National Defence Défense nationale

Flight Comment

ISSUE 2, 2013

FATIGUE

Canada

Views on Flight Safety

By Lieutenant-General J.Y. Blondin, Chief of the Air Force

With the RCAF having been through an extensive period of high operational tempo in various deployments around the world, I am most proud of the men and women who have stepped up and served in these most demanding conditions. The high turnover of personnel has led to additional demands upon our operations, and yet, we have had great success during this most active period.

> "It is imperative that everyone understands that Flight Safety cannot be separated from operations or from the chain of command but must remain an integral part of any future deployment."

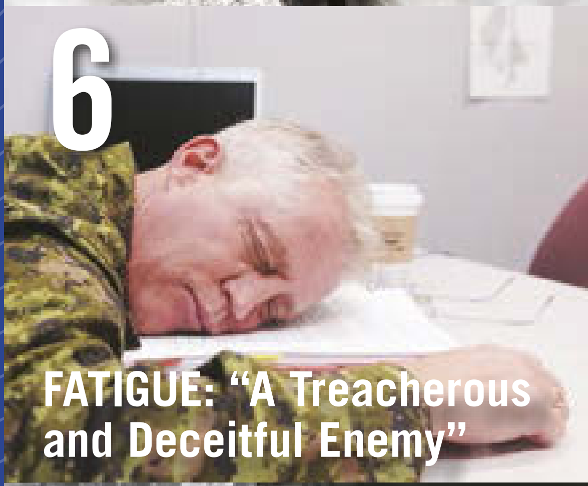
The current environment the RCAF faces is a most challenging one. In spite of the current drawback in tempo, the world is not getting any safer and there will surely be future deployment requirements. As we now find ourselves in a temporary period between major deployed operations, it is the ideal time to reflect on lessons learned and incorporate and consolidate these lessons towards improving future operations. An integral part of this discussion must include Flight Safety and how this most basic tool fits in with deployed operations.

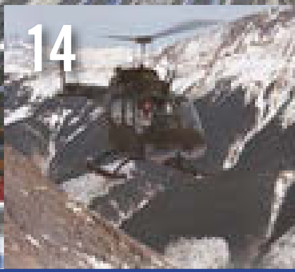
The RCAF's Flight Safety Program is recognized as one of the best systems in the world with a deeply rooted safety culture developed over many years. There has been no question about its relevancy in domestic, peacetime operations, but what about on deployment in more hazardous environments? Is that same reporting culture applicable? Is Flight Safety a help or hindrance to mission accomplishment under these difficult and challenging conditions? Certainly there were instances where, in this regard, we could have done a better job.

Flight Safety is not intended to restrict operations but to contribute to it through effective communication and coordination. Only with this in place can a successful risk assessment process be developed and implemented towards contributing to every facet of mission planning and execution. In order to do this, we must ensure that Flight Safety representatives are included in deployment planning from day one – and not seen as an afterthought or something to be left behind.

We have seen great success in recent operations, but there will be many more challenges in the years ahead. The generally lower experience levels of our personnel at the working and supervisory positions, combined with fewer available flight hours and training allotments, will contribute to a situation with higher potential risk. The increasingly unsafe external environments will most likely lead to further Government of Canada calls upon the RCAF. An effective and fully integrated Flight Safety Program will prove to be essential as a force multiplier towards contributing to mission accomplishment within an acceptable level of risk. ◆

Cover represents a member from the Air Force in a drowsy state, before or after deployment or major exercise, likely caused by excessive workload, extreme stress, and other related human factors.





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Good Show

For Excellence in Flight Safety

Civilian Instructor (CI) Nicola Nelson

Nicola Nelson was one of four adults and four staff cadets attached to the air cadet glider familiarization unit at Netook, Alberta for the summer of 2012. Hired as a glider familiarization pilot, Nicola was also tasked to be the Unit's Flight Safety Officer, though she had not yet attended the Flight Safety Course.

On the 14 August 2012, CI Nelson and all the Netook unit staff were about to complete the last flights when the winch rope broke. The gliders were parked while the rope was being repaired. During this period, a severe and unforecasted wind storm approached the Netook area and realizing they would not have enough time to move the gliders from the runway to the hangar, the staff tied down the gliders on the end of the runway. During the tie-down process, the storm intensified and wind speeds increased above 128 kilometers per hour. The winds quickly overcame the tie downs and both gliders were lifted off the ground by at least five metres, flipped upside down, and were thrown approximately 25 metres into a field. Both gliders received extensive damage.

The unit's two adult CI officers and one of the staff cadet pilots received serious injuries during the occurrence. CI Nelson suddenly found herself in charge of an extremely serious ground accident situation with one other CI and the three remaining teenage staff cadets. She had never experienced such a situation before and had minimal training about how to respond to such an event. She immediately realized she had to care for three injured personnel and provide guidance to the four staff left standing alongside of her.

CI Nelson overcame the intense emotions that such an accident can create and initiated a call to the local EMS to request a full emergency response while directing the remaining staff to secure the site as best they could and tend to the injured. She also contacted the Region Cadet Flight Safety Officer to report the accident and request further assistance. The storm intensified during this time, and fearing possible tornado activity, CI Nelson organized a plan to evacuate everyone from the site to the hangar where they would be sheltered from the elements. Once inside the shelter, she continued to provide advice, offer assistance to the injured, and provide encouragment to the staff cadets. The local EMS arrived in a timely manner and transported the three injured staff to the hospital by ambulance where they were treated for their injuries.

CI Nelson took charge and made timely and thoughtful decisions on providing for the care and well being of all her team, thereby preventing further injury during an extremely demanding ground accident. Her actions have impressed her peers and supervisors alike.

Civilian Instructor Nicola Nelson is awarded this Good Show award for the exceptional actions she took to preserve life and provide care for members of her team in a critical accident situation. ◆

Civilian Instructor Nicola Nelson is currently a member of the Gimli Gliding Centre in Gimli, Manitoba.

The Editor's Corner

Captain John Dixon, our previous Editor, has just been posted out to 437 Transport Squadron in Trenton to fly the CC150 *Airbus*. John has done a tremendous job as the Editor of *Flight Comment* over the last 30 months. A re-enrolee with extensive experience with the old Air Transport Group and various civilian airlines, he was somewhat surprised to be posted to a staff job in Ottawa with little prospect to return to flying. This did not undermine his professionalism and dedication to the task at hand. He introduced several changes to the format and content of the magazine and initiated themed issues of the publication with the concurrent phasing out of *On Target*. Kudos to you, John, for a job well done and best of luck in your future endeavours.

