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Flight Comment

ISSUE 1, 2016

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Chief of Defence Staff

VIEWS ON FLIGHT SAFETY
Commander Canadian Army

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Canada

Flight Comment

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From the Top

By General J.H. Vance, Chief of the Defence Staff

The Defence Administrative Orders and Directives mandate commanding officers to "conduct their own general and specialist safety programs in accordance with the General Safety Program and specialist safety programs." One vital specialist program that is well recognized nationally and internationally is the Canadian Armed Forces (CAF) Flight Safety Program.

The Flight Safety Program, which I strongly champion and support without reservation, reaches all elements of the CAF. Within the CAF, the Commander Royal Canadian Air Force is responsible for flight safety policy while the Director Flight Safety (DFS) administers the program as a whole on his behalf.

A capital element of the program stems from the Minister of National Defence designating DFS as the Airworthiness Investigative Authority as required by the *Aeronautics Act*. With this designation comes the authority and responsibility to investigate all matters concerning aviation safety, independently of the chain of command. Moreover, on Ministerial Direction, I have issued a CDS Order to the AIA delegating additional responsibilities to carry out this function within the Flight Safety and Airworthiness Programs.

With the introduction of unmanned air vehicles in different organizations of the CAF and the contracting out of many aircraft maintenance and support activities, a vigorous Flight Safety Program that spans to all elements of our organization is critical. Aviation assets, including aircraft and unmanned aerial vehicles, are expensive and hard to replace. Also, our personnel are critical to mission success. It is vital that our resources be well preserved through a pro-active flight safety program to ensure the operational viability of the CAF, at home and abroad. The program is a key component to support any operational deployment where aviation assets are involved.

I expect commanding officers involved with operating or supporting aviation assets to allocate the right balance of resources to have in place an effective Flight Safety Program. Furthermore, commanding officers have to demonstrate leadership and engagement in the program so our aviation assets are well protected.

Views on Flight Safety

By Lieutenant-General J.M.M Hainse, Commander Canadian Army

The Canadian Army (CA) is expected to force generate combat-capable, multi-purpose forces to meet Canada's defence needs. This implies inherent risks in developing personnel, equipment and capabilities for and during military operations. The preservation of our aviation support and resources (i.e. Unmanned Air Vehicles [UAV], helicopters, refuellers, flight feeding, etc.) plus their associated activities (parachuting, aerial delivery, rappelling, airspace control, drop zones, etc.) is vital in order to maintain the army's war fighting ability. An effective CA Flight Safety (FS) program is designed to help preserve these resources while contributing to mission success within an acceptable level of risk.

The Minister of National Defence is mandated under the *Aeronautics Act* to look after matters of military aviation safety, and this is accomplished by the Canadian Armed Forces Flight Safety Program. It applies to all personnel operating or mandated to support air operations plus their supporting activities. The Royal Canadian Air Force uses a robust airworthiness program, comprised of Technical Airworthiness Authority and an Operational Airworthiness Authority to ensure our personnel have airworthy/suitable equipment to operate, and to ensure that we have the proper/appropriate training and procedures to effectively employ our personnel and weapon systems at an acceptable level of risk. The CA must work within this framework in order to operate our UAV to support our mission.

The CA FS program is a tool that provides army commanders at all levels with a focus on the fundamental airworthiness programs. Fundamental safety principles, including free and open reporting plus the development and implementation of preventative measures, must be supported at all levels. Therefore, I expect that, with the introduction of new fleets like the CH147F *Chinook*, CU173 *Raven-B* and others, that the CA leadership at all levels, will set the example and ensure that those personnel that operate or work around these weapon systems understand the important role they play in this key program.

The Editor's Corner

Happy New Year! In our "From the Top segment", we begin by sharing with you the Canadian Armed Forces (CAF) Chief of Defence Staff's concise directive on the role that Flight Safety (FS) shall play in within our military. Worth mentioning is his comment explaining how our aviation assets are expensive and hard to replace hence why FS is a requirement both at home and abroad. What the CAF as a whole must similarly take away, and what the Directorate of Flight Safety (DFS) most often stresses, was the key statement that commanding officers have to demonstrate leadership and engagement in the program so all of our aviation assets are well protected. In "Views on Flight Safety", the Commander Canadian Army reiterates that point by insisting that FS is vital in order to maintain the army's war fighting ability and is designed to help preserve these resources while contributing to mission success within an acceptable level of risk.

Next, I'll draw your attention to our "From the Flight Surgeon" section which will examine what conventionally most if not all in the aviation community have deemed an important attribute for aircrew to possess: good lookout. This article probes further into a matter that was already showcased a few years back in *Flight Comment* (no. 1, 2010), except in this instance the author utilizes data from a recent near mid-air collision in her analysis of the subject. In what would be a shock to most, the article's author explains that no matter how much we insist that we could be doing it better, we as humans are actually limited physiologically in effectively executing the see-and-avoid principle and that perhaps insisting on a better 'lookout' isn't the only preventive measure to consider with respect to improving aircraft deconfliction methods.

Continued on page 7

Good Show

For Excellence in Flight Safety

Sergeant Keven Beaudry

On 5 June 2015, Sgt Keven Beaudry, a CC130H *Hercules* Instructor Flight Engineer, was off duty at his home on the north edge of the City of Belleville when he observed a *Hercules* flying overhead that seemed to be venting a significant amount of fuel.

Tiger 307, the primary Search and Rescue (SAR) aircraft, had departed runway 06 in Trenton, taking it over Sgt Beaudry's neighborhood at an altitude of 1800 feet. As the aircraft passed overhead, he glanced upwards, immediately observing that something was out of the ordinary. Looking more closely, Sgt Beaudry realized that a large amount of fuel was leaking from the *Hercules'* right hand wing between the outboard engine and the aileron. He quickly sprang into action, calling 424 Squadron Operations in order to have them pass a message to the crew of Tiger 307. Having received the message, Tiger 307's Flight Engineer verified Sgt Beaudry's observations and the crew declared an emergency, allowing them to rapidly return to the airfield. With the crew of Tiger 307 engrossed in the preparations for the impending SAR training, Sgt Beaudry's actions served to quickly alert the crew to this very serious situation. Given the proximity of the fuel leak to the number four engine and the volume of fuel leaving the aircraft, it is highly probable that fuel would have migrated down the flap well and leaked down into the number four engine nacelle. This would have led to fuel being sprayed directly into the exhaust stream, where it would likely have ignited. Had this occurred, the results could very well have proven tragic for the crew of Tiger 307.

Sgt Beaudry is to be commended for his keen observations and quick thinking that prevented what could have been a catastrophic incident. His actions also serve to demonstrate how anyone, at any time, can contribute significantly to Flight Safety. Sgt Beaudry is therefore most deserving of this Good Show Award.

For Professionalism

For commendable performance in flight safety

Master Corporal Frank Lizotte

In May 2015, while deployed as the Fighter Detachment Flight Safety NCM, MCpl Frank Lizotte demonstrated exceptional skill and perseverance in investigating and rectifying the issue of hung weapons.

After three missions with unsuccessful weapon delivery attempts, MCpl Lizotte decided to delve deeper into the situation to determine the root cause of the weapon release failures. He compared the cartridges from successfully released weapons to those of unsuccessful ones and, after consulting with a second line technician qualified on the BRU-32 bomb ejector rack, discovered that the center piston was missing from the suspect BRU-32. The center piston in the BRU-32 is used during the release of weapons as well as during the jettison and emergency jettison functions of onboard stores. An aircraft outfitted with a BRU-32 configured in this manner would not be able to release or jettison a weapon, either in response to the enemy or in the event of an airborne emergency; potentially endangering the safety of the aircrew and the aircraft. Furthermore, an aircraft returning with hung stores creates a hazard for technicians on the ground who must remove the weapon from the aircraft. After his discovery, MCpl Lizotte quickly initiated a survey of all CF188 aircraft to verify the serviceability of the BRU-32s, finding several units requiring repair.

MCpl Lizotte's tenacious investigative techniques, coupled with his swift actions to rectify the problem, corrected an extremely hazardous situation for both air and ground crew and allowed Royal Canadian Air Force CF188 aircraft to safely resume operations. MCpl Lizotte is truly worthy of this For Professionalism Award.

The Editor's Corner

This issue's theme turns to unmanned air vehicles (UAV) and with that, we'll provide you with and example on how the CAF is employing these systems in the field. Also, I'll take a look at where North American policy is at with respect to [civilian] UAV regulation. Our Check Six three-part segment on aviation medicine will conclude with a historical account of the development of ejection seats and the study of physiological illnesses related to flying. Thanks again to the Canadian Space Agency who let us reprint this fabulous account of the work of some of our great doctors and researchers.

For those who might find themselves flying cross-country and having to adjust their flight paths southwards in response to icing in cloud and the like, you will find this issue's "On Track" article a worthwhile read as we revisit the finer points on flying visual flight rules in the United States.

For all FS personnel, here's what to watch for in the upcoming months:

DFS 'Roadshow' visits:

- January 15: Pat Bay
- January 18: Abbotsford
- January 20-22: Moose Jaw
- February 2-3: Petawawa
- February 16-19: Trenton

DFS Annual Flight Safety Training Workshop

- March 8-10: Ottawa

Volare tute
Major Peter Butzphal

From the

Flight Surgeon

Photo: MCpl Pierre Thériault

Seeing is believing.
NOT SEEING IS BELIEVING, TOO!

By Lieutenant (N) Tracy Coulthard, Bioscience Officer, Assistant Deputy Minister's Office (Material), Ottawa

Introduction

Just because you can't see it, doesn't mean it isn't there. This truism has been amply demonstrated in repeated occurrences of 'near misses', or Near Mid-Air Collisions (NMACs). Every time there's an NMAC, there are inevitably calls for better lookout to help prevent future occurrences. Unfortunately, this is easier said than done, because calls for better lookout as a mitigation strategy for near mid-air collisions appear to be an attempt to change a physiological mental limitation that cannot be improved.

Visual traffic separation is based on the 'see and avoid' principle. However, its limitations do not appear to be fully appreciated by the aviation community, given the persistent calls for "better lookout" as a prime mitigation measure for NMACs. It has been established that a pilot cannot observe the entire surrounding space in the time available. So what determines the outcome? Whether knowingly or not, when pilots apportion their visual scan time, they are essentially guessing where best to look, since they cannot look everywhere. The success or failure of sighting a collision target depends in some measure on whether the pilot is lucky enough to guess at the right place to look, at the expense of not looking in another direction.

> ***"No matter how vigilant the pilot is, not all collision threat aircraft will be seen all the time, even if visual scanning were the only task the pilot had."***

This random uncertainty is what makes the problem probabilistic – either they are lucky enough to guess right, or they guess wrong. Because it is probability based, the difficulty in understanding the problem lies in accepting the outcome. It is similar to winning or losing a game based on chance. In other words, blaming the pilot for not seeing a target that was there to see, in the absence of any other information, is no more helpful than blaming a game show contestant for choosing the wrong door, when clearly they could have chosen the right door. Better lookout in this sense simply means better guessing, which explains why it won't mitigate the risk. You can replay the game, but in the absence of any other information the odds remain the same.

Summary of what happened

A review of the most important 'see and avoid' research findings is helpful in analyzing the following NMAC incident, involving a CT156 *Harvard II* aircraft that was returning to base from the military terminal control area and a CT114 *Tutor* that was outbound to its test flight area.

The *Tutor* had departed the aerodrome climbing to the southeast, and then turned west toward its intended work area, climbing to 10,000 ft. on a heading of approximately 270 degrees. Neither aircraft was seen by the other until the *Tutor* passed directly underneath the *Harvard*.

The *Harvard*'s heading was 344 degrees, which made the convergence angle 74 degrees with the *Tutor*. The *Tutor* pilot judged that the separation distance was approximately 200 ft., given the sound of the propeller. It is notable that the sound of the propeller was heard clearly through a sealed, pressurized cockpit and through the pilot's helmet.

Analysis of the research

The underlying assumption of 'see and avoid' is that, if we look, we will see. This is only partially true. No matter how vigilant the pilot is, not all collision threat aircraft will be seen all the time, even if visual scanning were the only task the pilot had.

It is obvious to all pilots that their field of view (FOV) from the cockpit is restricted due to the wings and structure of their aircraft. This alone creates blind spot conditions whereby other aircraft in the obscured area cannot be seen. What is perhaps not so obvious is the length of time an effective visual scan takes. The US Federal Aviation Authority (FAA) estimates that, in order to detect everything that could be seen, this process consumes 54 seconds. This would be effective in a static environment, but it is hopelessly imperfect in a dynamic flying environment, where an aircraft speed of 300 knots equates to a change in aircraft position of 4.5 nautical miles (NM) within this 54 second period.

