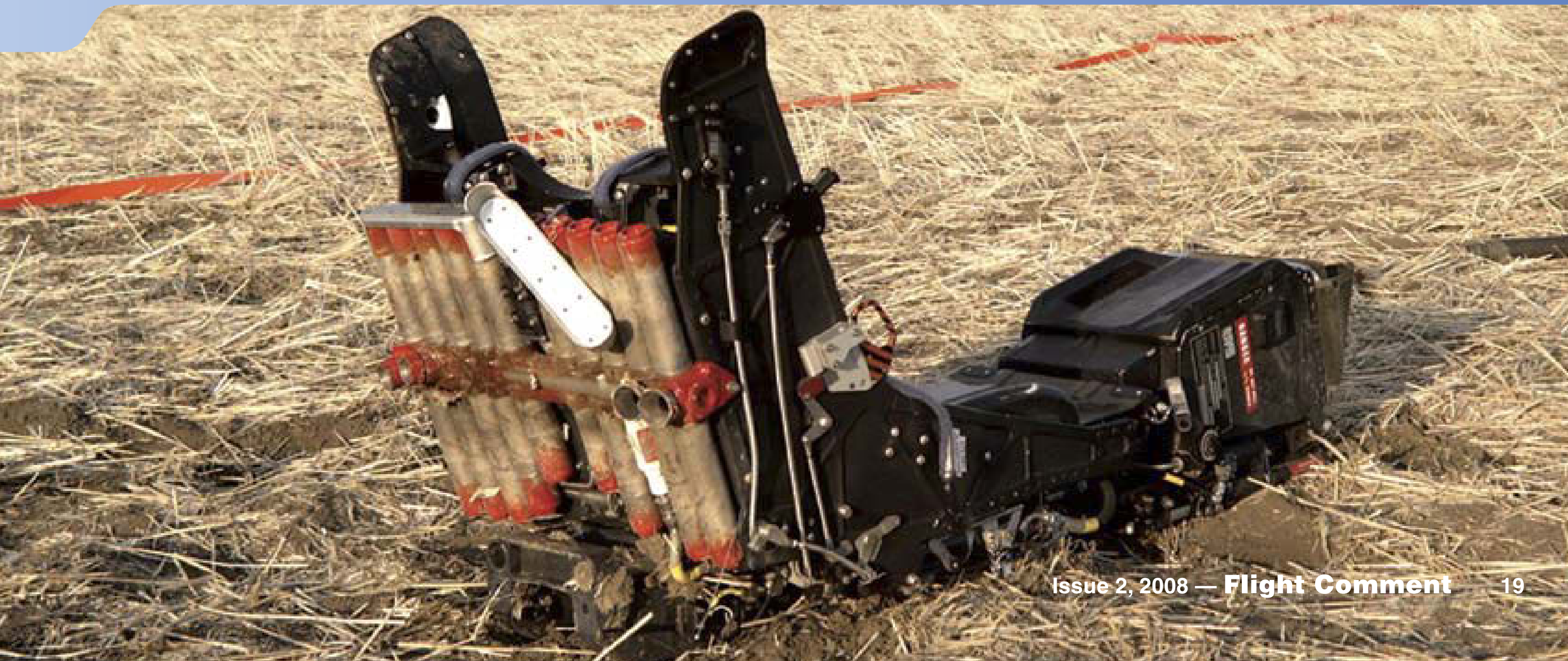
As the aircraft descended through about 1000 feet AGL, and after confirming the student was ready, the IP initiated the ejection. Both pilots survived the ejection, but the IP was seriously injured and the SP received minor injuries. The aircraft crashed in a farmer's field, about one mile north of 15 Wing, and was destroyed.

The CT155 Hawk is essentially equipped with the same SJU 9/10 (Mk 10L) ejection seat as the CF188 Hornet currently. One important difference with related systems is that the canopy, instead of being ejected, is shattered in place via a miniature detonation cord (MDC). The ejection parameters were as follows: 690 feet AGL, 142 kias, 2000 fpm down, wings level, and minus 14 degrees pitch. Following the ejection, the IP descended under a full canopy for about 30 seconds.

The aircrew were exposed to an engine malfunction in the worst possible regime of flight: low altitude and low airspeed. Two tasks had to be dealt with nearly simultaneously, and in short order: interpret the emergency then decide whether to stay with the aircraft or eject. In general, deciding to stay with the aircraft gives more time to interpret information and attempt to rectify the emergency; but, should a relight be unsuccessful, altitude for the ejection has been sacrificed. The ejection decision is often time critical, and a delay of even seconds can mean the difference between life and death.

In all ejections, it is favourable to have an upward vector as opposed to a rate of descent. Therefore, a less aggressive zoom resulting in a lower apex means more time prior to the onset of a descent rate. The IP did a wings level pull up initially, but entered a steep turn approaching the apex, sacrificing altitude by using the lift vector to turn the aircraft in an attempt to return to the airfield.

CT155 Hawk, 155202, 14 May 2004



Procedural deficiencies

The IP suffered injuries during the catapult phase, which were likely due to the fact that he was in a head down, and slightly hunched position at the time the seat fired. He immediately felt a sharp pain as the seat was propelled up the rails. After parachute opening, he attempted to relieve pressure/pain during the descent by lifting himself with the risers. This had the effect of rotating his parachute through 360 degrees as it descended and increased his descent rate. No attempt was made to deploy the parachute survival pack (PSP). He also suffered serious injuries on landing. The non-deployed PSP and high descent rate contributed to these ground impact injuries. The IP's ejection was classified as « unsuccessful/survivable ». An ejection is classified as successful if the aircrew can escape and evade (war time) or return to flying status within 24 hrs (peacetime).

On the other hand, the front seat was command ejected from the rear seat of the aircraft. The SP pushed himself against the back of the seat and grasped the seat-firing handle but did not pull it. The SP did not suffer injuries from either the catapult or rocket motor phases of the egress process. He was able to deploy his PSP prior to ground impact, although it took three attempts, and overall suffered minor injuries as a result of the ejection sequence. This ejection was classified as 'successful'.

This accident again highlighted the importance of following the proper strap-in procedure as per the AOI's. The IP had, here again, an excessive triangular void due to an improperly tightened harness, which resulted in riser slap. Despite the low speed nature of the ejection, there were indications on his ALSE and from his physical injuries that there was an interaction between the SCH and the IP's neck and helmet. His Life Preserver Survival Vest (LPSV) had signs of harness contact and was slightly damaged.

Figure 4. Helmet, visor and mask damage due to MDC and canopy material

One of the two pilots was not wearing dual layered flying clothing, which contributed to burn injuries and lacerations related to MDC splatter and canopy debris.

Material deficiencies

Both pilots suffered burns from contact with molten MDC material during the ejection. Both helmets and visors showed signs of pitting, scratches and residue deposits (figure 4). As well, the blast cover of one Beaufort Mk30LC LPSV was perforated rendering the floatation bladder, stored within the carrier, unserviceable. The investigation revealed that the punctures in the bladder were due to sharp canopy fragments impact during the ejection. This truly brings home the importance of wearing dual layered flying clothing, and to properly use the helmet-visor-mask ensemble for maximum protection. The Aerospace Engineering Test Establishment (AETE) escape systems (ES) team is currently evaluating a replacement solution in order to increase the resistance to perforation of the LPSV.

The GQ1000 17-foot aeroconical parachute installed in the CT155 Hawk seat has a history with regard to high descent rates and subsequent landing injuries, which is consistent with the serious injuries sustained by the IP. The GQ1000 is reliable and fast opening but its characteristics produce high total velocities near its maximum suspended weights, which was the case for the IP.

Based on data provided by the OEM,

his descent rate and total velocity in zero-wind conditions were estimated to be 26 feet per second (fps) and 36 fps respectively, beyond the limits of 24 fps and 30 fps published in the standards. Here again, beyond the attempt to relieve the pain from his ejection injury, it must be emphasised that, at low altitude over the ground and expecting an imminent landing, ejectees should avoid pulling on the risers or steering lines, as this will significantly increase the rate of descent.

CF188 Hornet, 188761, June 19th, 2004

Following a landing on a wet runway at a northern forward operating location, with a heavily configured aircraft, directional control was lost during the landing roll, resulting in the aircraft departing the runway sideways. The pilot ejected shortly thereafter with the aircraft travelling approximately 40 kias at 90 degrees sideways. He was propelled approximately 260 feet along the aircraft's trajectory.

Considering the ejection parameters, this one is considered as a "zero-zero" ejection, i.e. zero airspeed and zero altitude, which is one of the more challenging scenarios, as it gives the pilot minimum altitude clearance from the ground, and thus little time to prepare for the landing. The pilot was able to release the RSSK before ground contact but sustained a serious injury during the parachute landing on packed dirt and gravel. Thus, the ejection was classified as unsuccessful/survivable.

CF188 Hornet, 188761, June 19th, 2004

Given the above, and since all other aspects of the ejection sequence were evaluated as normal, the injury sustained by the pilot was assessed as directly related to the speed at which he hit the ground. The pilot ejected from the aircraft without any identifiable interference. He felt the tug of the parachute opening then immediately pulled the RSSK deployment handle and was able to deploy the seat pack. He then prepared himself for landing by bending his knees slightly.

The analysis of ES components, as well as pilot interviews revealed that given the low altitude of the ejection, the pilot's actions prior to landing were adequate and in accordance with the ejection training received. Worthy of note is the fact that the pilot landed on packed dirt and gravel, and narrowly missed the concrete tarmac. It is highly probable that his injuries could have been worse had he landed on the concrete.

The replacement of the current CF188 seat with the NACES, which uses the newer GQ-5000 main parachute, will provide for reduced descent rates, as well as an expanded ejection weight envelope.

CT114 Tutor, 114064, December 10th, 2004

CT114 Tutor, 114064, Dec 10th, 2004

The Snowbird team opposing solos were conducting training for the "co-loop" manoeuvre, when they collided head-on while inverted at the top of the loop. The collision occurred at about 3500 feet above ground level (AGL) with a closing speed of between 360 and 400 kias. One of the two pilots was fatally injured, while the second, the lead solo, survived with only minor injuries.

After the collision, a fireball engulfed the cockpit of the solo lead's aircraft, and the pilot, still in his seat, was expelled from the aircraft without initiating the ejection sequence.

On- site, post crash examination of the ejection components supported this scenario. Both ejection seats were found with the rails still attached to the seat. In addition, the canopy was not jettisoned and the ejection initiation handles on both seats had not been activated.

Shortly after the collision, the surviving pilot realised that he was outside his aircraft still attached to his seat, which was tumbling, and freefalling to the ground. He immediately reached for and pulled his manual parachute deployment "D" ring. After completing this action, he realised that he was not experiencing any parachute deployment. He then reached down to release his lap belt manually and made a conscious decision not to pull his ejection seat handles, as he was already free from his aircraft. However, he was not aware that his seat rocket catapult had not been activated.

When he manually released his lap belt, he instantly felt himself separated from his seat and the parachute deployed immediately. Once he had full parachute deployment, he reached down and deployed his seat-pack emergency kit. Next he closed his eyes and waited for the ground impact. The elapsed time from parachute opening to landing was estimated to be about five seconds. The pilot suffered no landing injuries.

By definition this cannot be classified as an ejection; however, it was a "successful bailout". The pilot and his parachute were soaked in a petroleum product during the escape sequence, most likely either diesel fuel from the smoke tanks or F-34 (aircraft fuel). No burnt sections were found on the post crash examination of the parachute. Of note, the pilot had completed his annual ejection seat training sequence on 02 December 2004, just 8 days prior to the accident, and one of the sequences covered was the "bailout" scenario.