By default, I have inherited (in the interim) the responsibility for *Flight Comment* – at least until a truly capable Editor is posted in the position. John has put together most of this *Fatigue* themed edition of the magazine. So if you are not happy with the content, direct your complaint to him. In the last few years, he has spent a lot of energy to canvass flight safety officers and commanders at different levels to contribute articles to this publication. I certainly pledge the same thing given that it will be very difficult to continue to publish a quality publication if DFS has to rely heavily on non CF sources and if, in a worst case scenario, we are unable to find a suitable permanent Editor.

There is a motto stating "Flight Safety is everyone's business." *Flight Comment* is your publication; hence each one of us can contribute content such that it remains pertinent and reflects issues that are affecting you and the FS program. Simple actions can go a long way. As an example, MCpl Camil Olsen from 12 AMS Shearwater recently took upon himself to inform the Divisional Flight Training Officer, Capt Sue Witchel, of an article he had read on an accident that happened in the United States where a pilot operating a medevac helicopter may have been distracted by multiple texting actions while preparing his helicopter for flight and during the flight. The helicopter eventually crashed and it seems that texting was one of the key cause factors for distracting the pilot during the pre-flight where he neglected to properly refuel the helicopter. Read the details of this accident in the article titled "Texting to death" at p. 19.

In any case, MCpl Olsen felt the article was pointing to a major hazard in the CF: the use of intelligent phones in and around airplanes. Sue Witchel contacted me and it was decided to relay by email the article to all members of the FS Team. Within half a day from the initial action of MCpl Olsen, the information was passed to all flying units in the CF. The intervention of MCpl Olsen supported perfectly the central poster of Edition 1 of *Flight Comment* showing the bloody severed arm of a person holding a cellular phone. A few minutes after the release of the CF wide email, Capt Ron Busch, the G3 Aviation from 2 Canadian Mechanized Brigade Group Headquarters, submitted a very probing example of the hazard of texting while on duty read his e-mail at p. 20.

Therefore, you are all invited to contribute. The next issue of *Flight Comment* will be on Human Factors with special emphasis on the new CF Human Factor Accident Classification System (CF HFACS V 3.0). Your contribution or ideas are welcomed. You can send your email to our shared DFS email address dfs.dsv@forces.gc.ca or directly to me at jacques.michaud@forces.gc.ca. ◆

BULLETIN BOARD

We need good dossier type flight safety articles. If you think that your material could be of interest and published in *Flight Comment*, please send it to **dfs.dsv@forces.gc.ca**.

From the

Flight Surgeon

Fatigue:

A Treacherous and Deceitful Enemy

By Major Stephen Cooper, Directorate of Flight Safety Medical Advisor, Ottawa

Fatigue is made more deadly because its affects are "insidious". Insidious is defined as: "treacherous or deceitful" and "operating or proceeding inconspicuously but with grave effect". Does this not sound like what our enemies try to do to us?

I was first introduced to the word "insidious" during my Aero Medical Training many years ago. My instructors used this word to describe the deadly effects of hypoxia (low oxygen). We trained for days to learn about the danger of hypoxia and even did a "chamber ride", putting ourselves at risk of decompression sickness ("the bends") just so we could experience the symptoms. We have designed complex and expensive systems to provide aircrew and passengers with oxygen, to detect and warn occupants of low oxygen states and provide extra oxygen in the event of an emergency. However, we do not do the same for fatigue.

Photo: Cpl Alex Paquin

Fatigue is as deadly as hypoxia and even more pervasive in our society. It affects aircrew, controllers, maintainers and our supervisors. Fatigue causes, poor communication, mental impairment, physical impairment and relationship conflict.

Fatigue is often a factor in transportation deaths and injuries. The Exxon Valdez accident was caused more by the fatigue of the officer steering the ship than the affects of alcohol on the Captain who was in his cabin. The fatigue and sleep inertia of the Captain of Air France flight 447 was a factor in the aircraft stalling and crashing into the Atlantic Ocean killing 228 people. Vehicle collisions, a leading cause of death and injury in our population, increase by 7% when we lose just one hour of sleep in the spring due to "Daylight Savings Time).

Fatigue is much more complex than other impairments such as hypoxia, alcohol impairment and "hang over" etc. Complex problems require a "systems" approach to successfully reduce accidents and death.

Your personal choices play a vital role in preventing your own death and injury. Here is some advice I would like to share with you as your Medical Advisor:

1. **Education:** You need to complete your HPMA (Human Factors in Military Aviation) training in order to learn about fatigue and how to manage it.
2. **Fatigue Friendly Scheduling:** Ensure that your organization schedules adequate rest breaks between duty shifts and that they understand that shift work, jet lag, and over time increase fatigue.


Photo: Shutterstock.com

3. **Reporting:** You need to report all fatigue related safety events (accidents, occurrences, "near misses") through the Chain of Command, General Safety organization and/or Flight Safety if safety of flight was compromised.
4. **Sleep opportunity:** When you are provided time off, you have a duty to obtain good quality sleep of adequate duration. Staying up late playing video games, participating in social media, or socializing when you should be sleeping increases your risk of getting hurt in an accident or hurting somebody else.
5. **Sleep hygiene:** You are responsible for setting up an adequate sleep area in your home: dark, quiet, no pets in the room, no TV in the room, and comfortable temperature. When you consume alcohol or caffeine in the evening or prior to sleep, you decrease the quality of your sleep.
6. **Recognize your symptoms of fatigue:** Day time fatigue, poor concentration, irritability, and "clumsiness" may be your first clues that you need to increase the amount and quality of sleep you are getting.
7. **Family and Friends:** Family and friends need to respect your requirements for sleep. This can be very difficult with young children and shift work. They are also your best ally because they will often recognize personality changes that are related to fatigue or a medical condition before you do. A subtle observation from somebody close to you may actually be a "flashing red" warning light that the insidious enemy of fatigue has attacked you.
8. **Medical Causes:** If the above symptoms do not get better with sleep, book an appointment with your health provider and tell them your symptoms. They will work with you to diagnoses and treat any underlying health issues.
9. **Fatigue "Counter Measures":** In spite of your best efforts, you may find yourself in a fatigued state at home or work. If so:
   - Inform your supervisor and co-workers immediately
   - Remove yourself from safety sensitive tasks
   - Remove yourself from duty to obtain a full length high quality sleep **if possible** (approx 8 hours)
   - Request a "tactical nap" (20 minutes) or a "short sleep" (4 hours)
   - Consider a dose of caffeine for short term stimulation to complete a critical task
   - Consult your health care provider if symptoms persist.