The time required to successfully avoid another converging aircraft once it is seen has been shown to be approximately 12.5 seconds. This is due to the collision avoidance decision cycle, which requires at least 12.5 seconds for a pilot to identify a target as an aircraft, identify it as a collision threat, decide on an avoidance manoeuvre, and then manoeuvre to avoid a collision.[1, 2] For aircraft on a collision course with a closing speed in excess of 300 knots, they would have to be detected at least 1 NM apart in order to avoid a collision. This leaves us with a mathematical impossibility.

Even if the pilot could commit 54 seconds to a complete visual scan, by the time the scan was even partially complete the scanned area would already be at risk of having a potential collision target appear before the scan cycle returns to the same area, leaving insufficient time to detect and react. In the above example, an aircraft moving at 300 knots that

Approximate flight paths of converging aircraft leading to the near mid-air collision.

Continued on next page

was not in the scanned field of view could move enough (as much as 4.5 NM) to appear in it before the scan returns, and that aircraft could also easily appear undetected inside the 1 NM range needed to avoid it.

Practically, the visual scan cycle would have to be completely effective within a period significantly shorter than 54 seconds, in order to capture and assess the entire air picture in successive quasi-static intervals without significant positional change within the scan cycle. This would optimize the probability of instantaneously detecting and then avoiding another aircraft, if it was within the pilot's field of view. Since this is not possible, what actually happens is that the pilot's visual scan is inevitably incomplete, since it is necessarily compressed into a much shorter cycle anyway, and it is overtaken by the positional dynamics of the air picture. This lowers the probability of detection, and creates a probability space where some aircraft will remain undetected.

"Given what is known about how these limitations adversely impact 'see and avoid' effectiveness, it should instead be considered that it is institutionally errant to expect these limitations can be overcome simply by prescribing better lookout."

This suggests that, no matter how vigilant the pilot is, not all collision threat aircraft will be seen all the time, even if visual scanning were the only task the pilot had. These are the first order effects of 'see and avoid' collision risk.

An FAA study found that the probability of detection (POD) is a function of closing speed, and that POD decreases dramatically from 0.84 with a closing speed below 200 knots to 0.32 with a closing speed over 400 knots.[3] It also found that POD increases with proximity, climbing steeply from a POD of 0.17 at 15 seconds prior to NMAC (for a closure speed of 252 knots) to 0.82 at zero seconds (closest approach). At 12.5 seconds prior, the POD was only 0.30. One study found that pilots scan much less effectively toward the side FOV angles than they do forward centre, with effectiveness as low as 0.30.[4]

Given the overwhelming weight of these research results, the frustrating persistence of NMAC occurrences should not be surprising. Rather, it is to be expected. Physiologically, there is simply not enough time available for a human to perceive everything in the surrounding space, compared to the rate at which that space is changing.

The probability of detection has also been shown to be affected by lower order factors, such as aircraft size and colour, windshield glare, sun in the eyes, and constantly changing attitudinal references. However, mitigation of these lower order factors does not resolve the fundamental problem of inadequate visual scan time.

Human factors analysis

In order to assess why 'see and avoid' could have failed in this incident, it is necessary to reconstruct the situation at least 12.5 seconds prior to the NMAC, when the aircraft could have avoided each other had they been detected. Given an angle of convergence of 74 degrees, and approximate true airspeeds of 300 knots for the *Harvard* and 240 knots for the *Tutor*, their closing speed was approximately 328 knots, and at 12.5 seconds prior they would have been 1.1 NM apart.

Research indicates a POD based on this closing speed of less than 0.3 at 12.5 seconds prior. Thus, it is 70 percent probable for each aircraft that they will not see the other in time to avoid each other. The combined probability translates to only a 51 percent chance that at least one of the aircraft will see the other in time.

The NMAC occurred at 17:22:00. According to radar, the *Tutor* departed the aerodrome on an approximate heading of 138 degrees, and commenced a right turn between 17:21:40 and 17:21:45, rolling out prior to the NMAC on a heading of 270 degrees. This would have required a turn rate of at least 6.6 degrees/second, or approximately rate two with 60 degrees of bank. The *Harvard* may have been in the *Tutor*'s FOV prior to the turn, likely at a distance of at least 4 NM. Even if the *Tutor* had seen the *Harvard* prior to the turn, it is extremely unlikely that the pilot could have perceived its flight profile at that distance and then forecast it would coincide at the same point of convergence several miles to the right after a 132 degree turn. Once in the turn, the *Tutor*'s steep bank angle combined with the pilot's location in the right seat would have left a POD of detecting the *Harvard* of approximately zero.

The *Tutor* may have been in the *Harvard*'s FOV prior to the encounter, but it would have been at a significant angle of azimuth (i.e. horizontal direction) to the right. The accuracy is not certain given that the *Tutor* was in a turn, but in the 10 seconds prior to the NMAC the *Tutor* is calculated to have been at an azimuthal position approximately 45 degrees to the right

of the *Harvard*'s track. This places it at best in the *Harvard*'s probable visual scanning effectiveness of 0.5 compared to if it had been centre-forward in the *Harvard*'s FOV. The *Tutor* also would have been seen against the backdrop of ground, without significant contrast. If this analysis is accurate, it leaves the combined probability that either aircraft would have seen the other in time below 50 percent.

It is worth noting that the closing speed of 328 knots far exceeds that considered safe for a formation rejoin, where the aircraft are intentionally planning a point of closest approach in a controlled manner. For experienced formation pilots, the acceptable safety margin for joining a formation is more intuitive as it has been honed through repetitive training and the pilot has the other aircraft in constant sight. The contrast between this situation and a typical NMAC is stark, where the traffic is unseen and the closure speed leaves dramatically less time to react.

Note that for aircraft that remain undetected until in very close proximity, they will be assessed as a collision threat instantaneously once detected, but it is far too late at that stage to complete the decision cycle, since the reaction and manoeuvre time alone (6.4 seconds) would almost certainly exceed the remaining time to act before closest approach. For example, from 500 ft. distance with a closing speed of 120 knots there are only 3 seconds to impact.

Conclusion

The inherent risks in the 'see and avoid' approach should not be considered human error, as if they somehow stem from mistakes. It is not errant for a pilot to be constrained by the limits of human perception. Given what is known about how these limitations adversely impact 'see and avoid' effectiveness, it should instead be considered that it is institutionally errant to expect these limitations can be overcome simply by prescribing better lookout.

Proponents of 'better lookout' fail to acknowledge its limitations. If in a post NMAC incident report it is determined that the pilot could have seen the other aircraft but did not, the natural tendency is to fault the pilot. However, the associated risks are already embedded in the problem. With proper vigilance, it is already as good as it will get. What such proponents are really doing is arguing to accept the very risks that they are concerned about.

In the case of perceiving visual traffic, mental limitation is just that: a limitation of human capability. Unfortunately, it appears to be commonly misinterpreted as a mental fault that can be rectified with rhetoric, which has not proven to be the case.

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3. Graham, W., See and Avoid/Cockpit Visibility. Technical Note DOT / FAA/ CT-TN89/18. October 1989, pp. 2.

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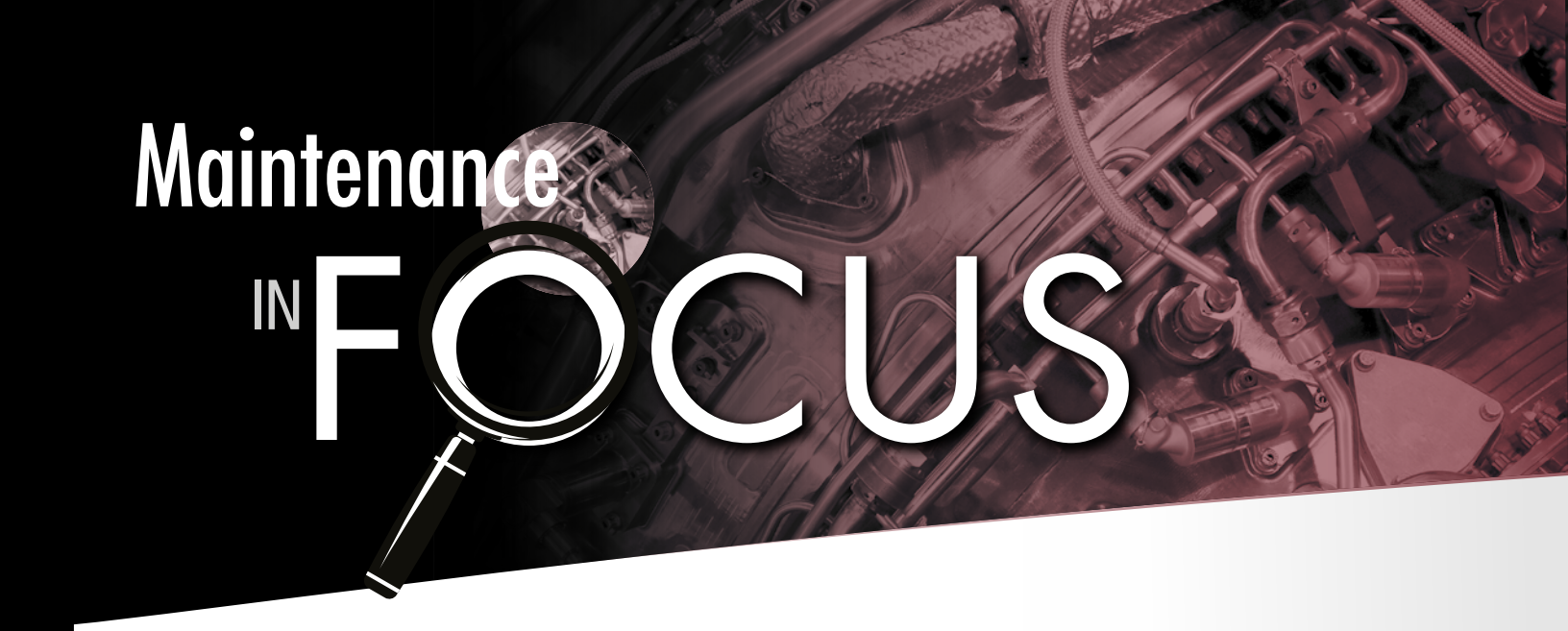
Photo: DND



Automated TECHNICIANS

By Major Hugo Pellerin, Directorate of Flight Safety 2-5, Ottawa

We have had unmanned aerial vehicles for a few years now, but when will we have automated servicing? I guess it will take a few years before we see this kind of operation on our flight lines. Yet, did you know that every day your brain switches to an 'automated mode' in order for you to function? Without this ability, our brain would simply be overloaded with information which would make us inefficient. Imagine if your brain had to think about walking; putting one foot in front of the other, adjusting the bend in your knees and ankles, keeping (or changing) the speed at which you walk, all that while trying to keep your balance. The reason why we're not constantly thinking about walking while doing it is that our mind is in an automated mode for that activity. The only time your brain will get out of this mode while you're walking is if something abnormal happens – if you start slipping for example. At that point, your brain will get out of an automated mode and will react to the situation.

Automated modes can be achieved through training and/or repetition. Another example is driving your car. If you approach a street corner and you see a red octagon sign, your brain will register it as a stop sign and you will slow down without thinking much about it. Our brain uses frameworks to recognise situations that we have experienced before. If that framework is repeated (or trained) and our mind associates that framework with a certain reaction, it will eventually put that framework and action into your automated mode so you can do it while thinking of something else. Mixed martial arts fighters use this quite extensively; they repeat routines hundreds of times so that their mind can recognise a framework and react immediately (also called muscle memory) without taking the time to analyse it.

So, if your brain can switch in automated mode when it recognises a framework, can your mind misinterpret a framework? Yes it can. Earlier this year a technician needed to inflate a main landing gear tire while in transit at a civilian airport. The technician needed to borrow a nitrogen cart from a privately-owned company to service the aircraft. When the technician looked at the nitrogen gauge, it looked almost the same as the gauge the squadron uses every day back at the Wing. The technician's mind recognised that framework and switched to an automated mode. A few minutes later, the tire exploded. In this case, the framework recognised by the technician was not accurate. Although the gauge looked the same, the measuring units were quite different. The technician was aiming for 150 psi, but this gauge was calibrated in bars. (1 bar = 14.5 psi)

Our brain can 'trick' us into thinking we're doing something normal or ordinary, that an action doesn't need a higher level of consideration from our brain. For that reason, we have to pay particular attention when using equipment that is not our own or that we are not familiar with. Although it may look the same, we have to take the extra time to make sure we understand its parameters, its capabilities and that we use it appropriately. After all and in a certain way, I guess automated servicing has been around for years...