This ejection survival was, by any standard, extraordinary, and truly highlighted the value of training. The egress training staff at 15 Wing was commended for a job well done, and for providing excellent training that was key to saving a pilot's life. The investigation team noted that, at the time, there was no common standard for ejection seat training in 1 Canadian Air Division. It was thus recommended that the Operational Airworthiness Authority (OAA) adopt the structure of 15 Wing egress training syllabus as the proposed standard upon which all similar training should be based. This is an on-going task of the CF ALSE working group.

CF188 Hornet, 188745, Aug 16th, 2005

During a defensive basic fighter manoeuvre (BFM) engagement, the aircraft departed controlled flight and entered a low yaw rate, auto-rotative spin, at approximately 13,000 feet above sea level (ASL). The pilot was unable to regain control of the aircraft and ejected as the aircraft descended through approximately 7,500 feet ASL, or 5700 feet AGL, with little or no forward speed, and a very high rate of descent.

The ejection was within the normal ejection design envelope and is classified as successful. The ejection was controlled and the pilot was able to adopt the correct posture. During the parachute descent, the pilot was able to steer the parachute towards a suitable landing site. He sustained minor injuries during the ejection and parachute landing, and was recovered 45 minutes after the accident via helicopter.

When the aircraft began to depart controlled flight, the occurrence pilot maintained radio contact with the other formation member, all the way to ejection. It is important to maintain mutual support during critical emergencies, and in this case, the other aircraft's pilot maintained visual contact, and provided cues to the occurrence pilot on his altitude, and eventually, prompted him to eject as the aircraft approached the minimum recommended ejection altitude.

Procedural deficiencies

Although the pilot properly used the risers to steer the parachute towards a suitable landing site, he attempted to flare prior to landing by pulling on both risers and subsequently experienced a hard landing. Luckily, he landed on soft ground covered with thick moss, and only suffered minor injuries. The GQ1000 parachute does not have 'flare' capability; pulling on the risers reduces forward velocity while significantly increasing rates of descent. The parachute virtual reality simulator at AETE was used to estimate the descent rates for the pilot. It was concluded that the probable rate of descent for a 'no-flare' landing was 24-26 fps; for a 'flared landing' this increased significantly to 32-38fps. The investigation revealed that this knowledge based deficiency was prevalent amongst ejection seat aircrew, and that, in some cases, annual recurrent training did not provide for thorough egress training with a full suspension exercise. In the same vein, it was noted that survival kit contents awareness is not prevalent amongst all CF188 pilots.

The pilot's helmet nape strap was not fitted as per the standards, and was found "rolled under". This may compromise helmet retention during high-speed ejections. As well, the pilot was wearing flying gloves without the inner liner, which compromises fire protection.

Another area of concern was that the CF188 bailout tone, which is automatically transmitted by the aircraft continuously from the moment the ejection is initiated. It was not readily recognized by all aircrew and ATC personnel. This is mainly due to the fact that the tone is emitted for a short time during every aircraft start, and when a pilot performs a communications "COMM BIT" check, thus reducing the awareness of its significance. This was corrected via additional training.

Material deficiencies

The ALSE examination revealed that riser slap had also occurred during this ejection, even though the pilot ejected at low speed. Still, the contact between the parachute risers and the pilot's helmet was sufficient to leave a crack in it, and to shear off one of the mask bayonet receiver. Again, this phenomenon will be minimised by the use of the torso harness and the NACES ejection seat.

The harness' single point release mechanism'T' handle 'V' strap was inspected and showed excessive wear caused by daily usage. The wear was assessed as being beyond the limits specified in Special Inspection (SI), SI NS-015.

The pencil flare used by the pilot to attract the attention of the CSS helicopter proved ineffective due to the bright daylight conditions. A replacement has since then been implemented.

CT114 Tutor, 114120, Aug 24th, 2005

The accident aircraft was part of the 431 Air Demonstration (AD) Squadron, the Snowbirds. During a pre-show "shakeout", the pilot rolled the aircraft inverted, and immediately heard a loud bang, followed by a loss of thrust. The pilot then rolled the aircraft upright and conducted emergency procedures. Faced with an unresponsive engine, the pilot confirmed the path ahead of the aircraft was suitable for ejection and after calling his lead, ejected with wings level, between 200-250 kias, and at an altitude between 1000 and 1500 feet AGL.

The pilot landed only about 500 meters from the crash site, in a swamp, and was recovered approximately 20 minutes later, with minor injuries only from the ejection. The ejection was classified as successful. This occurrence demonstrates the criticality of not delaying the decision to eject. Having rapidly assessed the situation, and realizing that the engine was unlikely to restart or generate any useful power, the pilot did not waste any more time and was able to eject well within the envelope of the seat. Establishing the parameters for a successful ejection must always be the first consideration in this type of emergency situation, particularly at low altitude.

Material deficiencies

Following the ejection sequence, the pilot realised that his Seat Pack Survival Kit, including the contents, were no longer attached to his life preserver/universal carrier (LP/UC). Thus, the pilot was deprived of his survival kit after landing. The seat pack survival kit, once deployed by the pilot after the ejection, is suspended under the pilot by the maritime lanyard, which in turn is attached to the LP/UC by a stitching patch. The investigation revealed that the stitching had failed, and did not conform to applicable orders. In all, out of 35 LP/UC deemed ready to use, 25 were found defective.

An examination of the pilot's parachute revealed that the cone plate had partially separated due to a previous repair that was not done

CT114 Tutor, 114120, Autust 24th, 2005

IAW the technical orders. This was determined to be an isolated incident.

Investigation of the pilots' helmet revealed that the dark visor did not match the oxygen mask. This in turn creates a gap between the mask and visor, which may result in injuries during ejection. Also, the helmet was found to have 12 coats of paint on it, versus the normal 5 coats. Although seemingly a minor deficiency, this can add to the weight of the helmet, which may contribute to neck injuries under heavy G loading.

CT156 Harvard, 156112, Apr 4th, 2007

The occurrence took place just prior to a CF pilot student's first flight on the CT156 Harvard (clearhood 1 mission). The student pilot completed his strap-in procedure in the front ejection seat under the supervision of the instructor pilot, who then strapped into the rear ejection seat.

As they were about to complete the pre-taxi checks and request a taxi clearance, the student pilot inadvertently ejected from the parked aircraft. He sustained minor injuries from the detonation of the canopy fracturing system (CFS) and subsequently the parachute landing on the hard surface of the concrete ramp. The instructor pilot also sustained minor injuries.

The CT156 is equipped with the most modern ejection seat currently in the CF, the Martin-Baker Mk C16LA, using a PCU 15/16 torso harness. This seat is obviously certified for zero-zero ejections, and uses a GQ5000 aeroconical, 21 ft diameter parachute.

As the investigation for this occurrence was still on-going at the time this article was written, not all the details are releasable. However, the following points can be published:

- The SP (ejectee, front seat) had his mask and visor in place. The IP had a visor down, but his mask was undone. The SP sustained minor injuries secondary to the detonation of the CFS and his parachute landing on the hard surface of the concrete ramp. The IP sustained minor injuries, mainly to his lower face, secondary to the detonation of the front canopy CFS and the fireball produced by the front underseat rocket motor.
- Both pilots were properly clothed which helped to mitigate the extent of their injuries.
- The investigation revealed that the SP's communication cord, which is attached to the oxygen mask hose, was inadvertently routed through the ejection seat handle during the strap-in procedure. It was determined that, with his oxygen mask donned, a pull force sufficient to initiate ejection was applied to the ejection handle. The CT156 ejection handle does not have a back plate similar to the one used in the CF188 to prevent this very occurrence.
- A survey of CT156 aircraft in Moose Jaw revealed several differing lengths of communications lines on oxygen hoses.
- One of the two seat initiator cartridges did not fire, resulting in the non-activation of the harness powered retraction unit (HPRU), which forcefully restrains the pilot in the seat

CT156 Harvard, 156112, April 4th, 2007

and helps in adopting the proper posture. This was likely due to an improper stowing of the leg restraint lines by the pilot under the seat.

- There are physical differences between the aircraft seat and the mock-up seats in the flying training device (FTD) and the ejection seat trainer, which may have resulted in negative training for certain items.
- The SP used the parachute toggles to steer away from aircraft on the ramp during his low level descent. This cleared him from obvious obstacles, but increased his rate of descent. The SP then attempted to flare the parachute prior to landing, thus increasing further his rate of descent, with no added benefit.
- Although the SP attempted to release both FROST type parachute release fittings simultaneously, one of them did not release, resulting in a asymmetric load on the remaining fitting which resulted in the SP not being able to release his parachute until he was helped by ground personnel. This is a well documented problem which resulted in another fitting type (generation 2 H. Koch) to be selected for the CF188 escape system modernization.
- One pilot did not have a tether on his shroud knife (used to cut away the parachute or its lines); the other pilot was not carrying his issued shroud knife.

CT155 Hawk, 155215, Apr 18th, 2008

Following the initial takeoff and climbing through 10,000 feet, the occurrence aircraft, manned by a SP in the front seat and an IP in the back seat, experienced an engine malfunction, which resulted in an engine failure. The crew attempted to perform a forced landing profile in an effort to land back at the departure airfield. However, about 1 mile back from the runway, the IP realized that they would not make the runway, and informed the SP of the imminent ejection. The IP then command ejected both pilots from the rear seat. Both pilots ejected at an estimated altitude of 200 ft to 300 ft above the ground, 1.6 seconds before the aircraft struck the ground and exploded, setting a stubble field on fire in the process (See actual photo sequence, right). Both pilots landed in the burning field, and the IP had to help the SP unhook his survival kit and untangle it from the harness. The SP's parachute was, at this point, already on fire. The two pilots then moved away from the encroaching fire, and were met by the local crash fire rescue personnel.

CT155 Hawk, 155215, April 18th, 2008

As the investigation for this accident is also on-going, not all the details are releasable. However, the following points can be published:

- Both IP and SP suffered serious injuries. The IP's injuries are consistent with loads imparted during the catapult phase, where contact with the aircraft canopy plexiglas, prior to it being ballistically removed, likely contributed to the injuries. The SP's injuries are consistent with loads experienced during the ejection and landing phase sequence. Based on these injuries, both ejections were classified as unsuccessful/survivable.
- The IP and SP estimated suspended weights were well within the published weight envelope for the CT155 ejection seat.
- The IP was in a proper ejection posture at the time of ejection; however, he did not have the minimum helmet/aircraft canopy clearance required for the rear seat of the Hawk (which is 76 mm).
- The IP's helmet and mask showed significant damage, and parts of his visor were recovered with the aircraft canopy debris.
- The IP did not attempt to steer his parachute or release the Personal Survival Pack (PSP), and landed with the PSP under the right side of his body. The student did not attempt to steer his parachute but did repeatedly attempt to deploy his PSP, unsuccessfully. He landed while still trying to deploy it.
- Both pilots did not wear dual protection clothing, and received burn injuries due to MDC spatter. The SP also received burns from exposure to the ground fire. However, both pilots did wear flying gloves with liners, which protected their hands.
- The IP had the lower pockets of his anti-G lower garment stuffed with flight publications. His G suit was significantly damaged, which can be related to the leg snagging in the rudder wells during the ejection.

Conclusion

As you can see, ejection seats are designed to save lives, and they do just that, when used properly. We've seen many procedural deficiencies related to training and knowledge, as well as material deficiencies due to both design and maintenance.

It is crucial for ejection seat operators to understand that, as per the comparison to driving in the winter, the addition of a new and improved ejection seat and other ALSE in no way means that we can push the ejection envelope, delay the decision to eject, and relax on training and procedural knowledge. In fact, the use of new tools such as JHMCS and NVIS, while providing operational enhancements, pose significant additional safety hazards during ejection by way of helmet weight increase, center of gravity shifts, and aerodynamic drag and interference.