Conclusion

Fatigue will injure and kill you just as quickly as drinking and driving or the actions of an enemy. The only cure for fatigue is to get regular, high quality sleep of sufficient length. If fatigue symptoms continue, you must make an appointment with your health provider to diagnose and treat any underlying health conditions.

Sleep and fatigue are complicated issues that involve individual behaviour, family dynamics, work schedule, medical conditions and operational requirements. You need to be an active participant in fighting this insidious enemy. ◆

Maintenance IN FOCUS

Got Ice?

The Basics of Fuel System Icing Inhibitor Additive

By Capt Karl Manuel, NDHQ Aerospace Fluids Officer, Quality Engineering Testing Establishment, Ottawa


Photo: WO Serge Peters

As aircraft ascend to altitude, the temperature of the air decreases at a rate of 2-3 degrees C for every 1000 ft of altitude. Even on a pleasant summer day, the air temperature a few thousand feet up can be well below freezing and fuel stored in the aircraft's fuel tanks can drop below 0 degrees C. Aviation fuels may contain a small quantity of free water. The maximum is 30 parts per million as per specification. As the fuel cools, roughly one part per million of dissolved water comes out of solution as free water for every degree C of temperature drop. Certain aircraft without in-line fuel system heaters require that fuel system icing inhibitor (FSII) additive be blended into the fuel to prevent the free water from forming ice crystals, which could cause blockage of fuel filters and fine passages within the fuel control unit, eventually leading to power loss or engine shut down.

The main ingredient of FSII is a substance called di-ethylene glycol monomethyl ether (DiEGME). When evenly distributed within the fuel, it will migrate into the free water coming out of solution, thereby lowering the freezing point of the affected water to approximately -43 degree C. FSII has also been shown to act as a biostat which means that it can retard the growth of microbes that inhabit the water and feed off the hydrocarbons in the fuel. Microbial growth will occur whenever free water is present in a fuel system and in extreme cases, can also result in blockages within the fuel system.

In many civilian designs, fuel is used to cool engine oil in a device called a fuel-oil heat exchanger and is one of the reasons why FSII is not typically a requirement in civil aviation. However, the design of the heat exchanger must be able to cope with fuel icing. One of the most well known examples of a fuel system blockage by ice contamination was the January 2008 accident of British Airways Flight 38, a Boeing 777-200ER that crash landed just short of the runway at London Heathrow Airport due to an ice clog on the inlet of the fuel-oil heat exchangers. The accident was caused when the fuel-oil heat exchanger could not cope with a sudden release of ice that had built-up within the fuel lines during the long flight.

What to Watch Out For

Regular water draining and good housekeeping are the most practical means to minimize microbial and water contamination. In addition, military fuels such as F-44 (JP-5) and F-34 (JP-8) contain FSII as a means to control ice crystals as well as microbial growth. When used in small quantities (0.10-0.15 % by volume), FSII is very effective at its job. However, (there always seems to be a "however" in a flight safety article), as good as FSII is, the old adage of "too much of a good thing" applies.

Photo: Sgt Errol Morel

Photo: MCpl Shilo Adamson

In higher concentrations, FSII when combined with water not only lowers the freezing point, but can form an aggressive solvent that can extract other components from both the jet fuel and from the fuel system itself [1]. QETE analyzed fuel samples from a flight safety incident where an aircraft performed an emergency landing due to fuel contamination. It was found that FSII had reacted with the polyurethane baffle material in fuel tanks resulting in a resin-like material that plugged fuel filters and reduced fuel flow to the engines. The investigation determined that the fuel contained up to 3% FSII per volume, a concentration that was over 20 times the allowable limit, which was caused by the lack of injection control of the additive by the fuel supplier.

Similarly, an undrained water layer in bottom of a fuel tank attracts the FSII, which reacts with polysulphide sealant material. On a separate occurrence, the investigation revealed that red dye was being extracted from sealant material at the bottom of fuel storage tanks by the excess FSII, compromising the sealant and resulting in a build-up of debris in the tank (Figure 1). This highlights the importance of draining any free water from the tanks.

One of the more complex substances that FSII can form in fuel is a substance known as "Apple Jelly" (Figure 2). FSII has been known to react with water and polymeric material contained in ground filtration system (EI 1583) to form a complex mixture that is reddish/

Figure 1. Sealant Material Found at the Bottom of Tank

Figure 2. Apple Jelly Found in a Horizontal Filter Vessel

Figure 3. Improper Method to Add FSII

brownish in colour and has the look and consistency of “Apple Jelly”. If you see Apple Jelly forming in your fuel system (example: filters), your fuel system is “toast”.

Conclusion

As you can see, as good as the FSII additive is for aircraft fuel systems with respect to free water, ice and microbial growth, it also has the potential to cause harm to our fuel systems when improperly added to the fuel. Proper education and correct fuel handling practices, as per C-82-010-007/TP-000, can help you understand the fuel and additives involved and provide safe flying conditions for the RCAF.

If you are forced to re-fuel from a non-DND source, you need to verify if FSII is present in the fuel. If not, you have options to either add FSII using an approved method, or fly without FSII (some fleets have formally documented the risks associated with this practice). If you must fly without FSII, extra vigilance is required to drain any excess water from your fuel system.