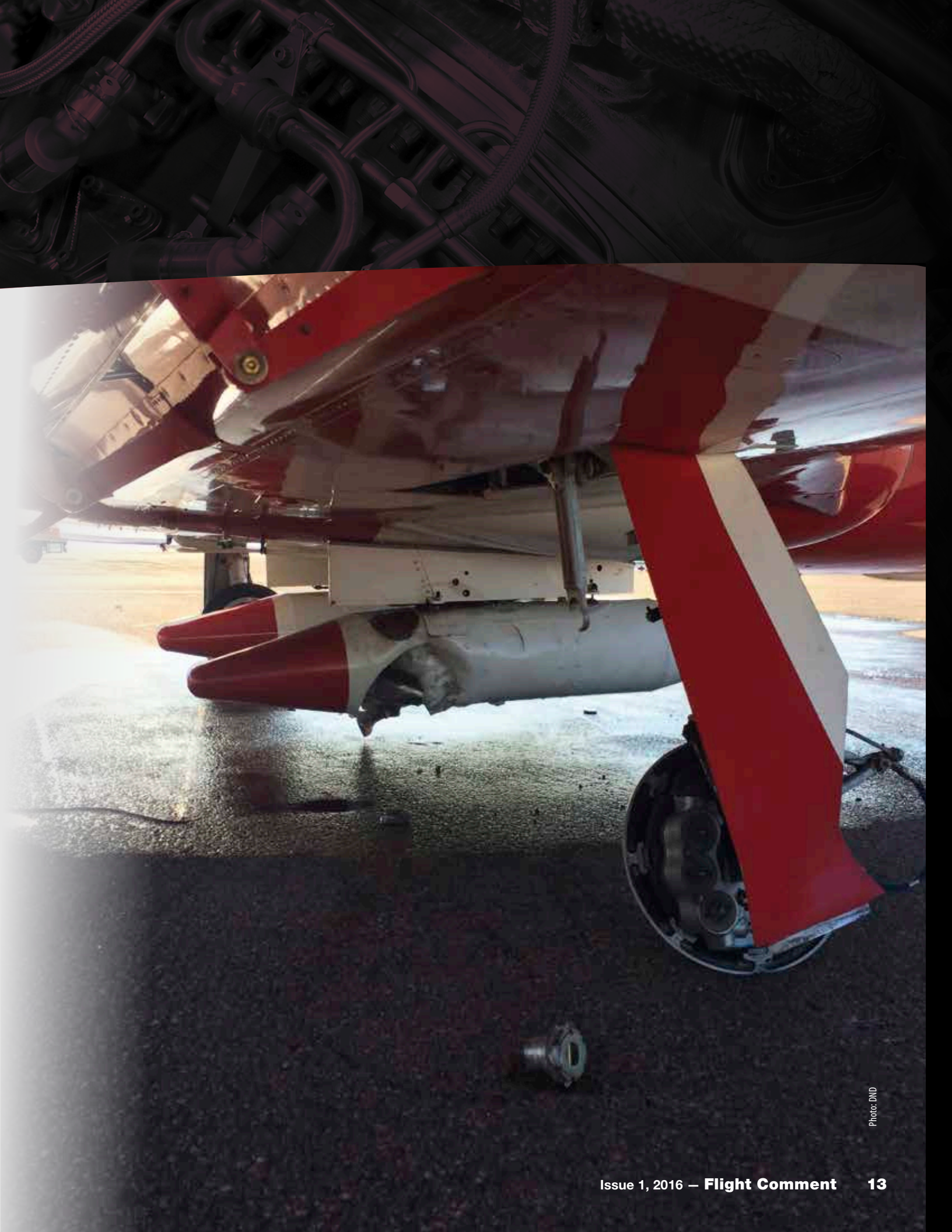


Photo: DND

CONCLUSION

Canada's Aviation Medicine Pioneers

By Lydia Dotto
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Ejection Seats

One of the most dangerous jobs at the Institute of Aviation Medicine was testing ejection seats. The seats were dangerous for pilots, too; even though they were intended as a life-saving device, many pilots were getting killed or injured while ejecting.

Roy Stubbs studied one particular issue with the ejection seat that was commonly used at the time, called the Martin Baker seat. "The problem with the early Martin Baker seats was that they put the parachute behind the head, so the head was forced forward in the head rest. When you ejected, you could break your neck."

To prevent this happening, the seat assembly had a D-ring device attached to the back of the seat above the pilot's head. In order to eject, he was supposed to pull this ring down over his helmet to restrain his head and keep it from snapping forward when the ejection seat fired. The D-ring also had a "face blind" that would protect his head from windblast.

"In an emergency situation, they might not get the D-ring all the way on, so there were a lot of broken necks," said Stubbs. In fact, his was one of them. During one experiment at a test facility in England, he didn't get the ring on properly and "my head went down until I was biting my navel. I had to wear a collar for six months or a year. Surgery wasn't good enough to do anything; it had to heal itself. For 20 years, I had a neck with very little movement; all the disks in the neck region were totally fused. It wasn't much fun but we learned a lot." He received the standard compensation for an injury on the job—two dollars.

In the end, it proved impossible to overcome the problem with the Martin Baker seats. The advent of rocket-propelled seats provided a better alternative, however. "The parachute was placed down on the back of the body to keep the spine lined up, so the head wasn't being pushed forward," Stubbs said.

The rocket seats also helped with another problem: the high G-forces that pilots endured during ejection and the danger of spinal damage this created. "We wanted to determine what kind of G we could have without breaking spines," said Stubbs.

One concern related to the survival pack the pilot sat on, which contained a radio, a water supply and other things they would need after ejecting. It was compressed by the force of ejection and there was concern that it would rebound from this compression within the first few tenths of a second and apply added force to the spine just as the ejecting pilot was experiencing maximum G-forces. There was also a need for a small depression to be created in the middle of pack to allow room for the pilot's tailbone, which might otherwise snap off when the body was pressed down during ejection.

Stubbs said the early seats were fired using a cartridge like that in a shotgun. "You had 30 inches to accelerate the seat out of the plane and clear the tail. You had to take a man from 0 to 60 miles per hour in one tenth of a second." It was quite a jolt, delivering up to 20 Gs.

Tests done in collaboration with the US Air Force on the ejection seat tower at Wright- Patterson Air Force base in Ohio showed that if seat packs were made from new fiberglass-resin material, "the rebound was delayed and did not produce the added force in the vital early time frame of the ejection sequence. So the risk of spinal injury was reduced in most ejections," Stubbs said.

When the rocket-propelled seats came in during the 1960s, they made things a little easier because they did not deliver their power

in one initial burst, but continued to burn for a time while the seat cleared the plane. "With the rocket giving thrust all the way up for 10 to 12 feet, you don't exceed four to five Gs," said Stubbs.

Douglas Soper investigated another aspect of the Martin Baker ejection seats used in the CF-100 aircraft, namely an alternative release mechanism to the standard over-the-head D-ring. There was concern that under high G-loads, the aircrew might not be able to raise their arms up to reach the D-ring.

He focused particularly on the ejection problems faced by the navigator, who sat behind the pilot. "They were being killed because they were not ejecting from the aircraft—they were just not getting out. Quite a large number of back seat occupants of the CF-100—perhaps 10 or 12—were killed without anyone successfully ejecting. Jan Zurakowski, the chief test pilot for Avro, lost his observer in an accident near Oshawa. We didn't know why."

Soper examined one mechanism that consisted of a rod extended over the navigator's left shoulder. "You grabbed this rod and sort of pulled it forward and you would be ejected." He tested the mechanism in flight, although he didn't actually eject from the aircraft. "The explosive charge had been removed since the purpose of the experiment was to prove that you could actually pull the handle on this particular design."

It was nevertheless quite an adventure. The aircraft ascended to around 10,000 feet with its canopy off, as would be the case if the aircrew were going to eject. "It was not only turbulent, but extremely noisy," said Soper. "At the right time, I reached up and pulled the handle. The slipstream grabbed my arm and pulled it back along the fuselage. Later, I joked that I was probably the only person who flew in the CF-100 who touched the tail with my hand."

Photo: DND

Early ejection seat with a variety of helmets used in testing

At the time, however, it wasn't a laughing matter. Soper dislocated his shoulder and lost his crash helmet, even though it was strapped on. "The slipstream cleaned it right off my head. Air could get underneath it and just lifted it right off. I never even felt it go." He had real difficulty at this point because he couldn't communicate with the pilot to let him know what was happening. The plane was too noisy for them to talk to each other—and, in any event, his communications system had flown away with his helmet—but Soper had rigged a system that would turn on a red light in the pilot's cockpit. "I had a toggle switch where I could wipe my hand down and tell him I was in trouble."

Unfortunately, with his left arm pinned back, he couldn't easily reach the switch. "It was in front of my left arm, which was trapped outside the aircraft. And I couldn't see anything because of the buffeting." However, he managed to move his right arm over enough to where he thought the switch should be and, luckily, was able to communicate his distress to the pilot, who immediately brought the plane down.

Despite his injury, he felt the test was a success because it solved the mystery that had puzzled him. "We now knew why the people in the rear seat couldn't get out of the plane. With the canopy off, as in a real ejection, the airflow over the rear cockpit became very turbulent. When the rear seat occupant reached up to use the standard over-the-head D-ring, the slipstream pinned his arms so that he couldn't pull the mechanism or do anything at all. This was verified later by a navigator who lived to tell the tale. He had been ordered to eject and when he didn't, his pilot managed to land the aircraft back at base. The navigator had his hands pinned in the extremely cold slipstream and lost portions of his fingers, which were frozen."

Continued on next page

The solution was to install a transparent windscreen in front of the rear seat to deflect the slipstream. "That seemed to solve the problem," said Soper. "However, at night, navigators couldn't see out because of interfering reflections from the windscreen. Some navigators wanted the windscreen removed. So you can solve one problem and unwittingly create another."

Decompression Sickness

Among the many risks faced by pilots flying at high altitudes is the danger of decompression sickness, also known as "the bends." Since air is about 79% nitrogen and 21% oxygen, body tissues such as fat, organs, muscles, skin and blood are normally saturated with nitrogen. When someone moves rapidly from a higher pressure to a lower pressure environment, this nitrogen can bubble out rapidly, causing symptoms ranging from joint and chest pains, shortness of breath and blurred vision to headaches, dizziness and nausea. Left untreated, severe cases can result in a coma and death.

Decompression sickness is a risk for divers who ascend too rapidly from deep waters, because they are moving from a higher pressure at the depths to a lower pressure at the surface. Similarly, as pilots ascend from the surface to high altitudes, the reduced pressure puts them at risk of decompression sickness. Astronauts also face this problem during spacewalks because their suits are pressurized at a lower level than the space shuttle or the space station.

The first decompression chamber in Canada was built in a lab at the Banting Institute. According to Peter Allen, Frederick Banting, who was "a great believer in the use of 'scientist rabbits' " was the first person to expose himself to an equivalent altitude of 40,000 feet. At the Institute of Aviation Medicine (IAM), the decompression chamber was used from its earliest days to study the causes of and treatments for decompression sickness, both for aviators and divers. This work continues today at its successor organization, the Defence and Civil Institute of Environmental Medicine (DCIEM – recently renamed Defense and Research Development Canada (DRDC)-Toronto), which is also doing decompression research related to spacewalks.

In fact, IAM developed the first decompression computer for use by divers who made repeated deep dives. Depending on the depth to which they'd dived, how long they'd remained at depth and how often they dived, such divers had to ascend slowly and stop at prescribed points along the way to allow nitrogen to escape from their tissues slowly. The IAM team developed a pneumatic computer that computed decompression schedules in real time and an electronic computer that computed schedules faster than real time (milliseconds rather than seconds).

"We designed an electronic computer before computers as we know them today existed," said Roy Stubbs. "If a diver got in trouble in the ocean, they would phone in and tell us what his experience had been, what depth he'd been to and how long. We would plug this into the computer and generate the procedure for him to come to the surface. This was radioed out to the ship and he would do it."

Stubbs later became the chief scientist at DCIEM, where he developed a diving research facility that could reach greater depths than any other in the world at the time—6000 feet. It was named after him when he retired.

Aviators generally experienced less severe cases of decompression sickness than divers, according to Harold Warwick, who, as an RCAF medical officer during World War II, was involved in evaluating the susceptibility of military crews. This is because more nitrogen is dissolved in body tissues at the high pressures found underwater than at the surface. "The decompression sickness that occurs when you take people to altitude from ground level is not as severe as in a person who is at increased pressure, like a diver, and is then brought to the surface. We never saw severe neurological problems."

When Warwick joined the RCAF Medical Branch in 1941, he was assigned to the No. 2 Clinical Investigation Unit in Regina, where he and his commanding officer, Chester Stewart, developed a program to evaluate the resistance of trainees to decompression sickness. "We had one pressure chamber there," he said. "We determined that a suitable method was to expose individuals for two hours at a simulated altitude of 35,000 feet, with a rate of ascent of half an hour. You didn't need to keep them there longer than that, because the symptoms would appear within that time."