I'll leave you with the following big picture items, which you will hopefully keep in your back pocket:

1. Ejection/egress training is crucial to success. A full suspension test should be conducted yearly during recurrent training. As well, operators should periodically review the specs and procedures on their own. There is no time to hesitate or scratch your head when the stuff hits the fan. As well, training should be done using ***all*** the types of equipment you are likely to use on the line: normal helmet, NVG, JHMCS, etc.
2. Unless one is trying to avoid an obstacle, no steering inputs should be applied to the parachute less than 250 feet above ground level, as steering increases the descent rate.
3. Remember: a round style parachute, which is used in all CF ejection seat aircraft, has no ability to be flared. Attempting to flare the parachute after an ejection is a mistake that has been frequently noted in previous CF flight safety investigations. Flaring the parachute will greatly increase its final descent rate and may lead to serious landing injuries.
4. Wear ***all*** of your issued ALSE equipment. No more, no less. Do not modify or substitute any component of your ALSE in an "ad-lib" fashion. Your ejection seat and personal ALSE make for a very dynamic and complex ensemble during ejection, which has been carefully designed and tested. Improperly adjusted or modified ALSE can lead to disastrous consequences.
5. Last but not least, do not delay the decision to eject when the situation dictates. Altitude is your ally here, and can be lost quickly.

After all, we can replace an airplane, but your colleagues, friends and family can't replace you ! ◆

Fighters & Trainers:

High Risk Fleets for Mid-Air Collisions

By Captain Gilles Demers, Aircraft Accident Investigator, Directorate of Flight Safety, Ottawa

It is inherent to some CF flight operations that the danger of two or more aircraft hitting each other in mid-air exists. When does a "near miss" event, also called an "airprox" by the Royal Air Force (RAF), concern flight safety, and how does it become dangerous beyond acceptable risk? Whether a mid air collision was prevented by an abrupt avoidance manoeuvre or in other cases by luck, a near miss is no laughing matter. Certain fleets have raised red flags due to an increasing number of near miss occurrences. What is being done or recommended to decrease mid air collision potential?

Statistics

Overall there were 191 reported near miss occurrences in the CF from 1 January 2001 to 31 December 2007. Most near misses occurred under visual flight rules (VFR). Instrument flight rules (IFR) near miss events can generally only be perceived by the crew through traffic collision avoidance systems (TCAS), also known as airborne collision avoidance system (ACAS). Such equipment can be found on some CF fleets, such as CC130 Hercules, CC144 Challenger, CC150 Airbus, Upgraded CP140 Aurora and C17 Globemaster. The last two are however not accounted for in these statistics.

One mid-air collision occurred in December 2004 between 2 Snowbird aircraft while working together and performing aerobatics. However, there have been countless other events with miss distances ranging from 20 feet to 200 feet. Have we just been lucky otherwise?

Figure 1 shows that the majority of near misses in the CF come from fighter and trainer fleets. In numbers, the CF188 Hornet (our sole fighter fleet) has seen the highest, followed closely by the CT156 Harvard and CT155 Hawk.

In the reporting period, the Hornet community reported 41 near misses. 22 of these were "blue on blue", i.e. friendly vs. friendly, 3 of which were at night; and an additional 9 were "blue on red" (friendly vs. aggressor). The remaining 10 were traditional near misses in the control area, within the Traffic Pattern (TP), and/or caused by air traffic control issues, VFR or IFR, or during transit in class "G" airspace, at times with civilian aircraft.

For the CT156 Harvard aircraft, there were 43 near miss occurrences. 27 of those took place within the control

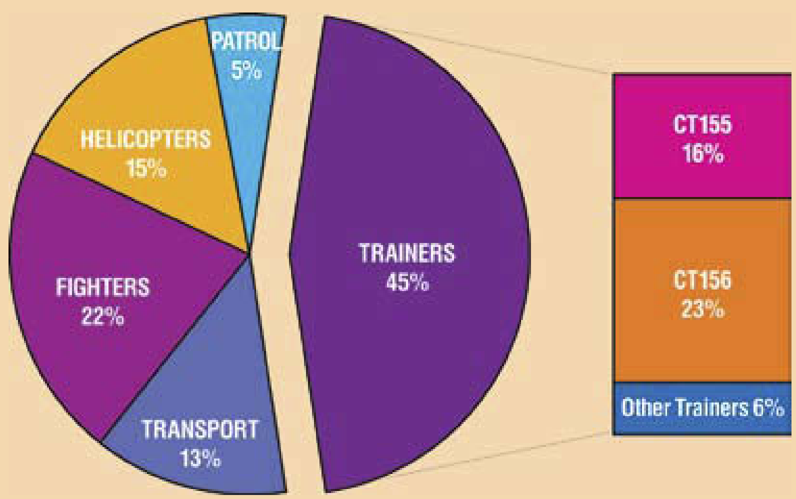


Figure 1. Near misses by aircraft family for 2001-2007

area (same description as above), 13 while flying randomly in the training area and 3 in other class G airspace.

Finally, on the CT155 Hawk aircraft, there were 30 near miss events; 12 came from the control area (same description as above), 10 from formation flying, and also from tactical formation, including basic fighter maneuvers (BFM), air-surface tactics (AST), double attack (DA) maneuvering and fighter engagement maneuvers. Finally, 8 occurred randomly while flying in either class G airspace or military flying areas. Class G airspace near miss events occasionally involve civilian aircraft.

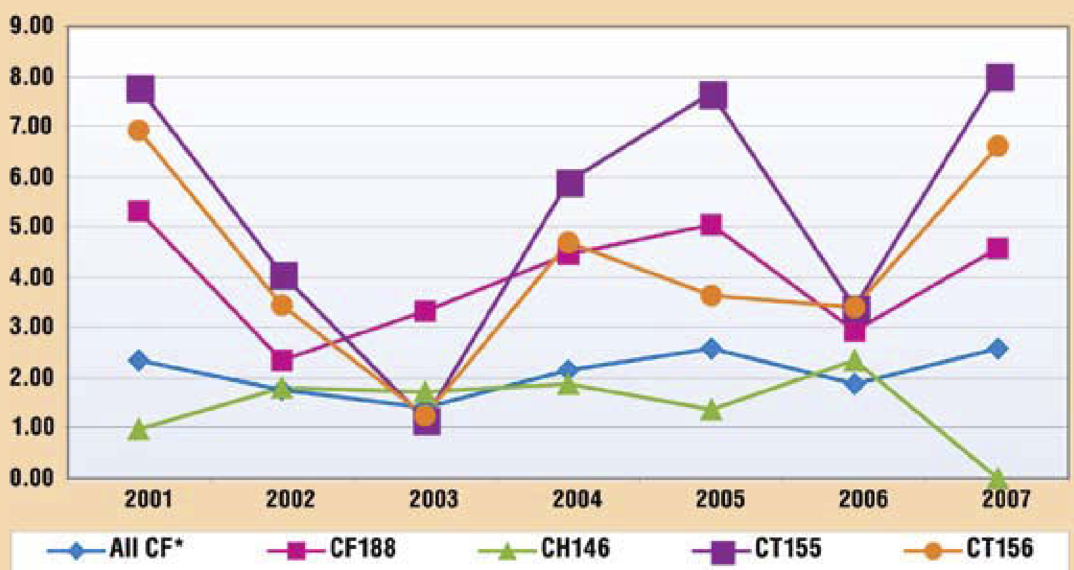


Figure 2. Near miss occurrence rates per 10,000 flying hours, 2001-2007

Noteworthy is the fact that near miss events in Moose Jaw, whether in the training area or the control area, may involve dissimilar aircraft: Harvards and Hawks. The same idea applies to Cold Lake between Hornets and Hawks. These statistics are based on FSOMS entries.

Looking at the rate of near miss events per ten thousand flying hours (figure 2), we can easily see that there are no overall trends, except for the Griffon helicopter, which was significantly lower in 2007. In that same year, the highest rate per 10, 000 hours was for the Hawk, followed closely by the Harvard and the Hornet. This has been the general trend in the CF since 2001, except in 2003 when the Hornet had the highest rate.

Analysis and Preventive Measures

Preventive measures against near miss events can involve everything from the use of basic procedures to the integration of onboard collision avoidance equipment. The following section reviews some strategies that have been shown to work.

Procedures, lookout discipline, and communications

It may sound elementary to be reminded how we should look out, but many near miss incidents come down to just that. In fact, many occurrences involved aircrew with thousands of hours of flying experience. A disciplined VFR lookout is a continuous cycle of inside and outside crosschecks. It takes discipline to continuously remind us to avoid over-concentrating too much on one reference or avoid looking only in one direction. A classic technique for improved look out is to focus the eyes first on a distant object, such as a ground features or edges of clouds, then divide your field of vision into sectors and scan each individual sector in vertical sweeps. These sectors should include the area from wingtip to wingtip[1].

The B-GA-100-001 flying orders (par 42) dictate lost wingman procedures. It also mentions the formation commander's responsibility to clearly brief lost wingman procedures for any specific manoeuvres. Nonetheless, we still had approximately 50 near miss occurrences (CF188, CT155, CT156, CT114) within formation flights during the 2001-2007 period.

The complexity and dynamics of missions and/or difficulties of manoeuvres and operating onboard systems such as radar and weapons, can easily hamper adherence to lost wingman procedures. When all put together, it becomes a good recipe for a pilot to lose situational awareness and to lose sight of one's formation members and/or opponent aircraft. Flight safety is indeed compromised at times by "mission-

[1] 2 CFFTS Moose Jaw, CT156 Harvard II Manual of Flying Training

itis", i.e. the overriding commitment of mission accomplishment on a training mission.

In addition, 1 Canadian Air Division 2-007, par 59, states the obligation to have navigation and anti-collision lights on at all times in VFR weather, with few exceptions such as formation flights, CF188 pre- briefed operational and training missions, and when called upon for operational necessities. Even though that order does leave some operational flexibility, it should never be forgotten that many studies have proven that lights remain the best aid to being seen.[2]

We certainly need to put a strong emphasis on this particular rule and remind ourselves that, even though we train like we fight, we have an obligation to maintain the proper balance between tactics and risk mitigation.

Communications within formation flights, and in general between aircraft, certainly play a big role in avoiding near miss events and mid air collision. Between separate flights, whether in class G airspace or within training areas, we cannot rely solely on our eyes, even when they constitute our primary tool. Unlike a well laid-out traffic pattern in a control zone, where everyone's path is predictable and pilots are making mandatory position reports, training areas and class G airspace can become more of a surprise box.

Position reports and traffic awareness can certainly augment pilots' situational awareness (SA) and subsequently reduce the likelihood of near misses. Statistics show that near miss events on aircraft not using reporting procedures have been high in the reporting period. It seems to me that we are relying more on good luck than on good management. Are we ready for the day our luck runs out?

Transport Canada and the CF mandate monitoring of 126.7 in class G airspace (GPH 204 article 716). Although it is not mandatory to give position reports, we can only imagine what could happen if 10 aircraft not TCAS or radar equipped decided to fly towards the same point at the same time. From 1 January 2001 through 31 December 2007, 30 have encountered this situation where near misses occurred. Airmanship dictates the use of standard position reporting (back of GPH 205).

For the fighter force, it is tactically impossible during daytime operation to do basic fighter manoeuvres (BFM) and air combat manoeuvres (ACM) without visual commitments. However, due to the high dynamics of events pilots may lose sight and become "blind". The need to "pipe it up" on the radio should be quickly identified, and evasive action or pre-briefed altitude or heading/longitudinal separation taken the very moment SA is lost. Waiting and hoping to regain SA or "joy" is a dangerous game, given the potential closing rates and relative proximity of other players.