Remember that proper maintenance goes a long way. Draining sumps, the use of proper filters and verifying FSII levels on the pre-subscribed periodicity will keep our forces safely in the air. ◆

Reference:

1. Southwest Research Institute Spring 2003 Technology Today Article: A Potentially Deadly Spread

Frequently asked questions:

1. **Does FSII depress the freezing point of the fuel?** *No, FSII, being a glycol material, has more affinity with water than fuel, hence will react with the presence of free water in aircraft fuel tanks will depress (lower) the freezing point of the free water to prevent the formation of ice crystals.*

2. **What are the acceptable FSII concentrations for aviation turbine fuel such F-34/F-37 and F-44 grades?** *IAW with CGSB-24, the fuel specification requirement for FSII is 0.10-0.15 % vol. C-82-005-001/AM-001 stipulates allowable FSII levels ranging from 0.07-0.20 % vol for RCAF operation.*

3. **Are we allowed to use FSII aerosol cans?** *QETE endorses the use of FSII aerosol cans as long as the entire can content is used to treat its corresponding amount of fuel as per manufacturer instructions because the delivery rate from aerosol cans are typically not constant over the delivery of the additive during injection from these cans. When not treating a known amount of fuel with a complete aerosol may cause an over-dosing situation.*

4. **Is FSII treated fuel compatible with all aviation fuel filtrations systems?** *Pre-blended fuel is filtered prior to aircraft refuelling at least two times. EI 1581 filter separators are the designed filtration equipment for pre-blended fuel with FSII. EI 1583 filter monitors (containing polymeric material) absorb free water in commercial jet fuel and are incompatible with FSII contained in military grade fuels. Fuel containing FSII is compatible with all aircraft fuel filters with no operational restrictions.*

Know your fuel:

Jet A	freezing point -40 degree C
Jet A-1	freezing Point -47 degree C with minimum flash point of 38 degree C
F-34	Jet A-1 with anti-oxidant, FSII, and Corrosion inhibitor (CI)
JP-8	This is the US designation for F-34
F-37	F-34 with +100 additive (= JP-8 +100)
F-44	Jet A-1 with anti-oxidant, FSII, and Corrosion inhibitor (CI) with minimum flash point of 60 degree C
JP-5	This is the US designation for F-44

YOUR ATTITUDE > FLIGHT SAFETY > YOUR LIFE

Photo: Cpl Igor Loutsiouk

What are the Chances?

By Captain Gillian Parker, 424 Transport and Rescue Squadron, 8 Wing Trenton, Ontario

There are some pretty extensive rules in the 1 Cdn Air Div Orders outlining crew rest, and crew day length, not only for SAR crews, but for all aircrew – and for good reason. There is little room for error or fatigue in the task of flying aircraft. Anyone who has flown a crew day to the limit knows that "sack of hammers" feeling when decision making and physical reactions are slowed by fatigue.

In the SAR community, crews holding standby must ensure they are well rested prior to and during their period of responsibility, such that if called out they can put in a full crew day, regardless of the time of callout. At first glance, this doesn't seem like such an onerous task, especially for the evening or "slash" crews who hold standby from 1600 hours to 0800 hours the following day; this just means a sleep mid day or a really good night's sleep the night before. The problem is that getting adequate rest during the day can sometimes be difficult, especially when there are so many other daytime tasks that need to be completed.

After a not-so-good sleep the night before, I had gone into the squadron to do some paperwork in the morning. (The Squadron orders allow for aircrew holding night standby to go in to work between 0800 and 1200 hours on the morning of a night duty. The individual must then leave work to ensure 4 hours off duty prior to commencing their standby period at 1600 hrs). I was successful in leaving the office by noon, however, I had to make a stop on the way

"After many nights in a row of no callouts, crews can get complacent, and think "what are the chances?" I inadvertently used this flawed rational one night when I was on the schedule holding standby as the First Officer on the CC130 at 424 Squadron. "

home, then the dog had to be walked, then there were the bills to be paid – in short, the afternoon became filled with many miscellaneous jobs around the house, which then melded with dinner preparation. After dinner, my sagging eyelids told me I needed to at least put my head down for a nap ... after just one more thing to do. Before I knew it, the time was 2100 hours and I was starting to feel the effects of a long day. Just when I was thinking "Boy, I really hope there won't be a callout tonight", the phone rang. It was a SAR callout to respond to a lost boat up in the James Bay area. "Unbelievable", I thought. It would be at least a 2-hour transit one way and a search low over the water at night. On the drive into the base, I reflected on my current state. I knew the adrenaline would keep me alert for the first part of the mission, but I would have to stay super vigilant after a few hours as I know my fatigue would catch up pretty quick. I looked at my options. I couldn't back out of the trip now, and I knew I was nowhere close to 100%. Not my most professional moment.

As I walked into Ops, the Aircraft Commander was just hanging up the phone with the Rescue Coordination Centre, and informed me the tasking had been stood down. Most of the time, SAR crews are excited for the opportunity to be called out, fly and accomplish a SAR mission. This time, however, I was never more thankful to be stood down. I immediately returned home to get some rest should we be re-tasked later that night. Thankfully, that didn't happen.

My previous evenings' lesson in poor preparedness was driven home the very next night. The SAR standby crew was tasked for a 2-hour electronic locator transmitter (ELT) search over Georgian Bay and after returning to Trenton, found poor weather with low ceilings and visibility. After 3 approaches down to minimums (and subsequent missed approaches), they had to fly to their alternate, wait 5 hours for the Trenton weather to improve, before returning home.

I wondered if that had been me on that trip, how sharp would I have been? Would I have put my whole crew at risk? It was such an easily preventable situation, and yet, I rolled the dice thinking we probably wouldn't be called out. After that gentle reminder, I am much more diligent about ensuring I am properly rested for SAR standby. ◆

Photo: MCpl Colin Aitken


Photo: DND

Fatigue and Inadvertent IMC

By Mr Jacques Michaud, Directorate of Flight Safety, Ottawa

Mr Michaud is a former RCAF pilot with close to 6,000 hours on the *Kiowa* and *Griffon* within the tactical helicopter community. He completed three tours with 430 Tactical Helicopter Squadron, his last one as the Commanding Officer from 1993 to 1996 and one tour as an instructor with 403 Operational Training Squadron. He retired from the Canadian Forces in 2002 and moved in his current position of Section Head for Promotion and Information within the Directorate of Flight Safety.

In your career, there are some accidents that really attract your attention because you may have survived very similar occurrence by nothing other than pure luck. For me, it was the loss of CH136265 in the spring of 1977. I was then struggling badly through the *Kiowa* Operational Training Unit in Gagetown, not having flown much recently because of the combination of bad local weather and the ground training requirements.