Warwick was another researcher who did not ask others to do what he wasn't willing to do himself. "I've had decompression sickness in

all its forms. We had to be in the chamber when trying to determine the best method for testing."

As a result of this work, in 1942, he and Stewart were assigned to the No. 1 Flying Personnel Medical Section of the Y Depot in Halifax, Nova Scotia, where 12 decompression chambers had been built to evaluate men headed for war. "That's where graduates of the joint air training plan assembled before they went overseas on the big ships," said Warwick. "It was not just pilots, but also navigators and gunners—what we called aircrew." Later this testing facility was transferred to Lachine, Quebec.

More than 6500 people were put through nearly 17,000 exposures. Warwick recalls that roughly a third exhibited a natural resistance to decompression sickness. The researchers found that the rate of ascent was an important factor in determining the extent to which subjects experienced decompression sickness. They also found correlations with time of day—the incidence was higher in the morning than in the afternoon—and with atmospheric pressure. And they discovered that people who tended to be big and heavy were more susceptible, possibly because their bodies had a higher percentage of fat that did not release nitrogen as quickly as other tissues.

In those days, aircraft were not pressurized and some would be flying at 30,000 feet or more— altitudes that would generally induce some degree of decompression sickness in many people. Warwick said there was particular concern about the susceptibility of crews on photo reconnaissance missions, which flew at quite high altitudes. "You wouldn't want a person to be doing photo reconnaissance or high-altitude bombing if they were going to be developing severe pain," Warwick said.

The men who were tested in Halifax had a note placed on their record whether they were susceptible or resistant to decompression sickness but Warwick says he doesn't know "what practical use came of that or what attention was paid to it. I can only assume they wouldn't pick a person for high altitude flights if they knew he was susceptible." He added that some crewmembers did regularly experience mild symptoms and "just carried on."

Warwick said the Royal Canadian Air Force's work in decompression sickness was a pioneering effort that attracted the interest of researchers elsewhere. "The Americans were quite interested—we had numerous visits from people in the U.S. to see what we were doing. We were ahead of them in that regard. In 1943, they were hardly into the war. Canada was a forerunner."

Motion Sickness

For millions of years, the human body evolved without ever encountering the conditions it experiences when strapped into a plane rolling around the sky and accelerating. It's not surprising, therefore, that the vestibular balancing system in the inner ear that controls our sense of position and motion has found the experience rather disconcerting.

The vestibular system is comprised of two elements: the semi-circular canals, which sense angular motions, and the otoliths, which sense changes in position relative to the force of gravity and tell us up from down. Both have evolved to cope with the range of conditions that humans normally experience on the earth's surface. The accelerations and maneuvers experienced in high-performance jets—as well as the lack of gravity in space—are beyond historical human experience. One consequence of this is motion sickness.

Motion sickness, with its attendant symptoms of nausea and vomiting, was recognized early as a threat to the safe operation of an aircraft or spacecraft. When Stubbs went to the Institute of Aviation Medicine (IAM) in 1950, "one of the first things I was asked to do was help study the physics of motion." The study involved cats as well as humans. "Cats are very susceptible to motion sickness," he said. "We studied what motions would make them sick, then did it ourselves. We wanted to define the math of the motions that were causing sickness."

Another researcher, Walter Johnson, a professor at the University of Western Ontario, was asked by Wilbur Franks to join IAM to study the problem. He examined the question of what kinds of motion would cause the worst motion sickness. "This research culminated in a new finding, an essential finding, as to how the inner ear is maximally stimulated to produce nausea," he said. "We showed that the inner ear acts like a gyroscope. If you spin it in one plane and tilt the gyro in another plane, forces are set up to produce a stronger stimulus that is very nauseating. Say you're in boat or plane that's pitching up and down and your turn your head sideways—that's the worst thing you could do. It's more effective in causing nausea than anything."

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Stubbs noted that one of the things that led them in this direction were old Navy tales that "you should nail your head to a bulkhead. The three of us, Johnson and Franks and I, sat down and talked and all the old tales came up."

The researchers invented diabolical machines that "would produce these terrible effects on people," said Johnson, who created a device that produced vertigo by spinning test subjects around like a top. Later, another machine, called the Precision Angular Mover, was developed; it rotated test subjects around all three axes—pitch, yaw and roll.

As usual, the researchers subjected themselves to the tortures they were asking others to endure. Johnson admits it wasn't easy to find volunteers. "I had my problems. Not everyone wanted to do it because they knew what would likely happen. But I got enough volunteers to publish my results."

As a result of this work, in 1951 Johnson, Stubbs and Franks wrote a scientific paper that concluded that the best way to prevent the worst nauseating stimulus was to strictly control head movements relative to the rest of the body—no bobbing motions or rotating the head. They patented a headrest designed to minimize motion sickness in pilots and astronauts essentially by immobilizing their heads.

Johnson put these findings to practical use when he investigated a problem with parachutists at a training base in Alberta. "They were complaining of getting nauseated before they jumped in rough air. In order to offset that effect, I suggested they install head rests in the airplanes that were taking them up and that helped a lot."

As a result of his discovery of the most potent stimulus on the inner ear that caused nausea, Johnson received an award from the Aerospace Medical Association in 1956 for "outstanding services to aviation medicine."

The researchers also found that antihistamines, which were just then being developed, were useful in reducing the symptoms of motion sickness. However, since they had a sedating effect, the drugs couldn't be given to pilots or others with operational responsibilities.

Johnson was also invited to work with the early groups of astronauts chosen for the U.S. space program in the early 1960s. He participated in training flights in aircraft that can create brief periods of weightlessness by flying a roller coaster pattern. "I was instructing them on how to keep their heads still," he said. (Johnson had to follow his own advice—he found he too was susceptible to motion sickness if he moved his head too much.)

Many people in the space program were surprised to discover that motion sickness was a problem. After all, the early astronauts were all veteran test pilots, used to doing all kinds of tricky maneuvers in high-performance jets. However, it turned out that weightlessness was another thing altogether. "With the lack of gravity, they thought could do whatever they wanted about moving their bodies," said Johnson.

He was not surprised that they couldn't, having already concluded that a lack of gravity could very likely make astronauts sick. He was well aware that gravity affected the inner ear; he'd seen patients who were disoriented because of problems with their otoliths and they sometimes experienced nausea and vomiting.

Although Johnson heard from other people that the early crews were experiencing nausea, the astronauts themselves didn't admit this to him. "It was sort of hard on their morale. They were supermen, carefully chosen." (In fact, the first time the problem was openly acknowledged was on Apollo 9 in 1969, when astronaut Russell Schweikart vomited twice. However, there were indications that the problem may have occurred on earlier Gemini flights; one Gemini spacecraft came back to earth with a dark stain on the console that was later determined to be chocolate pudding.

One issue that drove a lot of research into motion sickness in the space program was the search for a test that could predict who would get sick in space. The fact that seasoned test pilots were getting sick in space was the first indication that a failure to experience the malady on earth was no guarantee of what would happen on orbit. "There's a reason for that," said Johnson. "You can't experience weightlessness on earth. There's no way you can duplicate it on earth." The brief seconds of weightlessness that can be created in aircraft flying roller-coaster arcs are not sufficient, he said. "I don't think there's any way you can predict other than actual exposure in space."

Former Canadian astronaut, Ken Money, who worked with Johnson at DCIEM and devoted much of his career to studying motion sickness and vestibular disorientation, was one of those who searched for a predictive test. He commented that disorientation was, and still is, "a big killer of fighter pilots" and, in fact, the leading cause of all fatal fighter aircraft accidents. What was happening to pilots at that time was that a lot of them got motion sick at the beginning of flight training and a lot of them, after a considerable amount of expensive training, failed because of motion sickness. There was an interest in dealing with it efficiently—selecting those who weren't going to make it and getting rid of them early, and helping those who could get over it. I wasn't thinking of spaceflight at the time, although spaceflight was anticipated then."

His involvement with the space program came through Johnson. "Walter Johnson was a world authority on motion sickness. He was invited by the Americans, anticipating motion sickness in spaceflight, to help them make plans for it. Since I was his student at the time, he invited me to go with him."

Money started working part time on a project for NASA that involved altering the vestibular system of monkeys in an effort to understand whether it was the semi-circular canals or the otoliths that were primarily implicated in causing space motion sickness. The plan was to fly the monkeys in space, together with others whose vestibular systems had not been altered; however, the research project fell prey to funding cuts and the monkeys never flew.

It was not until more than a decade later that Money started working with American astronauts in an effort to find a predictive test. The astronauts weren't thrilled about the project because "nobody likes to get motion sickness, in a test or any other way," Money said. "But they had their assignment and they did it. "

Many were, in fact, quite astonished that they could even get sick. Their attitude was that "motion sickness was something that the guys who flunked out of pilot school had," said Money. "Several were surprised they got motion sickness at all, but of course we had fiendish devices that would get anybody sick. My major finding, after a lot of testing, was that there wasn't any ground-based test that would predict with any accuracy at all susceptibility to motion sickness in space, so we stopped doing that."

Like Johnson, he concluded that the space environment was unique. "The stimulus in space is quite different. You don't get prolonged weightlessness anywhere else. You can be quite immune to everything else and still get sick in space."

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Student aircrew in an early decompression chamber

There was another reason for giving up the testing: it was not only unpopular with the astronauts, it was expensive because tests had to be done before, during and after flight. One of the most significant problems was getting accurate reports of episodes of motion sickness in space. The astronauts just didn't like admitting to being sick, Money said. "We were never absolutely sure that we were getting reliable reports." In fact, he learned more about what really went on during informal social gatherings than he did in the formal debriefings. "We'd be sitting around after work, going to the local pub, and they'd get chatting and you'd be amazed what came out. We'd find out that so and so said he wasn't motion sick at all when he was vomiting all over the place. I said, you can't do science like this. I figured it was no use, so basically we gave it up."

There probably weren't a lot of people who were fudging their reports, Money said, but it mattered because he had such a limited number of people to work with. "When you're using small numbers, it only takes one or two to throw an entire experiment out the window. We never did get a test that would predict motion sickness."

The only alternative was to provide astronauts with medication if they feel sick in flight. At one time, Money said, rookie astronauts and those who'd been sick on previous flights were given medication on the ground before launch. This turned out to be a useless strategy. "They were thinking that using the medications was preventing the sickness, but they were only postponing it. They were slowing the normal habituation process to weightlessness, so the astronauts were drugged for two days, then they'd come off the medication and get sick."

As a result, the procedures were changed and now astronauts can take the medication in flight if they feel they need it. "It's up to the individual whether he wants treatment," said Money. "If he figures he can get his job done, they won't impose it on him."

Space motion sickness remains a significant problem that can affect mission operations, especially during the first few days of a flight. This is one reason why many critical tasks, such as spacewalks, are not scheduled during the habituation period. Money estimates that about 90% of all astronauts experience some degree of motion sickness, with nearly a third being sick enough to vomit. "NASA reports that around 70% have some motion sickness, but I think that's low," he said.