Airspace management

It may be at times worth assigning class F airspace for specific missions or formations. Airspace management via segregating activities has proven to be very effective when the confines are respected. Pilots seem to generally respond positively and respectfully to rules and regulations. Near miss incidents between a non-player and an aircraft operating within an advisory (CYA) and restricted (CYR) areas are rare. Separating specific aircraft activities within an assigned airspace can also significantly reduce the possibilities of "crowding" an area. After all, an improvised session of cloud chasing is a blast, but if you don't have radar or operate under close control, it is a risky business. There are also rules about VFR separation from clouds (B-GA-100-001 figures 7-1, 7-2) and they were created for good reason.

The use of TCAS/ACAS

Technology such as TCAS/ACAS has proven to be a great mid air collision prevention tool. TCAS was developed in the USA by the Federal Aviation Administration (FAA), while ACAS is the name applied by the International Civilian Aviation Organization (ICAO) for similar systems. The use of TCAS/ ACAS has been mandated in the USA and has been agreed upon and adopted by the ICAO member states, including Canada. Before regulation in Canadian civilian aviation, there were 13 mid air collisions with over 20 fatalities between 1990 and 2003. Since TCAS implementation in 2003, there have been 3 mid air collisions with 3 fatalities and 3 aircraft lost. None of those aircraft were required to be equipped with TCAS[3]. Since TCAS regulation over Canadian airspace in 2003, there have been 10 reported TCAS resolution advisory (RA) incidents, which one could take as accidents that TCAS avoided. See figures 3 and 4 for examples of common TCAS cockpit displays.

To date, there are no regulations on TCAS for CF aircraft. Recommendations to satisfy ICAO standards exist to fly within airspace such as reduced vertical separation minima (RVSM) airspace, etc. As mentioned earlier in the statistics section of the article, many CF transport aircraft are TCAS equipped: CC130, C177, CC144, C90B, upgraded CP140 and CC150. Article 455 of the GPH 204 describes

[2]DRDC Toronto CR 2003-125 Conspicuity of the Griffon Combat Support Helicopter.
[3]www.tc.gc.ca/CivilAviation/IMSdoc/ACs/700/700-004.htm#appendix-b

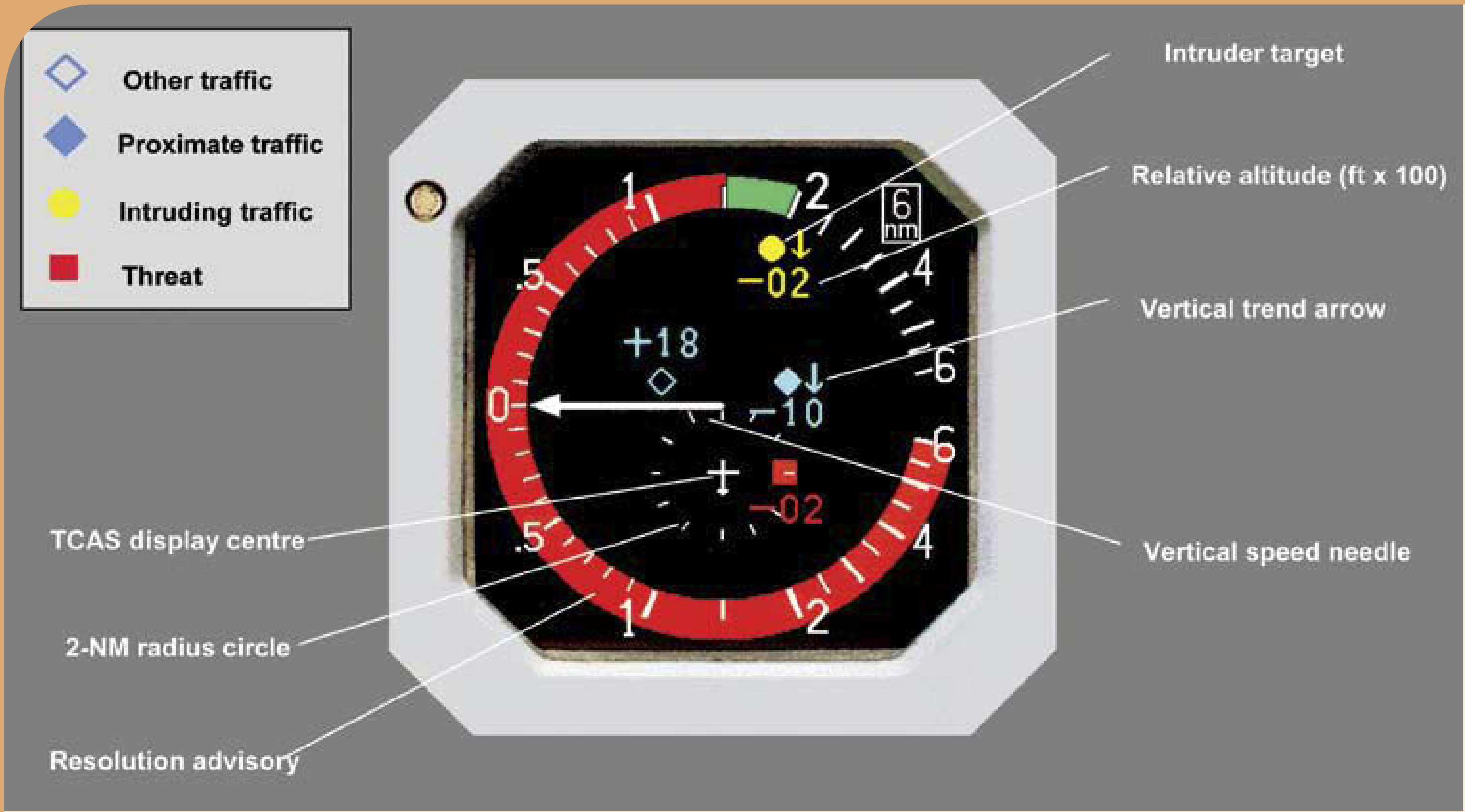


Figure 3. TCAS display on a vertical speed indicator

TCAS/ACAS types, equipment and procedures for traffic advisory (TA) and RA's. The systems have proven to be effective in avoiding mid air collisions. From the above fleets, for the reporting period, there were approximately 8 RA and 3 TA events necessitating avoidance manoeuvres.

The Royal Air Force (RAF) has implemented TCAS in all their military trainer fleets. Due to the increasing number of near misses and mid air collisions, as well as pressure from the Civil Aviation Authority in the UK, a board of inquiry recommended the installation of a collision warning system (CWS, equivalent to TCAS) on all fast jet and multi-engine trainers (TUCANO, HAWK 128 and KING AIR). The training community initially reacted with skepticism, questioning the efficiency of such a system. The perception was that it would decrease the students' ability to learn the principle of "see and be seen" since they would end up relying mostly on an instrument in the cockpit to see other aircraft, therefore decreasing the urge to look out. The system had proven to be efficient in the transport commercial aviation but how efficient would it be in an environment where aircraft operate at high speed, high rates of altitude change and high G?

Initial testing of CWS (TCAS 1) on the TUCANO revealed it to be very successful in such a training environment. It gave pilots an extra tool to increase spatial traffic awareness and alert them well in advance of possible conflicts. Distance, altitude and altitude change rates of conflicting traffic were deemed to be very precise. Contrary to expectations, it did not decrease the development of a proper look out but rather enhanced it. Since the TCAS display of conflicting traffic in the clock position is slightly imprecise, the pilot must look out to locate the traffic. As TCAS does not give the pilot any traffic alert on aircraft not transponder equipped, such as gliders, it does not alleviate the requirement for good look out.

In the year following TCAS implementation, there was only one reported near miss incident. TCAS is also considered a useful tool during instrument flying (IF) and low level navigation (LLNAV); it provides an excellent air picture of traffic, increasing SA. Most RAF qualified flying instructors reported that they would now be less comfortable flying without TCAS. A recommendation to equip CT156 Harvard and CT 155 Hawk fleets with TCAS was made in the enhanced supplementary report (ESR) of the near miss between Harvard 156115 and Hawk 155214 in Moose Jaw on October 19, 2007.

Fighter on-board tools

The CF188 Hornet has the distinct advantage of using on-board radar. Aside from its obvious tactical purpose, this is an excellent tool for

Figure 4. TCAS display on a horizontal situation indicator

general SA building and collision avoidance. However, although the upgraded Hornet's APG-73 radar offers significantly enhanced detection and tracking capabilities over its predecessor (APG-65), it is by no means infallible, and should not replace a thorough and methodical lookout routine, but rather enhance it, much like the use of TCAS as described above.

In the same vein, the second (R2) phase of the CF188 modernization saw the introduction of the multi-function information distribution system (MIDS). For readers not associated with fighter ops, this essentially translates into the use of a multi-colour digital display, which integrates a multitude of information sources via datalink, including other aircraft and ground radar information. Having the whole "tactical scene" fed onto a single screen is indeed something to stare at…perhaps at the expense of looking out the canopy.

Informal DFS interviews conducted with aircrew associated with the testing of MIDS revealed a real potential for loss of visual SA and the development of a dependence on such systems. One must realize that, when used on a large distance scale, such as 80 nm, it becomes difficult to discern other formation members or other aircraft that may be in close proximity.

Lastly, the introduction of the night vision imaging system (NVIS) in 2007 has opened a new realm of possibilities for night operations. The visual lookout technique with night vision goggles (NVG) is considerably different, given the narrow field of view and monochromatic display. The difference in perception ranges, visual illusions, and NVG spectrum interferences also come into play to create a very different visual arena. Thorough initial and recurrent training, as well as a constant effort to maintain an NVG lookout discipline are required in order to use NVIS as an effective anti-collision tool.

Figure 5. Recommended paint scheme for the CT156 Harvard. Shown here on an American aircraft

Aircraft visibility

Many studies on paint scheme were done to determine the best paint for conspicuity. Research conducted by the Defence Research and Development Centre (DRDC) in Toronto[4] on aircraft conspicuity concluded that a more reflective colour is easier to see against a darker background in daylight and also determined that the paint scheme, if conspicuity is important, must be a patterned colour scheme, which would have a darker bottom (easily seen against the sky) and a reflective colour top to improve aircraft visibility when looked at from the top down. Thus, a recommendation to change the color of training aircraft was made in the same ESR mentioned above. See figure 5 for an example of the paint scheme recommended.

Now, compare this with the CF188 Hornet formation depicted in figure 6 below, flying against a snowy

Figure 6. CF188s against a snowy background

[4]DRDC Toronto CR 2003-125 Conspicuity of the Griffon Combat Support Helicopter

Canadian background. The light gray colour of the Hornets make them rather difficult to see in certain background and lighting conditions. This is obviously a purposeful characteristic of fighter aircraft, which nonetheless makes a good lookout and communication discipline vitally important for the fighter community.

Conclusion

It is certainly reasonable to assume that the vast majority of military pilots treat their profession with safety in mind. Aircrew simply don't wake up in the morning thinking: "I'm bored…Let's have a near miss today!" However, despite the above practices and efforts to eliminate the spectre of mid-air collisions, near miss occurrences still happen in great numbers.

The way ahead may involve new technology, extra personnel horsepower, more research, and cost the CF some money, but we, the operators, need to be pro-active at all levels, and constantly strive for that delicate balance between mission accomplishment and safety, especially in times of accelerated force generation and training. We must be reminded that new aircraft fleets, or upgraded ones, will present new challenges for aircrew and, in some cases, more heads-down time and the temptation to spend less time looking out.

At the organizational level, it is important to clearly identify, and mitigate, the precursors that create the risk of near misses. Many solutions already exist, such as separating the airspace, changing aircraft colors, the proper use of, or acquisition of TCAS/ACAS, mandatory reporting procedures, etc.