We were crammed in the steamy and dysfunctional 403 Tactical Helicopter Squadron briefing room on 18 February 1977 when the leadership of the squadron gloomily entered the room. A *Kiowa* from 422 Squadron (CH136265), a small unit co-located with 403 Squadron in Gagetown, had crashed the day before on a lake while en route VFR between Botwood and Corner Brook, Newfoundland. The pilot (Capt Levesque) and passenger (Major St-Germain) were fatally injured on impact while the observer (Sgt Smith) died en route to the hospital. It was totally silent in the briefing room. Although the investigation was just underway, it appeared that the inexperienced pilot chose to fly across a large snow covered lake under conditions that were both indicative of and conducive to whiteout. They referred to these types of occurrences as inadvertent IMC (instrument meteorological conditions). The close proximity to the ground and the slow speed can cause this transition to quickly become dangerous. Many pilots have learned this the hard way. In this case, the pilot, having lost visual reference with the ground, suffered spatial disorientation and attempted to turn the aircraft without utilizing the flight instruments, and in so doing struck the ground. The investigation cited pilot judgment and technique as the cause of the accident.

At the time, DFS was using a rather simple taxonomy to classify human errors. The Standards Officer briefed our squadron pilots that if inadvertent IMC was encountered, immediately transition to instruments AND STAY ON INSTRUMENTS. This is an effective procedure for someone experienced and current with instrument and night flying, but not quite as effective for an inexperienced or less than current pilot. Were there other factors that came into play in this accident? This was difficult to assess with no CVR/FDR from the flight, no survivors and limited information reference their crew day in the days preceding the accident.

Fast forward to 21 April 1977, just 2 months after this accident. I had narrowly passed the OTU (I think my skills as a unit hockey player contributed to my passing grade) and had made it through my 430 Squadron unit check-out (UCO) earlier in April. The UCO did not include a night or instrument check. In those days, the instrument ticket ride was done at 3 CFTTU Portage La Prairie. My ticket ride was done on 13 Oct 76 on a 'stringent and thorough' instrument flight test of 1.3 hrs out of which 1.1 was on instruments. Practically, this meant that I had not flown instruments for a period of six months. You will see later how this came into play in a very serious occurrence.

My day started on a bright and sunny Thursday morning with presenting myself to the base gymnasium where the squadron was running the 1.5 mile fitness test. After a successful run, I changed and went to the morning briefing. The OpsO advised us that some of our personnel were on a flight from Alert to Trenton, in a CC130 *Hercules*. A formation of 3 *Kiowa* helicopters was to proceed to Trenton, wait for their arrival and then fly them back to Valcartier. I was chosen to fly the third aircraft.

The whole mission was to be conducted VFR, returning before dawn. We departed single pilot separated by 5 to 10 minutes between aircraft. Although the Section Lead was our Flight Commander, he had little experience on helicopters. We managed to arrive in Trenton before supper time having completed 3.8 hours of flight time: two easy hops Valcartier – St-Hubert and St-Hubert – Trenton. Up to this point, the plan was working like a charm. Unfortunately, the *Hercules* was delayed and landed around 2000 hours. Then it took what seemed like forever for our passengers to retrieve their baggage. I knew that the Flight Engineer (FE) that would be my passenger, so weight and balance would certainly not be an issue.

"I entered what I thought was the correct valley and shortly thereafter entered cloud."

However, by this time weather was becoming an issue and there was no way we could fly back direct Valcartier through the Laurentians or even to Montreal. At this point, fatigue was starting to become a factor. My duty day had begun at 0700 hours and at around 2100 hours we departed Trenton and flew separately to the Ottawa airport. The flight took only one hour but it was a pitch black night. The first two aircraft that called entering the control zone were not exactly 5 nm when they called so when I was approximately 15 nm from Ottawa, ATC called me to let me know exactly where I was.

In Ottawa, I was marshalled to a landing spot near transient servicing. The downwind landing was quite interesting with the wind that had picked up which contributed to a bit of a "fish tailing" on landing. The pilots from the first two aircraft had checked the weather and concluded it would be dangerous to attempt to proceed to Valcartier that night. In any case, our crew day had been 18 hours and it would not have been very smart to attempt a night trip under the circumstances. The other crew booked a room on base but I elected to call my sister who was a military Dentist living in Vanier which is on the east side of Ottawa. After a short visit, I managed to go to bed in the early hours and rapidly fell asleep.

I received a call at around 1,000 hours the next morning and was advised that the weather was good enough to proceed to Valcartier. The plan was to meet around noon at Uplands airport. When I entered the planning office, the other crew members were exiting the met office and provided me with a very fast synopsis of the weather conditions, NOTAMS and that we would contact each other on the standard squadron frequency.

I rapidly filed my flight plan and left as fast as I could. My trusted FE was holding the map and seemed to be a much better map reader than I was. As we progressed out of the control zone flying north of the Gatineau River toward the hills, it was obvious that some fast low moving clouds were still lingering in the area. I was in contact with the other two aircraft and the other pilots assured me that weather was not a problem. They had flown down a specific valley and suggested that there would be no problem for me to do the same. I entered what I thought was the correct valley and shortly thereafter entered cloud. "Simple Jacques – STAY ON INSTRUMENTS." Well things were not right with the heading indicator slowly turning and then turning much faster. My crosscheck was exasperatingly slow, even for a helicopter pilot. I had no clue about the local safe altitude, the freezing level, freezing precipitation conditions, and as an added challenge, my IFR publications were neatly tucked in the back seat. The FE opened his eyes extra wide and shouted: "STAY ON INSTRUMENTS!" My eyes were probably as big as his and I replied: "WHAT THE F*** DO YOU THINK I AM TRYING TO DO!" With aircraft bank about 70 degrees, if not more, I exited cloud descending rapidly towards the ground – luckily in a valley. I recovered the aircraft, selected a landing spot, landed, and shut down the aircraft. I was sure the helicopter had been overtorqued, overtemped and god knows what else. I called the squadron and the maintenance officer asked me some questions and compared my responses with those of the FE. We were eventually asked to do a thorough preflight inspection and, if nothing unusual was found, fly back to Valcartier. We did that and arrived at the heliport at dusk.

The next morning I was asked to brief my occurrence to the squadron and identifying the errors made. The leadership decided not to file a Flight Safety Report; their belief was that the same contributory factors as the previous accident with CH136265 were prevalent with my incident, and that another report on the same issue would be redundant. With added experience and hindsight, I would now beg to differ. There were obviously a multitude of lessons that could have been passed on if an occurrence report had been filed and the occurrence thoroughly investigated.