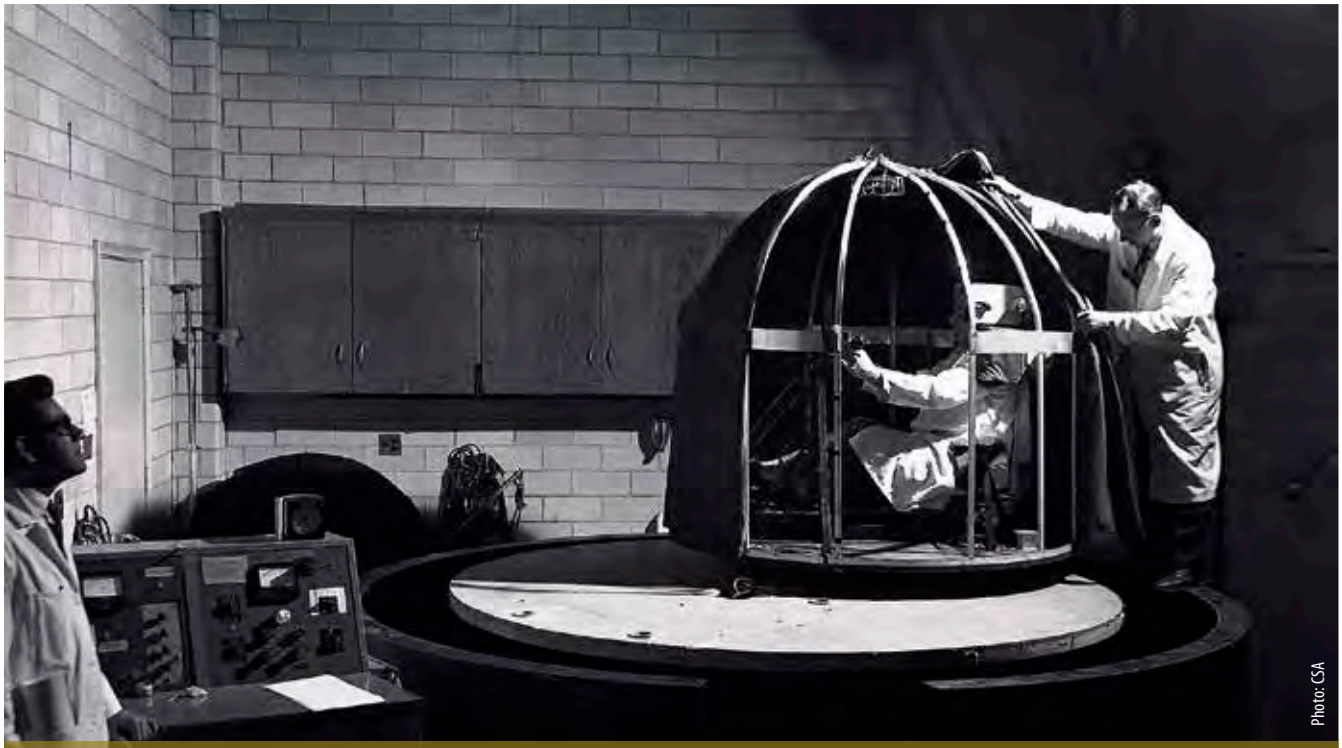

Photo: CSA

The motion sickness rotator, a machine used to produce the symptoms of motion sickness

A Legacy for the Space Program

Much of the research done at the Institute of Aviation Medicine (IAM) from the 1940s to the 1960s had direct relevance to the emerging space program, which had to deal with issues related to pressure and G-suits, oxygen masks, helmets, and even, in the early days, ejection seats

"In the Gemini and Mercury programs, they had ejection seats," said Roy Stubbs, who was invited to conferences to discuss the work he and his colleagues had been doing at IAM. He was even invited to join the team of NASA engineers designing equipment for the space program but he declined, preferring to stay in Canada and continue doing research for the military.

"It wasn't as important as what we were trying to do under NATO," he said. "It was far more interesting for me to do that. We were into our own programs, which were very good. I enjoyed being in Canada and I decided to stay. I never regretted that decision because I felt loyal to Canada and wanted to do what I could there." In recognition of his efforts, he was elected, along with Wilbur Franks, by their peers worldwide to the newly formed International Academy of Astronautics. They were the first Canadians to be so honored.

As for the risks the work entailed, that was just part of the deal, Stubbs said. "We knew there was risk involved, but we thought it would be manageable." And there was a payoff: "It was an exciting time—every step you took was a step forward."

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Editor's note: This concludes the last of a three part series on Canada's pioneers in aviation medicine. I wish to thank the Canadian Space agency for their consent in allowing *Flight Comment* to reproduce their article.

ON TRACK

So you want to fly VFR across the border…

This article is the next instalment of a continuous *Flight Comment* contribution from the Royal Canadian Air Force (RCAF) Instrument Check Pilot (ICP) School. With each "On Track" article, an ICP School instructor will reply to a question that the school received from students or from other aviation professionals in the RCAF. If you would like your question featured in a future "On Track" article, please contact the ICP School at: +AF_Stds_APF@AFStds@Winnipeg.

This quarter's article addresses a recent trend in Civilian Aviation Daily Occurrence Reporting System (CADORS) reporting incidents involving Visual Flight Rules (VFR) and cross-border flight plans. The answer comes from Captain Diana Dillard, United States Air Force, ICP Instructor.

Over the summer, there were at least three incidents reported by CADORS to the Division Instrument Check Pilot regarding VFR cross-border flight plans. They were from different units, flying different airplanes, and transiting between different locations each time, yet they all had one thing in common – the VFR flight plans were not activated.

When crossing a country border under VFR, a VFR flight plan is required. The Federal Aviation Administration (FAA) Aeronautical Information Manual (AIM), the FAA's official guide to basic flight information and air traffic control (ATC) procedures, states the following regarding VFR flight plan activation:

> *5-1-4.c. To obtain maximum benefits from the flight plan program, flight plans should be filed directly with the nearest FSS. Note: some states operate aeronautical communication facilities which will accept and forward flight plans to the Flight Service Station (FSS) for further handling.*
>
> *5-1-4.e. Pilots are encouraged to give their departure times directly to the FSS serving the departure airport or as otherwise indicated by the FSS when the flight plan is filed. This will ensure more efficient flight plan service and permit the FSS to advise you of significant changes in aeronautical facilities or meteorological conditions. When a VFR flight plan is filed, it will be held by the FSS until 1 hour after the proposed departure time unless the actual departure time is received, a revised proposed departure time is received, or at the time of filing, the FSS is informed that the proposed departure time will be met, but actual time cannot be given because of inadequate communications (assumed departures).*

In this instance, one of the occurrences happened under this assumption; the flight was reported to have been conducted VFR with auto-activation at a set time. However, if it is not made clear when filing that the crew wishes to utilize 'assumed departure' procedures due to poor communication capabilities at their location, the FSS may not have understood what was being asked of them. For example, saying "we'll be taking off at 12:00z, so please activate it then" may not be enough, even if it sounds like a clear enough request to most aircrew. Additionally, it benefits you to provide as accurate of a departure time as possible; for VFR flight plans in the United States (US), search and rescue (SAR) efforts begin 30 minutes after your last reported estimated time of arrival (ETA) if you have not closed your flight plan.

5-1-4.f. On pilot's request, at a location having an active tower, the aircraft identification will be forwarded by the tower to the FSS for reporting the actual departure time. This procedure should be avoided at busy airports.

While a control tower may advise the FSS of a departure at the pilot's request, this does not guarantee the tower controller will be able to complete this task. It is entirely possible that the controller could get busy and forget, or could, for whatever reason, be unable to get in contact with the FSS and not be able to pass that information along to you (if you've switched frequency or left their range of communications).

5-1-4.g. Although position reports are not required for VFR flight plans, a periodic report to an FSS along the route is good practice. Such contacts permit significant information to be passed to the transiting aircraft and also serve to check the progress of the flight should it be necessary for any reason to locate the aircraft.

Although the majority of the border between the US and Canada is not considered an Air Defence Identification Zone (ADIZ), be careful in certain areas near the coast; specifically, there is an ADIZ between the US east coast and Nova Scotia. AIM 5-6-1 details additional position reporting requirements for entering the ADIZ.

Lockheed Martin FSS has a website with a number of great tools to assist in VFR flying. There are options to get current weather and airfield information, how-to videos on filing flight plans, flight planning aids, and even a program to enable pilots to activate and close flight plans online without having to call anybody. The website even has services (must register, but they're free) called EasyActivate and EasyClose, which send an email to the user 30 minutes prior to the estimated time of departure for each filed VFR flight plan and 30 minutes prior to your ETA (based on your actual departure time); click on the link in the email, and your flight plan is then activated or closed, based on which email you had received. Visit https://www.1800wxbrief.com for more information.

To summarize, flight plans are required for VFR cross-border flights. File these flight plans with an FSS, and know that if you choose to go through a third party for filing/ activation, just like when playing telephone as a kid, the message may either become skewed or may not make it to the intended party. A best practice would be to file the flight plan, contact the FSS while on the ground (1-800-WXBRIEF in the United States) to confirm/update the times before departure, and then contact the FSS once off the ground or as soon as able to give an actual departure time. If you ask tower to activate the flight plan upon departure, contact the FSS as soon as you are able to confirm activation. As a last resort, very clearly request an 'assumed departure' with the FSS, but this should not be the standard procedure if you are able to avoid it (both for safety/ SAR reasons as well as the reasons this article was written). In any case, it is highly recommended that you do not try to cross a border without first confirming flight plan activation with a FSS!

DOSSIER

THE THREAT FROM
Unmanned Air Vehicle Proliferation

By Major Keith Fugger, Concept Development & Experimentation, Canadian Forces Aerospace Warfare Centre, Trenton

So far, we have been fortunate. What I worry about is the day I have a C-130 with a cargo load of soldiers, and a UAV comes right through the cockpit windshield.[1] – Lieutenant General Walter Buchanan, former United States Central Command Combined Force Air Component Commander.

Whether it intentionally manoeuvred to strike the C-130 mentioned above or not, unmanned air vehicles (UAVs) are presenting a growing threat to Canada and its allies. After decades of superiority in this realm, Western powers are rapidly being forced to consider and react to the emerging UAV-proliferation threat. When they were costly and rare, American UAVs enjoyed the unrivalled honeymoon period afforded any revolution in arms. Indeed, this platform proved itself in combat operations during the first Gulf War, was instrumental in targeting insurgents in Iraq and Afghanistan, and is still feared by Islamists in Yemen. Although each branch of the Canadian Armed Forces (CAF) has accumulated its own experiences with unarmed UAVs, advancements in technology and miniaturization as well as in production efficiencies have resulted in making them accessible to nearly anyone—not just militaries. Also, not everyone is aware of, or intends to respect, established UAV regulations. This is an obvious cause for concern and begs the question: what is the Royal Canadian Air Force's (RCAF's) counter-UAV capability?

Far from being just a theoretical problem, there have been a growing number of airspace incursions by UAVs; perhaps the most notable was evidenced in a video recorded by a UAV which was posted to YouTube by a user named Quadrotor Dragonfly in November 2013. The footage is of an aircraft landing at Vancouver International Airport.[2] In British Columbia alone, between 1 January and 28 November 2014, Transport Canada recorded 15 separate incidents of UAVs that posed a hazard to civil-aviation activities.[3] In response, Transport Canada recently published updated regulations for small UAVs.[4] However, some UAV operators do not know the regulations and, of even greater concern, others consciously choose to ignore them.

To date, there have been no recorded flight-safety accidents involving RCAF manned aircraft and UAVs; however, proven issues within the civilian aviation sector suggest military problems are imminent or have already occurred but have not been observed. Most future military airspace incursions will likely involve inadvertent or careless UAV operators, although it has been established that—sadly—the CAF can also be consciously targeted. The motivation for those within this nefarious sector can involve things as seemingly benign as information collection to disruptive actions as far reaching as aircraft, infrastructure, and personnel targeting.

While Canada may have been lucky thus far, our allies have been dealing directly with this issue for years, with attacks from state and non-state actors possessing UAVs often supplied via proxy forces. Examples include Iran's support to Hezbollah in the 2006 war against Israel and, more recently, in April 2013 when Hezbollah flew Iranian Ababil attack UAVs laden with explosives into Israel.[5] The expendable Ababils, 10-feet (3-metres) long and only 175 pounds (79 kilograms), were detected by Israeli Defence Force radar and successfully shot down by Israeli F16s before they could reach their intended targets.[6] Since Israel is constantly on a high state of alert, they have robust rules of engagement and counter-UAV capabilities. Unlike Israel, Canada is not at a constant state of high alert; however, the core ideology which plagues much of the Middle East is slowly manifesting itself throughout the West, suggesting at least embryonic concerns are on the horizon.

With pockets of criminality and terrorism already established within Canada, what will happen when smaller, cheaper UAVs—some the size of birds—that fly slowly and close

to the ground under radar coverage yet are capable of day/night intelligence collection begin affecting RCAF operations? The psychological and physical impacts resulting from a terrorist or criminal attack using a slightly larger UAV fitted with several kilograms of high explosive, or chemical or biological agents, would be even more catastrophic, especially if it occurred on home soil. What should the RCAF do to counter such threats?

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This USAF C130 *Hercules* was heavily damaged in Aug 2011 when it collided with a RQ-7 Shadow UAV in the skies over Afghanistan. Despite the relatively small size of the UAV, it damaged both left-hand engines, tore through the leading edge of the wing and punctured the fuel tank.

Deconfliction and Integration

The Duties of a Joint Terminal Attack Controller

By Capt S.B. Johnson, Joint Terminal Attack Controller, 2nd Regiment Royal Canadian Horse Artillery, Petawawa

Prosecuting targets, conducting Intelligence Surveillance and Reconnaissance and controlling helicopter extracts are just a few tools a Joint Terminal Attack Controller (JTAC) can bring to the fight.

All of these items were on display at Garrison Petawawa on 16 October 2015, when JTACs from the 2nd Regiment Royal Canadian Horse Artillery provided a realistic demonstration of their ability to integrate several different types of aircraft within a complex scenario for the leadership of the 2nd Canadian Mechanized Brigade Group.