Knowing rules and regulations, fostering good airmanship, maintaining sound SA, and being able to clearly identify and react when it is lost are all part of preventing near miss occurrences. Thorough mission preparation, and a clear and precise briefing make the essence for sound training and fighter missions.

Lastly, the thorough reporting of near misses has helped your flight safety team identify and analyze the risk elements herein, and promote preventives measures. Please continue reporting, and remember: you are never alone out there…

Editor's note

The complete ESR reports on recent near misses can be found in the *Reports* section of the DFS website at the following address:

www.airforce.forces.gc.ca/dfs/reports-rapports/l/reports-rapports-eng.asp

Here are a few of the most recent, which make worthwhile reading on near miss prevention:

- CF188744/CF188747 Hornet, China Lake, California
- CF188932/CF188935 Hornet, Cold Lake, Alberta
- CT155214 Hawk / CT156115 Harvard, Moose Jaw, Saskatchewan

As described by Capt Demers, the balance between mission tactics and risk mitigation can be difficult to identify, or to achieve. This is the very cornerstone of our flight safety system. Just remember that one does not hamper the other. On the contrary, in-theater modern air warfare in the past couple of decades has shown us that accidental losses of aviation resources far exceed combat losses.. ◆

The erosion of manual flying skills in highly automated aircraft

By Captain Jacques Drappier, Vice President Training Airbus Industries

Reprinted with kind permission from the editor of the Australian Defence Force's Aviation Safety Spotlight magazine

When we look at the safety records, we see that we have made tremendous progress over the years but unfortunately we have to admit that flight-crew error is still one of the most frequent contributors of major accidents.

During the past decades, automation has been brought into the cockpit to help the crew and to increase the overall safety of the flight. It is not in question that the major technological advances in aviation have resulted in faster, more efficient and safer operations. Without this automation, such things as CATIII, RVSM and RNP would simply be impossible.

How would a two-man crew cope with the complexity of modern aircraft in a very dense ATC system demanding extreme precision, after very long haul flights?

I believe that if we have seen this continuous improvement of safety over the years, it is clear that automation has been instrumental in this, and that the continued efforts of the manufacturers to further enhance safety, economy and comfort will bring even more automation in the cockpit.

But nothing is perfect, and with the undeniable advantages, automation has also brought some side effects.

The introduction in the '80s of the first glass cockpits with FMS etc showed, unfortunately with some accidents, that the crews were not adapted to this. Multiple studies have been made, and different agencies are still monitoring closely the evolution of automation.

Improved interfaces, SOP, and training have resulted in a good use and understanding of the systems.

Manual flying skills

Very quickly there was also the awareness that another side effect could be the loss of the manual flying skill and over reliance on automation.

When talking with fellow pilots on this subject, I could sense that everybody agreed that indeed the loss of flying skill was real. But very often the subject turned into a debate on airmanship.

When looking at cases where flying skill was to blame, the real cause of the accident was actually a lack of situational awareness, lack of airmanship, or disregard of rules. For example a hand-flown, nonprecision ends up coming high and fast on finals, lands halfway down the runway and overruns. Clearly the lack of briefing, situational , awareness and poor decision 1 making are the factors here, because even on autopilot in HDG and VS, this could have happened.

Is it true?

There are different ways to approach the question and to try to validate the answer.

Most of the accidents happen in approach and landing phases, where typically the pilot could be manual flying. Some examples are Toronto, Sao Paolo or the Philippines - where overruns happened after manual flights. But the question remains if handling is the main factor or a contributing factor.

Tail strikes and hard landings are probably more indicative of handling problems. Lately we have been seeing an increase of these events, especially with large, long-haul aircraft.

However, we must be cautious of making easy conclusions. Certainly if you hit the tail during flare, or slam it in the ground, there is a handling problem. But most of these incidents are a result of an unstabilised approach making the flare a difficult manoeuvre. SO is the unstabilised approach a result of poor handling or poor planning?

During check rides, and especially in base training, our instructors see clearly the difficulty pilots have in doing the basic handling in raw data or visuals. I was recently performing base traiping for a major carrier on a large aircraft, and some pilots had difficulty staying within the prescribed tolerances. We needed to complete additional landings to achieve the required proficiency because of handling issues.

But there is also some scientific data that show proof of the problem. Indeed a study published in 1995 revealed some interesting data. They used two groups of pilots from the same company, so with similar backgrounds and training, but one still flying old aircraft, and the other aualified on alass cock~i automated aircraft.

Take offs, approaches and landings were measured, both in normal and one engine out, and clearly the 'automated' group performed way below the 'classic' group in terms of handling precision.

Unfortunately there has been little scientific work since, at least that I am aware of, and it would of course be interesting to have a serious study on this topic.

Scientific studies

A study on the impact of glass cockpits in 1985 showed issues with automation. A study on performance of pilots in 1995 showed first signs of erosion of skills. No further studies.

Conclusion -the problem is not new but getting worse. So yes, it is true.

Furthermore we have to avoid generalising and thinking that all pilots have lost their skills. That is simply not true. In our training centre we certainly see some who are a bit rough on the edges, but we also %e some excellent handling.

Let's assume that we have indeed a problem, and that yes, it is true.

Is it important?

Now if the first question is not black or white, this one is even less easy to answer.

We need indeed to see what the impact is of this reduction of general handling skill on the safety to determine the importance.

To start with, none of the crews that I know who are flying today's FBW aircraft miss their old transports. They are all very happy with the capabilities of these new planes, which ease the workload and improve the safety and comfort.

Furthermore, they all realise that the job has changed over the years. The increasing numbers of aircraft in the air has changed the ATC environment we work in, which becomes more demanding, more precise and less forgiving. So we all agree that the automation is better for overall safety, efficiency and comfort.

Is it then important to keep the same level of manual flying skills as in the old days, or are other elements today more important?

- Auto flight is safer, more comfortable and more economical,
- Airlines encouraqelmandate the use of automation,
- Aircraft are more capable now,
- Handling skills in normal circumstances not so important.

So is it really so important to be able to hand fly an A380 to cruising altitude and being able to level off with a 20-ft precision? What do you want to prove? Is it so important to show you can precisely fly manually a Star followed by an ILS raw data?

What do you want to prove?

If you have the choice to use a coupled approach to the minima in poor weather or fly manually the ILS, which one is the safest?

Are we there to prove how skilful we are, or to bring the passengers home the safest way?

Knowing that precision hand flying is a full time job that takes up a very large chunk of the brain, wouldn't it be better to let the AP do the basic handling and keep your brainpower available for supervision and decision-making?

So maybe this perceived erosion of skill is not so important?

Or is it?

Radar vectors and CAT3 ILS systems are of course not available at all airports. And sometimes the weather is beyond what the AP is certified for. And sometimes the automation fails, and there is no other choice than bringing it back manuallv.

So actually whereas the use or importance of manual flying skills is reduced in normal operations, what I would call 95 per cent plus, these skills are necessary when it comes to some abnormal situations or challenging conditions, where then actually pretty sharp piloting is required. The transition between smooth easy flying on AP and being challenged by hair-raising situations can be very abrupt in the modern cockpits.

In some respects, automated aircraft may require a higher standard of basic stick and rudder skills, if only because these skills are practiced less often and maybe called upon in the most demanding emergency situations. What is also important is the perception by the pilot of his own piloting skills.

Let me explain this

Our captain has been flying for days, months, years according to company procedures letting the automation take care of the basic handling and doing an excellent job as a captain. He has done his compulsory one ILS with engine inoperative in the FFS every six months, and that has been it. Now one day he is confronted with some weather in an airport, which is not instrument-approach equipped, and he faces the challenge of a manual approach and landing in crosswind.

Now he becomes worried because he starts realising that maybe he is not up to it. He has not done that in months or years. But diverting does not seem an option because the book says he is within limits. His anxietv now takes over and deteriorates his performance even more. Results can be pretty bad.

Furthermore, physical flying skills are one of the critical elements of situational awareness. Maintaining proficiency allows a pilot to devote less mental energy to flying the aircraft, thus allowing more attention to be devoted to other mental tasks.

So finally, is it important or not?

I believe that the importance has been reduced from the past, but that basic handling skills are still essential for safe operations.

What can we do about it?

So since we believe that the erosion of flying skill is real, and since we believe there is an importance to this, the question is what to do about it?

We cannot answer that; however, without further analysing what are the root causes of this erosion. It is too easy to blame the automation itself. It is there to help, and most of it is selectable, meaning you can ignore it or switch it off.

The study I referred to earlier came to the conclusion that there is no evidence that the deterioration of skills was solely because of a lack of practice. Other contributing factors could be in play, and this applies especially today.

Let's talk about a few

First, if we say there is erosion of flying skills, we assume these were there to start with.

Let's begin with the first officers. Do you really believe that the cadets today have the same capabilities as those that came out of the schools 30 years ago, or out of the military? Self-sponsoring has brought a competitive element in the training, meaning the cheaper the better, and we can see in the last 10 years a reduction in flying hours to the bare regulatory minima, well below what was common practice in the '80s and beginning '90s. We had programs with 60 hours of multi, now down to 15. We had aerobatics included in the program. All gone.

Look at the back pages of an international magazine and you will see what I mean.

Next are the young captains. We used to have 10 years plus of first officer before transitioning to the captain seat. Now we see upgrades to commander in less then four years with as little as 3000 hours because of the rapid expansion of the business. Can we really believe that these youngsters have mastered the skills necessary in this time? Of course they show the necessary skills in their test, but how far are these regulatory checks really significant?

Second, if these skills existed, then why are they eroding? Obviously the lack of practice or training can be the only explanation. Pilots need to maintain their flight skills and be able to manoeuvre the aircraft manually within the standards set forth in the relevant regulations. This can only be achieved through regular practice.

Clearly here we have a dilemma. On one hand it is obvious and accepted that company policies are being set up insisting or mandating the maximum use of automation for the benefit of safety and economy. So there is a strong pressure to avoid hand flying.

On the other hand, without practice any motor skill will diminish, so will the piloting skills. It looks imperative that the pilots get a chance to practice. But even if the airline allows the captain to choose to fly manually sometimes, operational circumstances such as fatigue, or lack of self-confidence as discussed earlier will reduce further the reversion to manual flying.

Especially on long haul the lack of recency becomes an issue. Imagine a first officer flying a very long haul operation. For argument sake, a 14-hour leg. One return trip means 28 hours, so three trips per month covers more than his quota. But how many landings does he have? None. Could get worse. With all these ' heavy' crews, some of the first officers hardly get one landing every two months.

In some countries, airline management have adopted the FOQA automated decoding, but in an individual, repressive way. This will of course lead to a frantic avoidance of alerts rather than a sound judgment of the situation. In these cases, hand flying is totally gone.

Training

- Training and experience
- Lack of initial training
- Regulatory requirements
- Commercial pressure
- Airline policy and operational Constraints
- Auto pilot policy
- Visual pattern policy
- First officer flying rules
- Route structure

If we accept the above series of root causes, namely lack of proper initial training, lack of experience and lack of recency, then training is the obvious answer.

We have come a long way in . the training industry. We have implemented CRM, we have introduced LOFTS, we are on top of the automation, but we seem to have lost something else in the process.

Some companies have understood this and have taken some positive steps. One large company, for example, was suffering repetitive hard landings. They concluded that the lack of recency by flying augmented crews on very long haul created the problem. They introduced intermediate recency FFS sessions, and the problem has gone.

Operators must also take their responsibilities. It may be in the best interest of safety to enforce a strict automation policy, but then you either train in the FFS for the unexpected or exceptional manual flying cases, or, you accept that diversions based on weather such as strong crosswinds occur. You cannot expect your pilots to handle a plane like a test pilot in 45-knot crosswinds without sufficient training, or recurrent training.