But how much fatigue and peer pressure contributed to this very serious occurrence? While I could have listed many factors to explain my erratic performance over the two days of this mission, I was my worst enemy and fatigue probably played a significant part. We had exceeded our maximum crew day on day one. It was probably not smart of me to waste rest time by visiting my sister, which was almost an hour's drive from the airport, nor ideal to return to duty after barely six hours of sleep. Perhaps, if more experienced, I would have advised the other crews to go ahead and not wait for me, as I was definitely not mission ready given my expertise and level of confidence. I was, however, luckier than Capt Levesque. By the way, the Flight Engineer still talks to me although the details of the occurrence have varied over the years! ◆

Photo: DND

Photo: MCpl Jean-François Lauzé

WHEN TWO WORLDS *Join As One*

By Anne Lawrence, Top Aces AMT, ALSE Support Specialist and FS Representative

Anne Lawrence retired from the RCAF with 28 years of service. Her diversity of service has made a full circle starting off as a Safety System Technician, then an Airframe Technician. With trade amalgamation in 1995, she became an AVN Tech and took up the Aviation Life Support Equipment (ALSE) speciality. She became a member of the Top Aces Team in March 2012 and is now the ALSE Support Technician in Ottawa. Top Aces has been providing Contracted Airborne Training Services (CATS) to DND since 2005.

After 28 years of military aviation experience, I did not know what to expect when I began working for Top Aces. Being brought up in the Flight Safety mentality my entire career and having heard how different the "civvies' world" worked, I was a little cautious in my expectations. I had never worked with Aircraft Maintenance Engineers (AME's) before and to see civilian maintenance personnel, with no fighter experience, holding all the signatures in a fighter world, I did not know what to expect.

> "At first I wondered how this teaming of two worlds, similar, but very different, would work. I was used to working in a military "safety first" environment with a Chain of Command that always stressed safety."

Well, this civilian company had the foresight to take the best of both worlds and combine them to create a team comprised of a dedicated group of individuals, doing as unique a job as you could find in civilian industry. We have retired RCAF pilots, maintainers and civilian trained employees joining together to provide the flying resources that enable military establishments around the world to train with the realism that real air assets add to their training.

Top Aces is an active and required participant in the RCAF Flight Safety Program and the Transport Canada/ISO 9001 mandated Quality Management System, both working in parallel company-wide, ensuring 100% safety compliance, education and awareness. We have a dedicated Flight Safety Officer and representatives (pilots, engineers and technicians) at all of our locations. The excellent two-way interaction between our FS System, the PMO FSO and DFS has been paramount in ensuring timely occurrence reporting and appropriate Supplementary Report follow-ups.

As an example, our tool control program is based on the already established RCAF tool control program and was initiated from a Preventative Measure; we have now virtually eliminated tool control occurrences.

Our Ground Crew Duty Day/Crew Rest Guidelines were also initiated from a Preventative Measure and these guidelines are strictly adhered to, providing additional protection against personnel fatigue. These rules were also initiated as a result of information shared with military flight safety personnel regarding ground crew fatigue, at the 2009 Annual DFS Meeting in Ottawa.

We follow a well established and proven RCAF system verbatim, allowing us to utilize the mentality and the successes of this system and to thus exceed the requirements of the civilian regulations we also must adhere to.

While non-punitive flight safety investigation is not new to retired RCAF personnel, it is a little different for some of our non-military background employees; however they seem to quickly adapt to the Flight Safety way of thinking. With our strong and pro-active reporting system, which we all take very seriously, we try to learn from any errors, continuously striving to make the operation better.

Our strong Flight Safety Program is fully supported and recognized by the highest levels of our management. It really has been a big eye opener for me and sometimes when two worlds join, they can become one! ◆

Photo: Sgt Norm McLean


Photo: NTSB

Texting to DEATH

By Jacques Michaud, DFS 3 Promotion and Information, Ottawa

The last 10 years have represented a tremendous leap in how people communicate between each others. Electronic social networking was invented and its use has grown exponentially, especially with the arrival of intelligent phones. Texting is now the norm and has reached epidemic proportions. Athletes are texting to their fans during games, children are texting during family meals, and people even text to each other while sitting in opposite side of a room during a party. In larger crowds, you see children and adults alike walking erratically between pedestrians emphatically reading the latest 'important' text from god knows who. Despite local traffic laws imposing severe fines, automobile drivers are often seen talking on the phone or worse, texting.

These mobile or portable electronic devices (PEDs) have become integral parts of our modern life and will not go away. The B-GA-104-001/AA-001 *Operational Airworthiness Manual* (OAM) defines a PED as "as an electronic device that is not listed in the aircraft inventory and is carried on board by a passenger or crew member for personal use." Will PED invade our cockpits as they infiltrate our lives?

The civil aircraft accident related below shows the insidious danger created by these devices if we allow its' liberal use in and around aircraft. What is interesting about this accident is that it would apparently be the first fatal commercial aircraft in which texting has been implicated[1].

The accident was investigated by the US National Transportation Safety Board (Board). The Board members met in Apr 13 to make the final findings and recommendations on an accident involving a medevac helicopter. Overall, the mission was quite simple with navigation and terrain being assessed as non-challenging; the mission called for the helicopter to fly from its operating base to a hospital some 85 km to the North-East, to pick up a patient and transfer him to another hospital some 100 km to the South. The pilot eventually diverted to an airfield close to the final destination because the pilot was concerned with his fuel state. It crashed in a farm field just one nm short of destination, killing the pilot, flight nurse, flight paramedic, and patient[2].

The helicopter was according to the NTSB investigators fully serviceable. The direct cause of the accident cited by the Board was fuel starvation. How can a helicopter having an endurance of up to 4 hours run out of fuel on a flight of less than 90 minutes, if that?

Fatigue was cited as having contributed because the pilot only slept five hours before duty and the accident took place at the end of his 12-hour period of duty but it was probably not a key factor in this accident[3].

What has attracted the attention of the investigators is the key role played by texting in the chain of event.

On take-off from his home base, the pilot reported having an endurance of 2 hours to the ops centre. Upon arrival at the first hospital, he stated to Ops that he had 45 minutes of fuel on board, including a 20-min flight reserve (the investigation has determined that he had in fact 33 min of fuel)[4]. Given his concern with the amount of fuel left to complete the mission, various alternatives were discussed. It was finally decided to divert to an airport very close to the destination hospital, refuel and complete the medevac mission. The new destination was calculated to be 30 min away by air; hence the problem of fuel was not at all resolved.