Within the scenario, the JTAC had two *Alpha Jets*, a *Raven* Miniature Unmanned Aircraft System (MUAS), and one CH146 *Griffon* helicopter on station. There was also ongoing live M-777 artillery fire and the cloud deck was at 3,000 feet, just to complicate matters further. All this inside the Canadian Armed Forces most active and complex chunk of airspace.

As part of his deconfliction plan, the JTAC had the *Griffon* operate at 500 feet above ground level (AGL), the *Raven* operated at 1500 feet AGL, and the *Alpha Jets* operated between 4,000 – 6,000 feet above mean seal level (MSL). This deconfliction plan kept all air players safe and prepared to affect the battle.

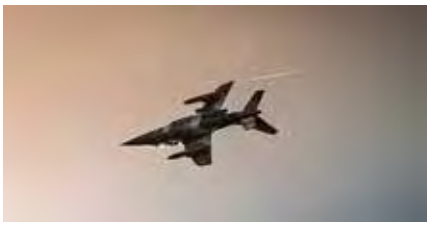
The dismounted JTAC was attached to a reconnaissance (recce) patrol, and were attempting to gain observation of a high value target within a built-up area. In order to identify the target and gain information regarding the pattern of life within the village, the JTAC worked collaboratively with the *Raven* MUAS Detachment. This enabled the JTAC to gain timely information about the target area, while also keeping the jets safe, and ensuring the target was not aware of an imminent air strike.

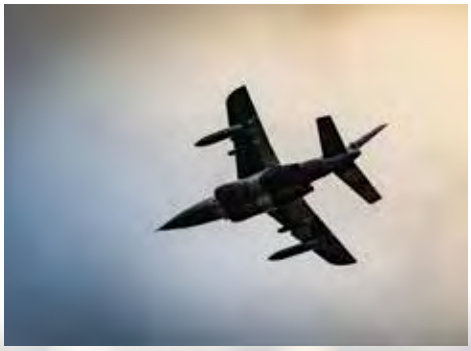
Once the target had been identified through the *Raven* MUAS live video feed, the JTAC was able to conduct a strike with the *Alpha Jets*. Due to the fact that the target was centrally located in the build-up area, the JTAC decided to use precision guided munitions in order to minimize the effects of collateral damage. Given the weather conditions and the cloud deck at 3,000 feet MSL, the *Alpha Jets* completed a low-level attack. This forced the JTAC to conduct dynamic deconfliction, sliding the MUAS West and pushing the *Griffon* south to a hasty battle position.

Following the strike, the JTAC brought the *Raven* overhead to conduct a Battle Damage Assessment. Again, the use of the MUAS provided real-time information to the JTAC and the ground force commander while keeping the attacking aircraft at a safe distance from the target area.

The initial CAS strike triggered the enemy quick reaction force, and the JTAC and recce element took effective enemy fire from within the village. To facilitate their extraction, the JTAC used a single CH146 *Griffon* helicopter from 427 Special Operations Aviation Squadron. The *Griffon* was able to provide continuous suppressing fire on the enemy location, as the JTAC and recce patrol were able to withdraw and secure the extraction site. Once contact was broken with the enemy force, the JTAC conducted a hurried helicopter landing site brief to bring in the Griffon and extract the friendly forces.

The safe deconfliction of airspace and the integration of all fires and effects in support of ground forces is always the JTAC's priority. This excellent demonstration of complex air land integration and deconfliction with multiple air players inside high intensity airspace showcased what can be accomplished in a joint training environment.





Photos: Aaron Nicholson

DOSSIER

UNMANNED AIR VEHICLES: WHERE DO WE STAND?

By Major Pete Butzphal, Deputy of Promotion and Information, Directorate of Flight Safety, Ottawa

The proliferation of drones, otherwise known as unmanned air vehicles (UAV), in our skies has been a hot topic of discussion within many a pilot's lounge and news report. Agriculture surveys, cinematography and film and police investigations are the "leading and most mature market applications of UAVs in Canada"[1] says Transport Canada (TC). From the numerous close-calls with commercial traffic and the wanton disregard towards the safety of firefighting aircraft witnessed in British-Columbia this past summer, UAVs are attracting the attention of much awaited regulation. The following is a brief overview of where we stand.

Current framework

Unlike the United States (US) Federal Aviation Administration (FAA), TC has adopted a permissive regulatory framework to safely integrate UAVs into Canada's airspace. This is being achieved through the issuance of Special Flight Operation Certificates (SFOC). To allow for safe operating practices, the *Canadian Aviation Regulations* categorizes UAVs into the following:

- Model aircraft: Aircraft of which the total weight does not exceed 35 kg that is mechanically driven or **launched into flight for recreational purposes**. That said, for large model aircraft with a maximum take-off weight of over 35 kg requires an SFOC
- UAV: Considered a power-driven aircraft, **other than a model aircraft**, that is designed to fly without a human operator on board and is required to operate in accordance with an SFOC.

This current structure allows TC to make the distinction between recreational and non-recreational operations. According to TC, the SFOC process has been an effective way for them to accommodate UAV operations in Canada, while at the same time assess the risks of individual UAV operations on a case-by-case basis.

This is in contrast to the Unites States' current regulatory process whereby at present, it has imposed a widespread ban on commercial drones altogether. That said, the FAA has provided limited use on non-recreational UAVs through the issuance of special airworthiness certificates. These certificates have so far been issued mostly to government agencies such as law enforcement, firefighting, border patrol and search and rescue flights. This reluctance towards issuing such certificates has led at least one US commercial operator, Amazon, to look north of the border to apply for and be granted an SFOC to test their *Prime Air* future delivery systems. As of December 2014, Amazon has been carrying out test flights of parcel delivering drones at an undisclosed location in Southern British Colombia.

US framework at a glance

In February 2015, the FAA presented a plan that would outline rules to govern operations of small unmanned aircraft systems (UAS) weighing less than 25 kg. In a Notice of Proposed rulemaking, the proposed rules were "intended to allow the routine use of certain small UAS [UAV] in today's aviation system while maintaining flexibility to accommodate future technological innovations".[2] The FAA accepted public comments up until April 24, 2015.

One of the proposed rules includes line of sight operation. Under this rule, the operator will be required to maintain a "constant visual contact with the aircraft".[3] The operator would be allowed to work with an observer, but this is not a requirement. Small UAS would equally be limited in use throughout daylight hours only.

> ***"The FAA proposal to label the operator of small UAVs as 'operator' is in stark contrast to Canadian regulation whereby 'UAV users are considered pilots and as such, are legitimate airspace users'."***

Other restrictions would include that the operator assess meteorological conditions, airspace restrictions and location of personnel to lessen the risks should the operator lose control. Much like general aviation, operators would equally be required to conduct pre-flight inspections on their equipment to ensure proper working order.

The FAA proposal to label the operator of small UAVs as 'operator' is in stark contrast to Canadian regulation whereby "UAV users are considered pilots and as such, are legitimate airspace users."[4] A US 'operator' would be required to be at least 17 years of age, pass an aeronautical knowledge test and obtain a UAV operator certificate from the FAA.

Anyone could be watching you

A lot of attention has been given towards the dangers of UAV operation at or around airports (or in and around a community-threatening forest fire), and rightfully so. However, an equally pressing matter is the question of how to ensure privacy laws are respected as we move forward throughout the regulatory process. "UAVs are quite frequently compared to other forms of video surveillance or aerial surveillance using manned aircraft; however they also present unique privacy challenges due to their unique abilities and flexibility in the way in which they may collect personal information, ranging from acute and persistent tracking of individual activities to systematic surveillance of a wide area."[5] What is worrisome

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is that these capabilities are no longer apportioned under the control of government/ municipal agencies but now any citizen, who is willing, can purchase a UAV from the nearby mall and accomplish the same feat – with little oversight.

The Office of the Privacy Commissioner in Canada assures us that "in terms of the current situation in Canada so far, there has been no indication that drones are being used for general surveillance or to gather personal information. However, Canada's privacy laws will apply to UAVs deployed by public or private sector organizations to collect and/or use personal information. Essentially, UAV operations that involve the surveillance of Canadians or the collection of personal information are subject to the same privacy law requirements as with any other data collection practice."[6]

"What is worrisome is that these capabilities are no longer apportioned under the control of government/municipal agencies but now any citizen, who is willing, can purchase a UAV from the nearby mall and accomplish the same feat – with little oversight."

As much as we are assured that Canadian privacy laws will apply to the UAV industry, the worry remains that such policy enforcement could be left hanging as"... aviation regulators believe they do not have direct authority to regulate privacy issues for UAVs. For example, the FAA states that their mandate is to regulate civil aviation to promote and improve the safety and efficiency of flight in U.S. airspace."[7] Interaction between policy makers will be essential in this regard.

Conclusion

The aforementioned framework is a start, but it is plain to see there is still a lot of work ahead for the regulators. The proliferation of UAVs in society today by virtue of their low cost and ease of use has kept regulatory process on its toes in a bid to keep up.

In terms of general safety, education, and a lot of it, will be the key. TC for their part has taken steps in that matter through the launch in October 2014 of a national safety awareness campaign for UAVs with the aim of helping Canadians better understand the risks and responsibilities of flying UAVs.

"When it comes to the privacy implications of drones, a lot will depend on who is using them and for what purposes, the context and location of their use, the type of technology mounted on them and the extent and type of personal information that may be captured. As drones are acquired and put to use in Canada's public and private sectors, it will be important to circumscribe their use within an accountability structure that ensures they are justified, necessary and proportional, and that the necessary checks and balances fundamental to a democratic society are in place to stave off proliferation of uses, abuses, and function creep."[8] UAVs are here to stay and this will require that government departments work alongside one another in ensuring that a smooth, safe and responsible use of these devices ensues in our skies.

References

1. Transport Canada, "Notice of Proposed Amendment (NPA): Unmanned Air Vehicles" Canadian Aviation Regulations Advisory Council Reporting Notice #2015-012 (May 2015)

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6. Ibid.

7. Ibid.

8. Ibid.

Transport Canada recently released this flyer to help curb negligent use of unmanned aircraft including respecting concerns over privacy.

Transport Canada Transports Canada

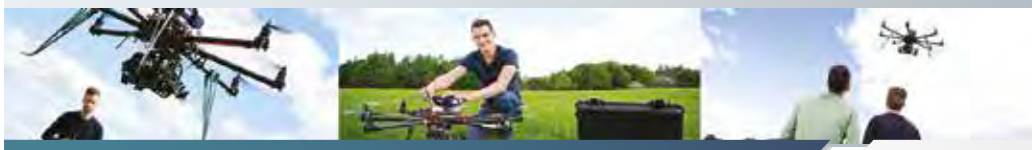
You're responsible to use your unmanned aircraft safely and legally

Always:

- Fly during daylight and in good weather (not in clouds or fog).
- Keep your aircraft in sight where you can see it with your own eyes.
- Make sure your aircraft is safe for flight before take-off.
- Know if you need permission to fly and when to apply for a Special Flight Operations Certificate.
- Respect the privacy of others – avoid flying over private property or taking photos or videos without permission.

Do not fly:

- Closer than 9 km from an airport, heliport, or aerodrome.
- Higher than 90 metres.
- Closer than 150 metres from people, animals, buildings, structures, or vehicles.
- In populated areas near large groups of people – such as beaches, sporting events, outdoor concerts, festivals, or firework shows.
- Near moving vehicles – avoid highways, bridges, busy streets or anywhere you could endanger or distract drivers.
- Within restricted airspace, including near or over military bases, prisons, and forest fires.
- Anywhere you may interfere with first responders.



tc.gc.ca/safetyfirst

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PANIC!

By Collin Fraser

Mr. Fraser has flown for over 35 years in many types of aircraft, at all levels of civil aviation, across Canada and abroad. Mr. Fraser flies with a major airline and contributes regularly to *Flight Comment*.

All of us in aviation are well trained for normal operations. We are also thoroughly drilled for the abnormal events and emergencies that can disrupt our enterprise. Training doesn't pretend to cover every conceivable eventuality, but the stated objective is to leave one equipped to figure out most things, as needed.

Aviation really does involve risk to our precious lives, not to mention someone else's expensive machinery. Accordingly, we approach our challenges to safe and efficient flight operations with careful preparation. When we do engage with our task, we have confidence in our tools and our procedures.

We also have confidence in ourselves. You will have noticed the title of this article. Maybe you wonder how the notion of panic could ever fit into the thinking of trained and alert aviators. Surely, if trouble starts, we will stay cool and power through!

As we are all technocrats of the 21st century, 'panic' is perhaps too primal a word for us to deal with comfortably. Panic sounds so chaotic and unlimited. Let's agree to move on to the new term infiltrating the training literature: 'startle factor'. Startle sounds more precise, less raw. We'll see.