Conclusion

- Long-term issue,
- Pilot skills are not equal but must be taken into account,
- Job changes to more decision making and monitoring,
- Manufacturers have introduced more automation to assist the pilots,
- Regulators should review their requirements based on solid studies,
- Operators should take their share of the responsibility,
- The whole industry must work together towards more safety including all aspects.

The debate on handling skills or pilot skills has been going on as long humans have been flying. As soon there was a second pilot around, the question of who was better was born.

There have always been people with more feeling, better touch, and more anticipation.

Over the years rules have been established, guidelines developed and standards been set to evaluate these skills.

In a continuous-and-successful quest for safety, the industry has introduced more and more tools to assist the pilots in their tasks. These tasks have been evolving as well, into more management of the airplane instead of flying.

Manufacturers have worked continuously to introduce elements to further assist the pilots. Fly by wire was certainly one of the most significant improvements that was introduced nearly 20 years ago. It let the pilot fly manually while giving a large protection against gross errors, and significantly reduces the difficulty of handling the plane. During the development and further refinement of the control laws we have always been careful to keep the basic handling principles the same.

But handling skill, be it less demanding then before, is still needed. And that can only be achieved through training and practice.

Regulators should carefully review the situation and see if the present rules are sufficient, and if enough data is available to determine which manoeuvres and how much hand flying is sufficient for the modern pilots to keep their basic skill sharp.

Operators should establish their rules and SOPS with safety as a prime goal, but without forgetting that safety one day can mean to be able to skilfully hand fly an approach and landing. If a balance between manual flying and automation in line operations is not practical or possible due to the type of operation, then training is the answer.

We must also remember my statement of the beginning -today we concentrate the discussion on handling skills, but most of the problems created by the erosion or lack of these skills could have been avoided by good airmanship, applying CRM, using threat and error management.

We must continue to practice handling, but balance it with much more effective employment of the defences to prevent the aircraft ever arriving in the unsafe condition.

Overall, each member of this industry has his role to play, and ‘ together we must strive towards our ultimate goal of safety, without forgetting any aspect of what it might encompass.

The superior pilot is one, who by superior airmanship, avoids situations where he or she needs the use of superior skills. ◆

Maintainer's Corner

Thinking Outside the Toolbox

By Major Sylvain Giguère, Aircraft Maintenance Accident Investigator, Directorate of Flight Safety, Ottawa

Is there a tool missing from your toolbox that you cannot find? Could it be airborne, clunking away under floorboards, floating in a fuel tank, sparking inside the electrical junction box of some aircraft?

We may be tempted to think that our organization is immune to those occurrences because we have a mature tool control program. We may be tempted to think that 3rd line contractor personnel are the biggest culprits. Well, think again! It just happens that we are our own worst enemy when it comes to flight safety occurrences due to a breakdown of the tool control system.

A review of flight safety data for the past 10 years (see figure 1) shows that occurrences related to tool control are slowly creeping up. Better reporting accounts for some of the increase. However, there are other contributing factors. The best way to deal with these contributing factors is to implement preventive measures to foolproof the tool control program. The recurring nature of tool control occurrences makes it clear that traditional preventive measures have limited effectiveness. Any reduction will be achieved by implementing preventive measures focused on the basics of tool control and by taking advantage of state-of-the-art processes and technologies.

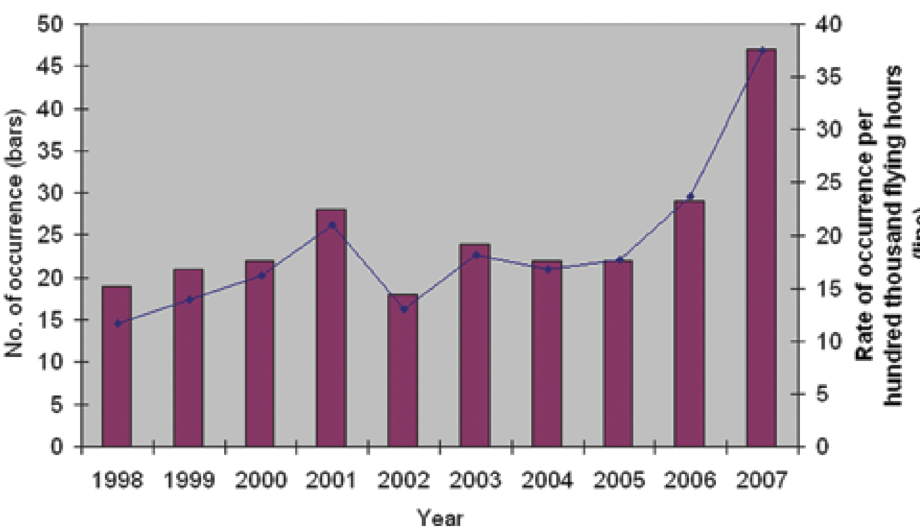


Figure 1. Number of occurrences related to Tool Control in the past 10 years in the CF.

Basics of Tool Control

The purpose of tool control is to ensure that all tools, without exception, are accounted for before and after every job. To this end, maintenance organizations have developed processes that give each tool a specific place and allow for quick identification if a tool is missing. The basic elements of tool control include:

Shadowing – Shadowing involves specifying a space for each tool that makes it easy to determine that a tool is missing. For toolboxes, a foam product is used with spots cut out for each tool. For tool boards, pegboards and hooks are used and the item is generally outlined and shadowed.

Identification – Identification is the permanent marking of tools. Identification is done to quickly identify where the tool belongs and for tracking and calibration purposes. For technicians at 3rd line facilities, it also helps assure compliance with the applicable missing tool reporting policy.

Inventory - Tool inventory is to account for tools. It should be done on a regular basis so that any missing tool can be quickly identified and searched for before they affect the safety of an aircraft. Ideally, this should be done after every job.

Inspection - Tools should be inspected before and after each use to ensure they are in proper working order and no parts are missing. This aspect can be easily overlooked.

Reporting - This procedure should be clear as to how often tools need to be inventoried, how an employee should report a missing tool, and steps to be taken once a tool is reported missing.

Sustaining the Tool Control Program

Tool control has to be supported from the top down; and it has to be worked up from the grass root level. It has to be part of the culture. A successful implementation of tool control depends heavily upon the proper indoctrination of all personnel. Technicians need to know how it applies to their day-to-day tasks.

Once the indoctrination is done, reminders are required to keep the tool control message alive and maintain success in the program. This can be done through posters, newsletters, incentive programs, etc. The following messages are normally conveyed:

"Clean up after each job to ensure that the area is FOD-free" - FOD goes hand in hand with the tool control program.

"Report lost tools or lost items" - It is very important that people are praised for coming forward to report missing items. If they feel threatened by that, you won't hear anything.

"Be accountable for the tools used" i.e., whatever is taken onto the aircraft, must be brought back, and verification is required to ensure an area is FOD and tool free before closeout.

The next leap forward …

Tool control programs need to evolve and adapt to changes if we are to reduce the number of related flight safety occurrences. Flight safety surveys have revealed that the industry is in the process of developing and adopting new processes intended to improve quality, efficiency, and safety. The CF should pay close attention to these industry initiatives if lessons are to be learned.

The means used by 3rd line contractors to improve quality, efficiency, and safety calls for the reduction of waste. Waste, from a manufacturing standpoint, may be found in: inventory, unnecessary processing, poor task sequencing, poor work organization and poor supply chain. In the context of tool control, waste could translate in time spent searching for a misplaced tool, redoing work because of overdue tool calibration, tool crib hours of operation, time spent on tool inventory, or other similar activities. However, to reduce waste, 3rd line contractors have determined that metrics had to be established and goals set. In fact, the establishment of metrics is key for assessing improvements to the tool control program. It allows us to measure the effectiveness of change and therefore the movement towards the established goals.

Once the stage is set, the industry implemented reduction of waste strategies. A popular strategy is the "5S" philosophy. "5S" is intended to simplify the work environment, reduce waste and non-value activity while improving quality, efficiency, and safety.

The adoption of the "5S" philosophy is compatible with new technologies and processes. One example is bar coding and optical sensors. Nothing too fancy here, this system is already in use in most grocery stores. With this system, each tool is identified with a unique bar code. When maintenance is performed, technicians sign-off tools against a given job by scanning the tool with the optical sensor. As a result, it is possible to determine which tools are in use, for how long and on what aircraft. There are numerous virtues to this type of accountability. For one thing, it can be used to validate that the appropriate tools are used in the conduct of given maintenance actions. Second, when a tool is mistakenly left on an aircraft, the absence of electronic sign-off precludes the closing of an entry. Such a system has the potential to reduce the number of tools lost, to track usage of tools, to control tool inventory and purchasing, and to enable the management of tool calibration. This accountability can be a lifesaver, as aircraft can be grounded if a tool is indicated to be out of the box by the monitoring system.

Achieving a reduction in the number of flight safety occurrences sometimes requires the implementation of novel ideas. Initiatives taken by 3rd line contractors are intended to address deficiencies, or waste, observed in their organization. There are plenty of opportunities available to address age-old problems. We only need to "think outside the box" and not be afraid to embrace something new. ◆

The "5S" philosophy requires the organization to:

- *Sort - clean up and eliminate unnecessary items.*
- *Set in order - organize, identify and arrange everything in a work area.*
- *Shine – carry out regular cleaning and maintenance, not an occasional activity.*
- *Standardize - operate in a consistent and standardized fashion using best practices.*
- *Sustain - maintain focus on what has been accomplished.*

EPILOGUE

TYPE: CT155 Hawk (155214), CT156 Harvard II (156115)
LOCATION: YMJ 190 radial 028 DME at 13 000'
DATE: 19 Oct 2007

A Harvard II and a Hawk narrowly avoided a collision while flying in the MFA. The weather was VMC with blue sky against dark ground (fall in the prairies). The Harvard dual aircraft was in straight and level flight when suddenly the IP saw a "sudden dark flash" at his 8:30 position. The Hawk solo pilot had just engaged in a rapid descent via a "barrel down" manoeuvre and was in a 20 degrees nose down attitude at 320 KIAS. As he rolled back in the upright position he suddenly saw the Harvard aircraft going from left to right in a split second. Separation was estimated to be 100-200 feet.

The investigation found that at the time of the occurrence there was no airspace management in the MFA except for a few restricted areas. There were also no calls made by either aircraft on the common frequency (CH 14). 15 Wing operates under the "see and be seen" principle and there was no regulation for mandatory calls in the training area. The Hawk pilot did not clear the airspace below immediately prior to his descent manoeuvre Investigation revealed a lack of guidance (specially in the Hawk MFT) on the requirement of clearing the airspace below prior to a rapid descent. The Harvard's dark color would also have been hard for the Hawk pilot to have seen against the dark ground.

Despite efforts on education and awareness briefs, near miss occurrences have been increasing in Moose Jaw. Shortly after this incident, 2 CFFTS published an AIF to help manage congested areas, limiting the maximum number of aircraft in a specific area. The investigation recommended using common frequencies as part of the airspace management AIF, and providing clear guidance regarding airspace safety prior to executing rapid descents. The investigation recommended that TCAS/ACAS 1 be implemented in both Harvard and Hawk fleets to increase traffic awareness. This measure has proven itself in similar flying training operations in other countries. It was also recommended that the current paint scheme be changed to a two tone (dark and reflective) to optimize aircraft conspicuity. ◆

EPILOGUE

TYPE: CH149 Cormorant (149914)
LOCATION: Chedabucto Bay, near Canso, NS
DATE: 13 July 2006

The accident involved a CH149 Cormorant Search and Rescue (SAR) helicopter with a crew of seven that was on a training mission to practice night boat hoists from the fishing vessel Four Sisters No.1. The cockpit crew consisted of a First Officer (FO) in the left pilot seat, an FO acting as Aircraft Captain (AAC) in the right pilot seat and the actual Aircraft Captain (AC), seated in the cockpit jump seat. The crew in the cabin area comprised a Flight Engineer (FE), a Flight Engineer under training (FEUT), a SAR Tech Team Lead (SAR Tech TL) and a SAR Tech Team Member (SAR Tech TM).