The pilot was distracted by texting extensively with his girlfriend in the hours preceding his mission and in flight during the final leg leading to the crash. **He had sent 25 text messages and received 60 during his 12-hour shift. Some 20 messages were exchanged during the last 100 minutes before the crash.**[5] No text message was sent in the final 11 minutes before the fatal crashed, but at least three were sent and five received while the helicopter was in flight (representing a span of approximately 19 minutes). The pilot was even texting during his conversation with the ops centre, while attempting to determine what courses of action were available to.[6] This case certainly underscores that the use of PED is increasingly becoming a concern in accidents and incidents across all modes of transportation.[7]

Are these unsafe habits moving to our flight line and cockpits? Only a few PED occurrences have populated our Flight Safety Occurrence Management database so far but it does not mean we are immune of this phenomenon. When we found out about this accident through Cpl Olsen (see Editor's Corner), a CF FS Team wide e-mail was sent out. A few hours after the e-mail went out, DFS received an interesting e-mail from Capt Busch supporting our concerns (*see sidebar text*).

The airline regulation concerning the limitation on the use of PED have initially been related to concerns over the possible interference of these devices with the aircraft communication systems. It will probably change as a result of this accident. What about the CF? The OAM governs the use of PED[8]. It stipulates that use of a PED must be pre-authorized by the aircraft commander and shall not:

- transmit
- be used during critical phases of flight (i.e. take-off, climb, approach, landing)
- during tactical portion of flight
- on the flight deck
- for navigation

It indicates that if a PED is used within the above specified restrictions, it must have been cleared for use IAW the airworthiness clearance process like any aeronautical product.

Further, in Dec 2011, the Comd 1 Cdn Air Div issued a message[9] that he was concerned about the use of PEDs on CF aircraft in contravention of DND flying orders[10]. The Comd at the time wanted to rectify this potential degradation in the level of safety for in-service aeronautical products. Hopefully, the situation has been corrected since then, not only onboard our aircraft but in the maintenance hangars and on the flight line. ***What is so compelling that risks … texting to death?*** ◆

E-mail received by DFS 3, Tuesday, 9, April, 2013 13:25 PM

"Jacques, I have seen something similar to the accident related in your e-mail although no accident or incident resulted. With cell phones, I think individuals now truly take their personal life onto the flight line and into the aircraft.

While in Ft Rucker during Chinook training I saw the baggage that comes with cellulars being used near aircraft, and the potential impact to flight operations.

I was doing part of a pre-flight on an aircraft when I heard my crew chief having a heated discussion with someone. It threw me off as the nature of the discussion wasn't relevant to any of the other crew at the aircraft, so I was initially at a loss with whom he was having the conversation. When I looked under the aircraft, I saw he was on his cell phone while carrying out cargo hook checks. Needless to say the nature of the call from his ex-wife definitely broke his concentration from his primary duty. Once the call was over we got him to take a moment to reset his gyro then redo that portion of the pre flight again.

The implication of having these devices on the flight line or aircraft doesn't just apply to aircrew. On that flight line in particular, maintenance personnel driving AMSE vehicles while talking or texting on cell phones was even more of a concern than taxiing aircraft.

In the past, we were concerned about the dangers of personnel electronic devices being used in an aircraft for its' possible impact to aircraft systems. We may have underestimated the distracting impact these devices can have on the individual."

Ron Busch
Capt
G3 Avn
2 CMBG HQ
1 WG HQ Det

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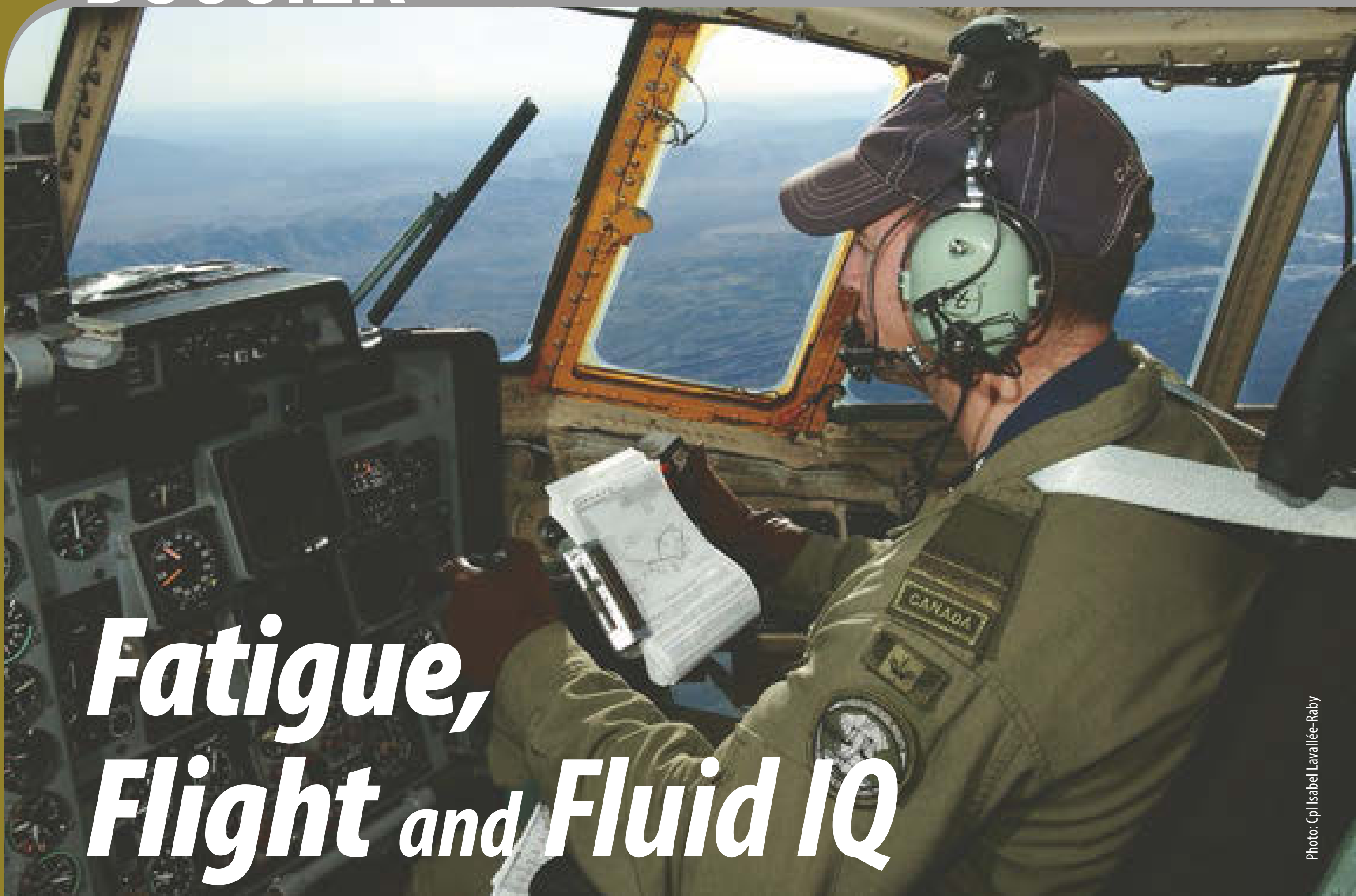