Science informs us that humans react strongly to life-threatening surprises. Some of that reaction *is* truly primal: most of us have had such a scare that we have experienced an instant and massive surge of adrenaline, a singular focus on the subject of threat, and the powerful urge to 'fight or flee.' When dealing with a big set of hostile teeth, trusting our animal reactions might be appropriate. In aviation, unless the call is "Break Left!" our most effective response to a sudden threat is usually somewhat complex. In every case, there is the startle factor to deal with; those first few moments as the realization of your emergency first engulfs you.

The fundamental point of this article is that when a *real* emergency occurs, it is nearly always a huge surprise.

My second main point is that no primate pilot is immune to startle factor. If, for instance, a bear shows up at our campfire, or our flying machine goes boom, we *all* spike on adrenaline. Our discussion today is about having and managing the initial urges of p..., I mean startle.

Continuing with flying as an example, pilots are trained to manage engine failures, with very heavy emphasis on the most critical situations. In reality, engine failures are extremely rare. Many pilots will retire without having had one. Those engine failures that do occur have a far more random distribution throughout phases of flight than training leads one to expect.

Given that pilots are obsessively trained to guard against engine failure emergencies, which are events that actually occur very seldom, and then at unexpected times, we could reasonably think that any *real* engine failure would be simultaneously perceived as both a complete surprise, and a serious personal threat. Startle factor time!

If we take a look at three recalled incidents of engine failure, maybe we could extract useful information, or at least some thoughts, on how startle factor could affect us personally.

In the first case, I was a very new co-pilot on the turbo-prop twin. The captain was hand-flying a climb in cloud. It was my job to monitor the engine temperatures and trim the throttles to stay within limits. In an instant, one engine temperature started shooting up. The captain had felt asymmetry in the controls, and before I could move, he closed the throttle on the overheating turbine. The temperature continued to rise, and the captain then shut off fuel to the malfunctioning engine. Only then did we two pilots start communicating: I was used to run checklists.

The type of failure was beyond my training or experience, and while I recognized the anomaly, its unfamiliar nature slowed my reaction and, interestingly, lessened my peak alarm state. The captain then acted so quickly and arbitrarily that I was busy playing catch-up and had no real opportunity to fully absorb the nature of the threat. My reaction was spread over time, and while I did wake right up, I did not have any adrenal overdoses to work through.

It seems, on reflection, that the captain might have experienced a sharp enough mental jolt to cause him to revert to single-pilot thought and action.

Another time, I was co-pilot, hand-flying a descent in cloud, when an engine fault light came on. The captain was reading back a clearance from traffic control, and did not at first notice the annunciator.

The short delay in accessing my partner's attention gave me time to appreciate the possible implications of the fault, which were abnormal enough to be alarming. Then I had a powerful surge of adrenaline like never before. I felt electrocuted, unable to speak or move! If a bite was coming, why was I freezing up? Then, that fraction of time was past: my focus widened up, there was an aircraft to control, a mandatory exercise to initiate, and breathing to resume. By the time my shaking hand had pointed a finger at the fault light, my voice had returned.

"Number 2 Chip Light, Carl."

Carl turned his head to look straight at the light. I couldn't see through his sunglasses, but his neck locked tight. For one second. I asked for the checklist, he got it out, and we ran it. Then captain Carl discussed his thinking with me. He elected the option of us shutting down the suspect engine, and directed me to land the aircraft while he monitor the big picture.

Our situation, an elective inflight engine shutdown, was not technically an emergency. Even so, I believe that both of us pilots had an encounter with startle factor. We each absorbed an overwhelming shock, and took a similar brief moment to reframe our reaction, from fending off the fangs into something more useful to an intrepid modern aviator.

Continued on next page

In the third instance, finally I was captain. But never mind me. My partner was flying the autopilot climb, and I was storing my departure charts. Our trusty airliner gave a tremendous BANG, and began a deafening shriek of mechanical agony. The whole airframe was suddenly vibrating so hard that we could not read the instrument panel. None of this behavior had been mentioned in training.

My nervous system went bang, too. I had to raise my head to see what was happening, and I thought my eyeballs were going to pop out with the effort to seek information. They didn't. My brain felt struck by lightning, but I quickly formulated a desire to gain an understanding of the situation and begin a team effort to mitigate our difficulty. Still, I needed a moment. I said, "What the hell was that?"

My partner was quiet, trying to make sense of it all, I supposed. The screaming vibration slowed and stopped. The airplane attitude was starting to twist as the autopilot was reaching its limits. Nothing really good was happening, so I took control, disengaged the autopilot, pitched down some, and fed in rudder to straighten us out. It felt like a problem with our left engine.

Our instruments, having survived the shaking, told the story: no power, no oil pressure, no anything. Well, the propeller was windmilling, now a source of drag rather than thrust. "Confirm Number 1 Engine Failure." My partner remained silent. I looked at him. He responded, "Yes."

I called for the emergency drill, it being composed of the first two or three key teamwork actions, which are memorized. I began to notice that my partner was lagging and seemed uninvolved. I placed my hand in the guard position for the first control actuation, and he began participating.

Following the drill, it became apparent that our initial attempts to secure the damaged engine had not been entirely successful. One gauge did not match expectations, so I looked out the window. "Hey, that thing is still turning out there."

Fortunately, we had an alternate procedure. I said, "Let's use the alternate procedure."

The backup switches were located ahead of my partner's knee, not a location where I could comfortably reach, and not at all while hand flying the aircraft. The two switches were set close beside each other. Flipping one meant trouble all gone. Selection of the wrong switch meant destroying our one operating engine, followed by a world of hurt.

Our team discipline for these critical scenarios is for one pilot to put a finger on the control intended for actuation and verbally request confirmation that the selection is correct. The other pilot observes the physical indication, considers its validity, and verbally responds. All of that happens before we make any vital and irrevocable changes to the aircraft.

So far, we had run our drill just that way: "Confirm... etc." Now, my partner reached for the switches only inches from his hand. He did not lead with a fingertip, but with a pinch grip. I was watching, because I knew this was important. My partner aimed straight for the wrong switch. This was a mistake that must not happen. I reached out myself and wrapped my partner's forearm with my hand. I apologize if my fingerprints are still there.

"I think we should secure Engine 1," I offered. And so we did.

Unlike my first two incidents, this time there was a debriefing. My partner and I agreed on the course of events concerning the aircraft. We discussed that he had misidentified, and was perhaps going to impulsively actuate, a critical control switch. He said that he had been very stressed by the sudden violence of the engine failure. He felt he had not focused well for some time thereafter, that he was reacting to my lead, and was flustered when our primary drill had revealed a secondary failure. He did not remember how he had decided on one switch or the other. He was aware of the implications of his possible error, and was mortified both as a pilot and as the fine man I knew him to be. There was no mention of big teeth.

I pointed out the obvious: you can't fault success, and here we were chatting in the office after an interesting flight. I told my partner that I thought the incident offered numerous learning points, valuable to us and to our training establishment. I closed by saying that I understood how much he regretted his mistake, and that he would always be forearmed against that sort of trap, to the benefit of all his future crewmates, myself included.

My partner and I did not thoroughly explore his mental functions. Thinking about it later, I realized that his level of surprise was most definitely maxed out. Mine sure was. Plus, we were at the edge of our training envelope.

I believe that, like anyone, the first blast of adrenaline overrode his mind, and that he was pre-occupied by struggling with that overwhelming state. When I began demanding considered thought and action from my partner, he was not yet available.

The intensity of my own experience had been even *more* than any previous time. During the split second that it seemed the airplane might be exploding, I thought I might, too. Having priors did nothing to lessen a very nasty scare. What experience did provide me was sure knowledge that the wave quickly passes, and that taking an extra breath before plunging ahead can provide time to come up with an actual plan.

So, within our vast sampling of real engine failure incidents, there are some interesting themes and variations. The startle factor reflex seems common to us humans. The urge to jump normally changes, very quickly, to intense awareness and peak responses. Sometimes, however, the initial shock seems to lock or drag on, to the detriment of crew function. Also, previous emergencies do not lessen subsequent adrenal reactions.

I think that anyone with experience of a real emergency has an advantage. They have gained the chance to learn their own initial reaction to a sudden fright. Having ridden the wave before, one has a better likelihood of quickly returning to effective performance. Maybe you already have your own version of my clever delay question.

I hope it is possible that one airman's honest discussion about the effects of panic, I mean startle factor, can put all of us a step ahead next time we face the teeth.

The Voice of INEXPERIENCE

By Warrant Officer Al Wallace, 431 Air Demonstration Squadron, Moose Jaw

Not all flight safety incidents are the result of mechanical failures. Sometimes it is just plain lack of experience to blame, but not in the way one would think.

In the late 1990's when I was a recent occupational transfer from the Navy, I found myself working in the 19 Air Maintenance Squadron avionics shop. Back then I didn't know what the acronym 'FOD' (foreign object debris) stood for or anything about the Canadian Armed Forces Flight Safety program.

I noticed shortly after my arrival in Comox that there was a potential FOD issue with some of the needle nose pliers we were using in our tool kits. There was a small spring between the handles which increased opening tension for ease of use. The problem was that the spring was just held in by the coil pressure and could easily be removed, or worse, pop out and end up on the inside of an electronic unit without anyone noticing. I checked the different tool boards and found that there were many tools without its spring. It was impossible to tell if any of the missing springs were accounted for because there wasn't any documentation that specified the technicians to look for one.

I brought this to the attention of my supervisors right away but they blew it off with the knowledge that those pliers had been in use for years and had never been a problem before. I was told that "...the pliers had been in use and useful a lot longer than I had been" and that my job was "to learn and not to cause waves". Accepting that my chain of command had rank and experience beyond my own, I let it go and didn't bring up the subject again.

Fast forward fifteen, yes fifteen years later. I was reading through recent flight safety incidents and came across an one involving the very same spring from the very same pliers which had ended up shorting out electronic components on the inside of a radio receiver. The result was that all pressure fit springs were ordered to be removed from all pliers at that time.

Had I followed my instinct and forced the issue back when I was in the avionics shop, it would have been corrected then and there and this flight safety incident I was reading about would never have happened. Unfortunately, I just didn't have enough experience or confidence to follow my instincts.

You can't count on ever being able to have a second chance to take the right action. Trust your instincts and never let rank or experience deter you from doing what is necessary to promote airworthiness and keep personnel and equipment from harm.

Don't discount an observation because of who it came from or because you failed to notice it yourself. Flight safety is the responsibility of every person and should always take centre stage in our minds, in our workplace and in our training program. Sometimes a fresh set of eyes is what it takes to see the obvious.

Photo: Operation Impact, DND

Things are not always AS YOU EXPECT

Photo: Canadian forces combat camera

By Captain Justin King, 425 Tactical Fighter Squadron, Bagotville

As professional aviators, we use checklists in our job to remove variability from complex tasks we carry out on each flight. Furthermore, we memorize checklists verbatim to react appropriately to known emergencies. Under stressful conditions, an emergency dealt with improperly can have drastic consequences. In simulators, we train to react swiftly to specific emergency situations, executing a checklist most of the time in an unconscious manner, often stating that we can execute that red page in our sleep. However, it can also lead professional aviators into a potential trap. I pose the question, "How would you react when the emergency presents itself in a manner which conflicts with your automatic response? When you receive conflicting information and no single checklist makes sense to solve the set of variables that you are experiencing, what then?"

One day, during my first tour on the CF188 *Hornet*, I was on a flight returning to base. I had some extra fuel remaining so I decided to do some additional night training before landing. Just then, I received a master warning. My displays showed that both the left and right bleed air systems had disengaged. I quickly executed a recovery to a wings level state and started to assess my situation. The indications I had were not what one would expect: a bleed air leak emergency with both the left and right bleed air systems disengaging and with no indications of fire. There is no checklist emergency response for BOTH bleed air systems simultaneously shutting off. It was 10 o'clock on a Sunday night. I had no other pilots with which to communicate on a common frequency. I assessed the problem as a system fault and cycled the bleed air. Instantaneously they kicked off again with the same aural cautions. I found myself becoming extremely confused at 20,000 feet, at night and entirely alone. My heart was pounding and my mind was racing. I took a moment to assess the situation and I diagnosed that while I did not have all the indications, I could still potentially be in what is considered a dangerous situation: a dual bleed air leak causing an overheat in the system. This could potentially lead to a catastrophic fire and ejection. Confused and still not grasping what was happening with the system, I decided to execute the response for the worst case scenario and treat it as though I was in the premature stages of a dual bleed air leak. I declared an emergency, executed an approach, landed, took the arrestor cable, shutdown the engines and egressed on the runway; all without incident.

Returning to work after a long night of trying to figure out what had happened, I was greeted by the engineering officer who told me after inspecting the aircraft that they had found evidence of a bleed air leak and an overheat condition. It was in an area where the left and right engine bleed systems merge together and thus, the reason for both systems kicking off. However, it hadn't become advanced enough to initiate the fire warning system.