The accident occurred during an attempted go-around from an approach to a fishing vessel. During the go-around the helicopter entered a nose-low attitude and seconds later the aircraft impacted the water with 69 knots forward speed in an 18 degree nose-down attitude. The three pilots and the SAR Tech TL were injured but survived the crash. The two flight engineers and the SAR Tech TM were unable to egress the aircraft and did not survive. The aircraft sustained damage beyond economical repair.

No evidence was found that any system malfunction contributed to the accident, so the investigation focused on the environment, organizational and human factors. The investigation found that the flying pilot's trim technique caused the flight control pitch actuators to become saturated, which in turn caused the loss of the helicopter's automatic stabilization system. In this condition, the helicopter's inherent instability combined with the pilot's inputs to create a large but unrecognized nose down attitude and descending flight path.

The environmental conditions (darkness, distant dim horizon and calm water) were not suitable for continued flight using outside references only. The nose down attitude and descent was not noticed by any of the three pilots in the low visual cueing environment because they did not adequately reference their flight instruments.

The investigation also found that prolonged training restrictions imposed due to on-going tail-rotor half-hub cracking had a serious detrimental effect on overall CH149 aircrew proficiency, particulary at 413(TR) Squadron. The resultant risk to operational airworthiness was underestimated and not effectively mitigated.

Although the four cabin area crew members survived the impact, only one was able to successfully egress the aircraft before his air supply was exhausted. Survivability issues included cabin layout, storage of equipment, and the suitability of the Aircraft Life Support Equipment. Activity is underway to rectify many of the safety deficiencies identified through the course of the investigation. The Flight Safety Investigation Report contains many recommendations to improve CH149 pilot proficiency, training and survivability / life support equipment issues for CH149 aircrew. ◆

EPILOGUE

TYPE: CC130 Hercules (130311)
LOCATION: Alert, Nunavut
DATE: 25 April 2006

The incident occurred during the landing phase of a resupply mission to Canadian Forces Station Alert in support of Op BOXTOP. Upon completion of a precision radar approach (PAR), the aircraft landed long and after touchdown experienced directional control difficulties. The aircraft was unable to stop in the remaining runway available and departed the end, coming to rest in two-foot deep snow. There were no injuries. The aircraft sustained minor damage.

The crew transitioned from the PAR to visual flight prior to reaching minimums and at this point the aircraft was 225 feet above glidepath. Corrections were made and the aircraft crossed the runway threshold 75 feet high and nine knots fast. The aircraft touched down with 2950 feet remaining on the 5500 foot, snow-packed runway. The remaining distance was 200 feet more than the minimum required to safely stop the aircraft; however, CC130 deceleration mechanisms were not employed in accordance with the Aircraft Operating Instructions and this distance was compromised.

The investigation assessed that Human Performance in Military Aviation (HPMA) practices were not gainfully employed by the crew and regulatory stabilized approach and go-around criteria were not available to ensure the safest possible mission outcome. Symptoms, including degraded situational awareness, task saturation, channelized attention, normalized deviancy and an un-optimized authority gradient, were present in the cockpit and went unchecked. As a result, sound decision-making processes were displaced and the aircraft was unwittingly flown beyond the edge of its performance envelope.

Outstanding preventive measures include the development of an HPMA training module incorporating lessons learned from this occurrence and amendment to current CC130 pilot training associated with CC130 normal and maximum effort landing performance. Additional recommendations include the development of regulatory stabilized approach and G/A criteria for all types and phases of approaches, development of a PMA proficiency Standard and amendment to current direction pertaining to pilot monitored approach selection criteria. ◆

EPILOGUE

TYPE: CF188 Hornet (188744/188747)
LOCATION: NAWS China Lake, California
DATE: 27 October 2006

The flight of occurrence was a tasked mission in support of the Fighter Operational Test and Evaluation Flight (FOTEF) and the Fighter Electronic Warfare and Advanced Radar (FEWAR) course in Naval Air Weapons Station (NAWS) China Lake, California. The FEWAR course had been in NAWS China Lake for one week. The mission being flown when the occurrence arose was the last mission of the deployment.

The intent of the mission was two-fold: first, to provide the FEWAR instructor pilot (IP) cadre exposure to a high order surface threat, of the type only available at NAWS China Lake, and the opportunity to test multi-axis attacks against such a threat; second, to assist the FOTEF, also operating at NAWS China Lake, with test and evaluation of defensive reactions and the effectiveness of the Defensive Electronic Warfare Suite (DEWS) of the CF188 against a high order threat. The mission involved multi-axis attacks on a specified target by two elements (of two ships) and a single ship (2 + 2 + 1). Each of the five aircraft was being flown solo by a FEWAR IP.

The original plan was for the detachment commander (DetCO) to serve as mission lead. However, the DetCO felt that the various administrative responsibilities associated with the position would diminish his ability to serve as mission lead; he was reassigned as a member of the flight and a new mission lead was chosen the day before the mission. However, the change of mission lead along with the complexity of the upcoming mission were only revealed to the new lead on the morning of the mission. As a result, pre-mission planning was compressed, mission lead omitted to consider key contingencies, such as the impact of reactions to surface threats on TOT and a sound de-confliction plan, and briefing was rushed and given over a few minutes only. This hastened approach was considered "necessary" by all pilots involved in order to arrive at the range on time.

In the face of such a hurried plan and a complex mission, no pilot voiced any concern or offered critical appraisal of the plan at any time. Formation members felt compelled to "press" to take training advantage of exposure to a high order threat, to maximize the FOTEF objective and to avoid financial losses that would have been incurred by not using the China Lake range.

After the first multi-axis attack and before conducting a second one, the mission lead adjusted separation between elements over the target. This required an in-air calculation and transmission of new Time On Target (TOT) blocks to all elements. During radio transmissions (RT), confusion ensued for the wingman of the element attacking first (KUGR 22).

During the target run, KUGR 22 entered the target area well after his element's prescribed TOT block had expired and 15 seconds past the one-minute "buffer" period separating his element's TOT block from the next one. The wingman of the second element (MAXIM 12) arrived over the target area at the beginning of his element's prescribed TOT block and as a result, a near collision with a miss distance of approximately 200 feet occurred between KUGR 22 and MAXIM 12.

This occurrence illustrates the risks involved in

EPILOGUE

conducting complex missions with incomplete pre-mission planning and poor communication.

The investigation revealed three main contributing factors to this accident. The first was a generalized communication breakdown in that, the day before the flight, as well as during pre-mission briefing and execution of the mission, key information was not conveyed clearly between pilots. The second factor was a rushed pre-mission planning and briefing during which several aspects of the mission were not considered, most importantly contingencies. Unrealistic expectations, misplaced motivation and mission-itis on the part of all pilots were at the source of such an approach. The third factor was a human resource management issue, in that limited personnel supplied to the detachment required the DetCO to serve as an IP and be compelled to fly, in order to respect the training plan. Administrative duties associated with his position affected his ability to concentrate on the task at hand; consequently, inattention, distraction and preoccupation resulted, which became preconditions of this mishap.

Preventive measures focussed on the need to develop a tactical risk management tool for all deployed air operations, on the requirement to adhere to a minimal standard of pre-mission planning and briefing (in terms of time or content), on communication, namely the need to reinforce compliance with standard RT and acknowledgement of critical information, and on the necessity to provide sufficient squadron resources during deployments so that administrative duties will not interfere with the ability to perform day-to-day activities. ◆

TYPE: Robolans 018 – Launcher for Sperwer CU161 Uninhabited Air Vehicle (UAV)
LOCATION: Kandahar, Afghanistan
DATE: 6 December 2007

The accident occurred during post-launch procedures following a day UAV launch conducted at the Kandahar Airfield in support of Op ARCHER. The UAV launcher was being reloaded in preparation for the next mission. During the reload, which essentially involved the application of hydraulic force to compress two large pistons into their pneumatic cylinders, an explosion occurred. Two personnel received minor injuries and the launcher sustained very serious damage. The occurrence had no impact on the UAV mission.

The design of the launcher was such that hydraulic and pneumatic forces opposed each other in a manner which required the precise alignment of two pairs of large piston rods. At the time of the occurrence, the alignment was compromised which resulted in an explosive release of pneumatic pressure and the expulsion of numerous components. The investigation concluded that the launcher's design did not adequately and consistently ensure that the required alignment be maintained.

Outstanding recommendations include a redesign of the launcher to ensure that the required alignment be maintained and that the checklist include a step for operator inspection of the alignment interface at the appropriate phase of operation. ◆

EPILOGUE

TYPE: Schweizer 2-33 (C-GCLJ)
LOCATION: North Battleford, SK
DATE: 05 May 2007

The accident occurred during the Air Cadet Spring Glider Familiarization Flying Program. During the winch launch sequence, as the glider climbed through approximately 150 feet above ground level (AGL), the winch operator saw a glint on the winch cable, followed by loud bang that was accompanied with a sharp 'lurch' of the winch. The winch operator immediately cut power to the winch. As the power was cut, the glider pilot felt the deceleration and observed the airspeed decreasing slowly to 50 miles per hour (MPH), and then rapidly to 30 MPH. At this point the glider pilot attempted to lower the nose and release from the winch cable. The glider then stalled and impacted the ground on the glider's skid plate. The glider bounced and came to rest 86 feet from its initial impact point. Both occupants were extricated from the glider by Emergency Medical Services personnel and transported to a local hospital where they were examined and released with minor injuries. The glider was destroyed.

Investigation has determined that the initial problems with the winch originated from a partially failed splice being wrapped around the winch drum. The reactions of the winch operator to an unknown winch malfunction were immediate and consistent with procedures.

Faced with a power loss, the glider pilot initially raised the nose of the glider. This increased the rate of deceleration and by the time the pilot applied the correct procedure, the glider had stalled. The investigation revealed that the pilot had not received adequate winch power loss training.

Immediate actions were taken to address the training deficiencies, and further preventive measures have been recommended which will minimize the likelihood of a recurrence of this type of accident. ◆

For Professionalism

For commendable performance in flight safety

SERGEANT MICHAEL DONNELLY

On the 26 June 2007, Sergeant Michael Donnelly, a 403 Squadron flight engineer, was on a cross-country mission to Kingston on board a CH146 Griffon. During a stop-over in Sherbrooke, Sgt Donnelly performed the pre-flight inspection and noticed a very minor accumulation of black dust on two of the main rotor head pitch links. After closer visual investigation and discussion with the aircraft commander and crew regarding controllability, it was decided to proceed to Kingston and re-check for further accumulation of the black dust.

Although there was a large amount of flight associated grime around the pitch links upon arrival at Kingston, Sgt Donnelly's very meticulous inspection revealed the presence of a larger amount of black dust on the pitch links. Using his vast technical knowledge to determine beyond a doubt that there may be controllability defects, he elected to slightly manipulate the collective lever to reduce the load on the pitch links. This simple but decisive test revealed that two of the pitch links had excessive play. The resultant disassembly of the pitch links revealed that several washers, P/N NAS1149C0532R, were omitted during the configuration of the pitch links and horn assembly.

Without these washers installed, the nut bottomed out on the grip length of the bolt, resulting in insufficient clamping pressure on the pitch horns which caused an accelerated wear of the attachment bolts. Damage and corrosion were also found on the bolts due to the excessive wear and metal particle build up.