This experience clearly showed me that unconscious execution of emergency checklists to standard practiced emergencies is imperative. However, I also realized that it is necessary for pilots to continuously stay sharp on all aircraft systems. We must be able to think quickly and diagnose complex emergencies that do not show up as your typical 'garden variety'. When I reviewed my tapes of the flight the next day I was shocked. So much of my mental energy was poured into assessing what was occurring. In doing so my flying had become sloppy. It proved that confusion in the cockpit can drastically affect the pilot's ability to make sound decisions. Staying sharp on aircraft systems knowledge as well as the correct execution of critical checklists will ensure your greatest chance of success at getting safely back on the ground!

Horns and *ice*

By Captain Bryn Evans, 442 Transport and Rescue Squadron, Comox

In the early spring of 2015, I, with less than a year as an Aircraft Commander flying with a brand new Air Combat Systems Officer and a First Officer (FO), learned a valuable lesson about respecting Mother Nature. Over the course of a one hour flight, a benign electronic search turned into one of the most serious emergencies experienced by a CC115 *Buffalo* Search and Rescue (SAR) crew in recent memory.

We were tasked at 01:30 local time by the Victoria Joint Rescue Coordination Centre (JRCC) to track an Emergency Locater Transmitter (ELT) being picked up by other aircraft operating near Abbotsford, British Columbia. There was a cold front rolling in from the Pacific Ocean with associated nasty weather, but over Vancouver and Abbotsford at the time there was nothing of note. The icing was a potential issue over Comox and was rolling in from the west but was capped at 16000 feet and assessed as moderate. The *Buffalo* is an aging bird with vulnerabilities to icing; the aircraft operating instructions state that flight in icing is not recommended. However it also states that the *Buffalo* is certified for flight in icing, and due to the nature of our SAR operations it is routinely operated in as such.

The plan was simple: JRCC wanted us to proceed directly to the Abbotsford area at as high of an altitude as possible and locate the ELT. Normally when icing is an issue we climb over Comox and assess if it is safe to continue, but with the worst of it forecast to be over Comox we elected to depart immediately eastbound and get ahead of and above the weather. Several delays due to serviceability pushed back our departure time and the weather began to roll in, with rain starting to fall in Comox. We pressed on and departed to the east. Due to delays we were no longer ahead of the weather but rather immediately in it. The plan was still sound based on the information we had: we would either get ahead of it enroute or get above it. Roughly thirty minutes into our flight, Environment Canada would issue a heavy rainfall warning for towns all along our route. We were flying into an icing nightmare that hadn't been forecasted.

Initially our icing was assessed as moderate and of no great concern. The de-icing equipment was working as advertised and we weren't planning on staying in the ice for very long. As we climbed through 12,000 feet our first problem became apparent. The plane had engines that were just barely making their minimum charted power and our climb rate was dropping dramatically. We turned off our environmental control system and bled back the speed to expedite the climb. Through 15,000 feet we entered a pocket of severe clear icing. In perhaps two minutes our icing situation

went from somewhat annoying to very serious. Just below the forecasted top of icing (16,000 feet) we were forced into a snap decision: Press a little bit further to get above the ice, turn back or descend back through the ice and knock off the mission. We continued, taking emergency power to further expedite the climb and discovered upon arriving at 17,000 feet that we were still in heavy icing with a terrible rate of climb. The decision was easy at this point; we would knock it off and descend as quickly as possible to below the freezing level to take care of the situation.

Levelling at 17,000 the situation became dramatically worse. My FO, the pilot flying, calmly brought to my attention that he couldn't level the aircraft. He was fairly new to the plane so I smiled and took control to show him how. I also couldn't level the aircraft! The elevator was in a stuck position and we were trapped in a plus or minus 500 foot, 20 knot oscillation. The elevator horns (located on the outboard edges of the elevator) are designed to aerodynamically assist the pilot in moving the elevator; however, they are not de-iced on a *Buffalo*. It's a design flaw that has been rectified on subsequent De-Havilland aircraft. It's a flaw unfortunately that no-one on the crew was aware of up until this point. At first a tail-stall was feared, another vulnerability of the tail design, but fairly quickly it was established that ice was impeding the movement of the elevator. An emergency was declared and a vector for descent was given by air traffic control. Reduction of power along with firm pressure on the yoke got our descent going and after a few stressful minutes we got below the freezing level at which point the ice broke off and we landed without further incident.

We were very fortunate to come out of this unscathed. Many *what-ifs* came up after the fact, such as what if there was no possibility of going below the freezing level. The incident will be much discussed at the squadron for years to come. All the aircrew have gained a new respect for local weather patterns and *Buffalo* vulnerabilities to icing. I've gained even more respect for Mother Nature, and have learned that sometimes when a plan isn't working out, knock it off early, while you still can.

Photo: DND

Flight Safety and the Raven B Miniature Unmanned Arial System

By Corporal J.A.G. Boisvert, 12e Régiment blindé du Canada, Valcartier

The Canadian Armed Forces (CAF) has recently purchased a new Miniature Unmanned Aerial System (MUAS) named the *Raven B* to replace *Maverick* MUAS. The *Raven B* is the CAFs new hand launched MUAS capability. Presently only six units possess the *Raven B* systems, and training to master their employment has become a major focus for these units. This new capability brings many advantages to accomplish the Land Force (LF) Intelligence, Surveillance, Target Acquisition, and Reconnaissance requirements.

The 5th Canadian Mechanized Brigade Group was recently charged with conducting one of the first exported serials of the MUAS Detachment Commander Course from the Royal Canadian Artillery School. During the student evaluations a recurring incident, in which the *Raven B* would over roll and stall, causing a crash while in Navigation Mode (autopilot) was identified.

The *Raven B* is not a traditional aircraft, however, is controlled under to the same laws and regulations as any other aircraft in the sky. For example, if a *Raven B* where to crash it must be reported to the unit Flight Safety Officer (FSO) in accordance with prescribed standards. Therefore the course staff rapidly informed their FSO of this recurring incident.

Having contacted the FSO and talking with other units who also employ the *Raven B*, it was discovered that this was not an incident isolated only to the course. Within two days of the crashes, an e-mail from the controlling authority at National Defence Headquarters was transmitted. This urgent message stated that all *Raven B* MUAS were to be grounded do to a suspected fault in the aircraft's autopilot programming until a fix could be released.

In conclusion, had Flight Safety regulations not been followed in the event of these crashes this critical fault would not have been identified for repair. The non-identification of this fault during training could have had serious ramifications for all units employing the *Raven B*, as more systems would have been lost either in training or operations abroad.

Photo: Corporal Genevieve Lapointe

From the Investigator

TYPE: CT114058 *Tutor*
LOCATION: Moncton, NB
DATE: 25 August 2015

A Snowbird aircraft was diverted from the rest of the deployed team due to an in-flight emergency. The aircraft was repaired, including a successful maintenance flight test, and was refuelled for a later departure to re-join the Snowbird team. The aircraft tire was due for its 7-day inspection/refill and nitrogen tanks were borrowed from a local facility to service the aircraft. While topping up the right hand main tire with nitrogen, the tire was over pressurized and exploded. The force of the explosion seriously damaged the right hand main landing gear leg, the wing rear spar and the split rim was propelled into and crushed the right hand diesel tank. The aircraft sustained "Category B" damage, primarily due to the damage in the wing spar. There were no injuries resulting from this occurrence.

The investigation determined that the technician misinterpreted the gauges on this unfamiliar equipment, and attempted to fill the tire to 150 Bars instead of 150 pounds per square inches (PSI). The wheel/tire assembly failed around 120 Bars (over 1700 PSI). The investigation is focussing on the human factors aspects surrounding this occurrence.

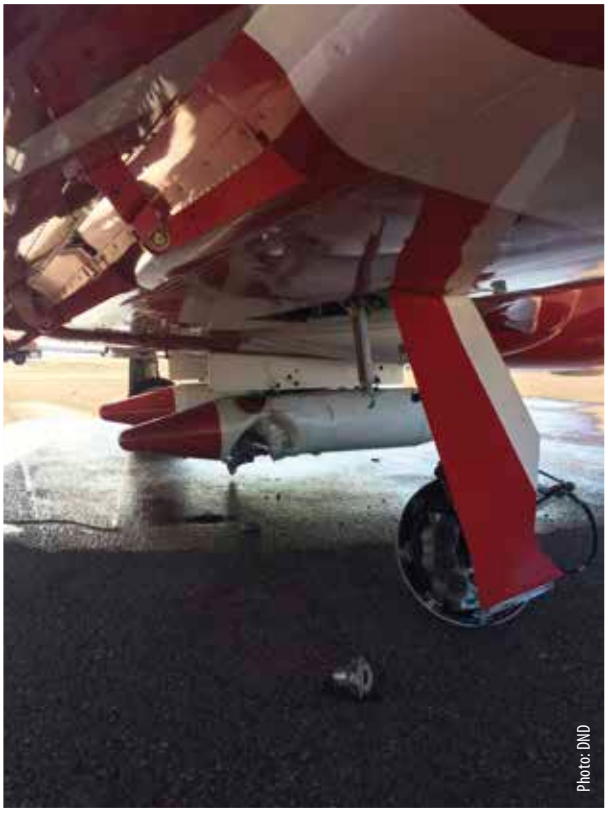
Photo: DND

From the Investigator

TYPE: CP140103 *Aurora*
LOCATION: 14 Wing Greenwood, NS
DATE: 27 August 2015

The CP140 Aurora was taking off from 14 Wing Greenwood, Nova Scotia, on a transit mission to Iqaluit, Nunavut, in support of Operation *Qimmiq*. Thunderstorms had recently passed over the airport and the ground surfaces were wet. During the takeoff roll, the crew observed a flock of birds heading towards the runway. Seeing a conflict and concerned about the risk of collision, the aircraft commander directed the pilot flying to abort the takeoff. During the abort procedure, when the pilot flying selected full reverse on all four propellers, both propellers on the left side of the aircraft went into full reverse; however both propellers on the right side of the aircraft continued to produce some forward thrust. The crew was not successful at keeping the aircraft on the runway and it departed off the left side of the runway approximately 1000 feet before the end. The propellers contacted a Runway Distance Marker and a Precision Approach Path Indicator (PAPI) light. The aircraft plowed through the soft earth and the nose gear collapsed, causing the inside propeller on the right side of the aircraft to strike the ground and break away from the engine. All personnel on board exited the aircraft safely and only minor injuries were incurred.

The investigation is focussing on a combination of factors, both human factors and technical, including the weather, the take-off abort procedure and the propellers' pitch control mechanism. The possibility of reverted rubber hydroplaning is also being examined.

Epilogue

TYPE: SZ2-33A
LOCATION: Picton, ON
DATE: 13 August 2014

This mission was the Cadet Pilot's (CP's) first flight of the day, and 6th solo flight of the Cadet Glider course. As per the Air Cadet Gliding Program Manual the tow rope the tow rope was inspected prior to launch by the Glider Hook-Up Person as well as the CP. The glider was pulled aloft by a tow plane from runway 28 at 1039 (L). The flight called for a tow to 1500 feet above ground level (AGL), but climbing through approximately 230 feet AGL, the tow rope broke at the glider tow ring.

The CP immediately turned back towards the runway to conduct a downwind landing on the runway. The CP landed hard, which caused the glider to bounce into the air three times, before the glider came to rest prior to the end of the runway. The CP incurred only minor injuries whereas damage to the glider was very serious.

The investigation determined the following: the accident tow rope visual inspection was carried out by the glider Hook-Up person and the CP prior to launch, however, the inspection was ineffective due to tape preventing a visual inspection of tow rope integrity at the tow ring attachment; the tow rope taping procedure was approved IAW the ACGPM section 3; the tape does provide the tow rope protection from abrasion, however, its use does not facilitate accurate detection of tow rope wear; lastly, the three methods -Schweizer, Half-Ball and Tube, Full and Half-Ball – are effective at protecting tow ropes, and facilitate a visual inspection of tow rope integrity before all launches.

Three preventative measures have been recommended:

1. NCA Ops should update the ACGPM stressing the three rope protection methods for protecting tow rope where it attaches to the tow ring.
2. NCA Ops should update the ACGPM stressing duct tape use only for securing tow rope splices and knots.
3. Each Cadet Flying Centre and/or each Cadet Flying Site shall designate a Staff Officer as OPI, responsible to ensure tow rope tracking is carried out IAW the National Technical Authority (NTA) – AEPM RDIMS # 1077171 document. Oversight of tow rope tracking shall be provided by the National HQ, through the Regional HQ.


Photo: DND


Photo: DND

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