Sgt Donnelly's outstanding attention to detail, thoroughness and professional approach to his trade led to the identification of major damage on two of the pitch horn bolts that had eluded others for 139.8 flying hours. His steadfast determination to ensure safety of flight is maintained at all times as well as his concern for both personnel and material resources make him very deserving of this For Professionalism award. ◆

Sgt Donnelly is currently serving with 403 Helicopter Operational Training Squadron, CFB Gagetown.

MASTER CORPORAL DWAYNE BOWN

On 30 October 2007, Master Corporal Dwayne Bown, a 14 Wing Greenwood aviation technician working at 413 Squadron, was tasked to supervise a rudder boost package removal and installation on Canadian Forces Hercules aircraft CC130320.

For this procedure, the pilot and co-pilot seats as well as the floor boards were removed to facilitate access for the flight control cables. Employing every maintenance action as a developmental opportunity for his subordinates, he tasked his personnel to install a rig pin into the rudder control for security as stated in the Canadian Forces Technical Order.

Upon inspection to ensure that this was carried out correctly, he made the extra effort to look deeper under the flight deck area to ensure nothing could interfere with the rudder cables. This area, not normally inspected for this type of maintenance, is difficult to access and was poorly lit. It was at this time he discovered a paint brush, one inch wide and eight inches long, lying on a wire bundle several inches from the flight controls. MCpl Bown informed his supervisor and the unit flight safety non commissioned member about the foreign object. They both attempted to see the paint brush but could not until it was pointed out to them.

After an extensive automated data for aerospace maintenance history review, it was determined that since the aircraft's return from periodic maintenance on 1 September 2006, Canadian Forces personnel had been in that area twice for the same maintenance action.

MCpl Bown is to be commended for going well beyond the normal inspection requirements in order to ensure that this critical area was safe. His attention to detail, professionalism and steadfast determination to constantly ensure that safety of flight is not compromised, make him very deserving of this For Professionalism award. ◆

MCpl Bown is currently serving with 413 Transport and Rescue Squadron, 14 Wing Greenwood.

For Professionalism

For commendable performance in flight safety

MASTER CORPORAL DALE WARREN
WARRANT OFFICER RAY TANGUAY

On 29 November 2007, members of 408 tactical helicopter squadron were on deployment in support of exercise Gander Fury in Fort Sill, Oklahoma.

Master Corporal Dale Warren had just completed a pre-flight inspection of a CH 146 Griffon Helicopter when he noticed that an American C130 Hercules aircraft out of Youngstown, Ohio, was about to taxi out to the runway for take-off. His attention was drawn to a large piece of yellow material flapping behind the trailing edge of the aircraft's starboard wing. Recognizing this was not a normal condition, MCpl Warren consulted Warrant Officer Ray Tanguay, who had extensive knowledge of the Hercules aircraft.

WO Tanguay quickly recognized the yellow material as part of a flap from a partially deployed life raft. Both Canadian Forces members immediately proceeded to the front of the taxing American aircraft and signalled to the crew to stop. The Hercules aircraft captain and flight engineer disembarked the aircraft and were briefed of the potential danger by WO Tanguay. The aircraft was then shut down and rendered unserviceable pending repairs.

MCpl Warren's and WO Tanguay's superior attention to detail and professionalism were noteworthy and clearly displayed a high degree of airmanship and concern for all fellow allied personnel and aircraft. Their simple selfless act is the cornerstone upon which mutual respect is developed and fully demonstrates that they are truly deserving of this For Professionalism award. ◆

MCpl Warren and WO Tanguay are currently serving with 408 Tactical Helicopter Squadron, CFB Edmonton.

PRIVATE JAMIE KELLOW

On 6 September 2007 while on deployment with the Canadian Forces Snowbirds, Private Jamie Kellow demonstrated a keen sense of situational awareness and reacted with great confidence to avert a potentially dangerous situation. Pte Kellow, a mobile support equipment (MSE) operator with the 17 Wing transport electrical mechanical engineering (TEME) squadron, was the driver for their mobile support vehicle (MSV) and as such, had little experience with military flying operations.

While the Snowbird team was preparing to depart in three separate formations, Pte Kellow was busy preparing the support vehicle for the road transit to the next location as well as observing the flight line operations. After the first jets departed, crews were strapped in the next three jets, ready and in the process of starting the engines when Pte Kellow perceived an abnormality that caught his attention. From his distant vantage point, he realized that an unfamiliar object appeared to be attached to one of the jets. Although not familiar with the aircraft operating procedures, he did not think that this was normal. He immediately took action, locating and informing a pilot that was in the vicinity that something appeared wrong. On the strength of Pte Kellow's observation and insistence the start crew were directed to cease operations.

Once the start sequence was terminated it was discovered that an engine intake cover was still in place. With the cover being constructed of vinyl, it would have been easily ingested causing major damage to the engine and possibly the aircraft. A jet engine this severely contaminated with foreign object debris (FOD) would also have become very unstable and present an extremely hazardous risk to all personnel within the immediate area.

Pte Kellow's attention to detail, quick thinking, and confidence, undoubtedly saved an aircraft from serious damage and personnel from a potentially life threatening situation. His actions were clearly above the call of duty expected from an MSE operator. His concern for all resources validates that the spirit of flight safety is a force multiplier. Pte Kellow is most deserving of this For Professionalism award. ◆

Pte Kellow is currently serving at CFB Petawawa.

SECOND LIEUTENANT DAVID RYAN

On 27 February 2008, Second Lieutenant (2Lt) David Ryan was under training as a terminal controller at 15 Wing Moose Jaw. At approximately 10:00 am local, the CT114 Tutor (Snowbird) training area (Military Restricted Area, CYR 303 - surface to 10,000 feet Above Sea Level) became active.

It is not in the terminal controller's mandate to monitor this controlled airspace to ensure that aircraft (ac) do not violate its parameters. However, if noticed, the normal procedure is to transmit to the ac on the emergency frequency and have them switch to the terminal's frequency where they will receive an advisory regarding the active airspace.

At approximately 10:30 hours, 2Lt Ryan was observing operations when he noticed a CT156 Harvard aircraft turn and proceed directly toward the Snowbird training area at an altitude of 6000 feet. At the same time, 2Lt Ryan also observed a formation of CT114 Tutor ac in the area at 4600 feet in a climb attitude and heading towards the Harvard ac.

Realizing that there was not sufficient time to have the ac switch to the terminal's frequency, 2Lt Ryan took immediate action and broadcast on the emergency frequency "the Snowbird area is active". This transmission was heard by the pilot of the Harvard ac, who instantaneously turned away from the active area. The nine ac formation of Snowbirds who were about to pull up in a loop also heard this transmission and abruptly terminated their manoeuvre.

2Lt Ryan demonstrated a level of professionalism and aptitude that is far above what is expected of an individual so junior in rank. He is to be commended for his initiative and complete understanding of the safety of flight as well as the inherent dangers associated with his profession. His decisive action and full appreciation of a highly critical and dangerous situation make him very deserving of this For Professionalism award. ◆

2Lt Ryan is currently serving with Wing Operations, 15 Wing Moose Jaw.

MASTER CORPORAL BRIAN KILBRIDE
MASTER CORPORAL ENRICO MOEHRLE

In February 2007, following its periodic inspection at the third line inspection and repair (TLIR) facility in Nova Scotia, Sea King Helicopter CH12437 arrived at 443 maritime helicopter (MH) squadron (Sqn) Pat Bay British Columbia. Pilots at 443 Sqn reported that the aircraft "felt" different and was difficult to handle with the automatic stabilization equipment (ASE) turned off. The pilots accepted this flying irregularity for over 300 hundred hours because of documentation from the airworthiness authority which gave authorization to deviate from the standard rigging procedure.

Following an additional operator complaint and at the specific request of Master Corporal Kilbride, maintenance form CF349 was drafted calling for a complete rigging check of the aircraft. MCpl Kilbride, an avionics technician, and MCpl Moehrle, an aviation technician, both extremely experienced personnel and highly conversant with the ASE systems as well as rigging adjustments, obtained the senior aircraft maintenance engineering officer's (SAMEO) approval to lead a dedicated team to rig ac 437 to the standard specifications dictated within the Canadian Forces technical order CFTO C-12-124-AA0/MF-000.

The dedication, knowledge, experience and leadership of MCpl Kilbride and MCpl Moehrle expertly guided their team mates through over 250 maintenance man-hours to correct a problem that could not be repaired by the contractor. During troubleshooting, many components were found out of limits and were either adjusted or replaced. Following the in-depth, labour intensive repairs, aircraft 437 returned to normal operations without incident and the deviation authorization message was removed from the maintenance record set.

The initiative and confidence displayed by MCpls Kilbride and Moehrle to challenge and ultimately repair this accepted problem is noteworthy. Their superior level of professionalism, untiring investigation and steadfast determination to succeed is second to none. Their masterful blending of fault finding, tutelage of less experienced personnel and the restoration of operator confidence in the aircraft make them very deserving of this For Professionalism award. ◆

MCpl Kilbride and MCpl Moehrle are currently serving with 443 Maritime Helicopter Squadron in Pat Bay, BC.

For Professionalism

For commendable performance in flight safety

MASTER CORPORAL DAVID DEMERS

On 5 February 2008, while carrying out a daily inspection (DI) on Dash 8 aircraft CT142805, recently promoted Master Corporal Demers noted that the 10-man life raft had been inadvertently installed upside down.

Drawing on his aircraft life support equipment (ALSE) expertise, he quickly recognized that this incorrect installation could result in damage to the life raft due to the possibility that, when upside down, the CO2 bottle could puncture a hole in the life raft. He immediately informed his supervisors, and took action to have the life raft removed and routed to shops for inspection.

The subsequent ac cabin inspections identified another life raft in an upside down configuration. This incorrect configuration resulted in the suspect life rafts being damaged and they would not have remained inflated when used in an emergency. Additional investigation brought to light that the critical need to have the life raft orientated properly was not fully understood by fellow technicians and supervisors in MCpl Demers' chain of command.

This observation is particularly noteworthy because the inspection of the life raft assembly is not part of the DI. MCpl Demers' determination to always expand his inspection process to collateral ac areas and equipment clearly demonstrates his professionalism and pride in a job very well done. He is a new supervisor who possesses strong potential to succeed and is very deserving of this For Professionalism award. ◆

MCpl Demers is currently serving with 402 Squadron, 17 Wing Winnipeg.

MASTER CORPORAL LUC JOBIN

In December 2006, Master Corporal Jobin, an aviation technician with 430 Tactical Helicopter Squadron, was conducting a 25-hour inspection on CH146 Griffon helicopter 467. As he was inspecting the engine area, he discovered a major problem with the installation and safety of number two engine.

His examination revealed that the retaining nut on the bolt of the engine's bipod support did not appear to be properly secured. Further examination of this confined area revealed that the nut-retaining clip was missing, causing the nut to lose its integrity to a point where it was being held in place by only a few threads. If the problem had not been found and corrected, the potential existed for severe engine vibrations, engine damage and the compromising of the safety of flight. This in turn possessed the potential to result in a catastrophic equipment failure.

The resultant flight safety investigation revealed that before MCpl Jobin's discovery, 182.3 flying hours had been flown, nine 25 hour/30 day inspections, one quality-assurance (QA) inspection and 145 pre-flight inspections had been conducted. After his discovery, an amendment (DAEPMTH 64077, 0714) was made to the technical publication highlighting the importance of being very thorough when expecting this particular area of the aircraft engines.

MCpl Jobin's keen eye, refined technical prowess and tenacity clearly averted the loss of highly valued aircrew and mechanical resources. His efforts clearly demonstrate he is deserving of this For Professionalism award. ◆

MCpl Jobin is currently serving with 430 Tactical Helicopter Squadron, CFB Valcartier.