Photo: Cpl Isabel Lavallée-Raby

Fatigue, Flight and Fluid IQ

Measuring Fatigue in Sustained Air Operations

Written by Dr. Oshin Vartanian and Dr. Bob Cheung from DRDC Toronto, Canada and Group Captain Donald Ross from the United Kingdom Royal Air Force.

The authors would like to acknowledge the contributions of Dr. Fethi Bouak, WO Barry MacMillan, Sgt Lissa Taylor, Sgt Rick Auger, Lt(N) David Brookes, Mr. Kevin Hofer, and Ms. Ingrid Smith to data collection and analysis.

Dr. Oshin Vartanian is a defence scientist in the Individual Behaviour and Performance Section at DRDC Toronto. His research involves studying the impact of fatigue, workload and emotion on psychological and neural function.

Group Captain Donald Ross is a Royal Air Force Flight Surgeon who was on exchange in the USAF SG Office as Chief of Aerospace Medicine Interoperability. He was one of the authors of the ASIC fatigue guidelines and one of the designers of the fatigue trial. He has now returned to the UK and is the Deputy Assistant COS Health for the RAF.

Dr. Bob Cheung is the senior defence scientist in the Joint Operational Human Sciences Centre at DRDC Toronto. He is recognized as a subject matter expert in spatial orientation and vestibular studies, in addition, he contributes to a wide range of military operational research including fatigue countermeasures, blast induced brain injury and operational pharmacokinetics.

Fatigue management is a critical requirement in sustained air operations. To establish and harmonize guidelines for addressing fatigue management, the Air & Space Interoperability Council (ASIC) recently generated an advisory publication following their annual meeting in November 2009. This publication outlines various non-pharmacological behavioural interventions for mitigating the effects of fatigue on aircrew during sustained and continuous operations.[1] The key recommendations include good sleep hygiene and optimal work/rest scheduling, among others. Although the recommendations outlined in this and other ASIC publications are based on current academic research and operational knowledge, rigorous empirical assessment in the field would facilitate the implementation into the Air Force doctrines. As the first step toward testing ASIC's recommendations, we set out to quantify how sustained operations impact cognitive performance and self-assessments of fatigue in the field, and we did so in the context of a large multinational Air Force training exercise–Red Flag.

Red Flag is an international air combat exercise held annually at Nellis Air Force Base (Nevada). Last year's Red Flag took place in January-February 2012, covering consecutive 2-week periods. Red Flag provides important training for US and allied fighter aircrew, as well as transport, electronic warfare, air refuelling, air defence, and airborne early warning and control assets from many different nations. Using the vast, unrestricted airspace and multiple targets, US and international participants engage in a simulated campaign, involving daily missions that include confronting and dealing with air- and ground-based adversaries.

Against the backdrop of this large-scale air combat exercise, we opted to focus specifically on the fighter group, and were successful in soliciting interest from the flight surgeons and pilots of two different squadrons to participate in our study. The participants–all F-15 or F-16 pilots–consented to daily testing on a battery of cognitive tests and self-report measures of fatigue on 6 consecutive days. The cognitive tests included previously validated measures of attention, visual short-term memory, and grammatical reasoning, although our focus in this paper will be on a test of working memory–defined as the mental capacity to maintain and manipulate information in the focus of attention. We included these measures because the abilities they measure may contribute to optimal performance in the fighter group, but also because performance on those measures has been shown to exhibit decrements under conditions of sleep deprivation.[2] The self-report measure of fatigue employed in this study was the Multidimensional Fatigue Inventory (MFI).[3] This 20-item measure generates scores for the five dimensions of mental, physical, activity, motivation, and overall fatigue. In our focal analyses reported below we will focus on mental fatigue because it is most closely related to cognitive performance.

Importantly, at baseline–defined as the morning prior to the commencement of the combat exercise–we administered to all participants the *Shipley Institute of Living Scale* (Shipley-2).[4] Shipley-2 generates separate scores for crystallized and fluid intelligence (IQ). Briefly, whereas crystallized IQ is a repository of one's knowledge and tends to increase over one's lifetime, fluid IQ is a measure of one's ability to adaptively solve novel problems and patterns, and tends to peak in early adulthood. We were interested in the relationship between fatigue, fluid IQ, and working memory capacity for the following reason. First, previous studies have shown that fluid IQ is correlated with working memory capacity.[5,6] Bringing these two strands of findings together, it stands to reason that persons with higher fluid IQ might be more resistant to the effects of fatigue on working memory. If so, our test of fluid IQ could potentially provide a proficient method for exploring vulnerability to mental fatigue in the course of sustained operations–in this case Red Flag.

Our sample of F-15 and F-16 pilots ($N = 18$) were all male. Their ranks consisted of First Lieutenant ($N = 1$), Captain ($N = 14$), Major ($N = 1$), and Lieutenant-Colonel ($N = 2$). Their average number of years in service was 9.03 ($SD = 4.04$). Their education levels varied between college diploma ($N = 2$), undergraduate degree ($N = 8$), and graduate degree ($N = 10$). Average crystallized IQ was 112.56 ($SD = 6.58$), whereas average fluid IQ was 112.22 ($SD = 8.61$) –both of which are interpreted to be in the "above average" category based on norms derived from the larger adult population.[4] The above average scores on both crystallized and fluid IQ likely reflect the rigorous selection process for fighter pilots, given that it emphasizes the possession of both a large knowledge base as well as the ability to solve novel problems and patterns adaptively. Importantly, the correlation between crystallized and fluid IQ was not significant ($r^{[16]} = .04$, $p = .87$), demonstrating that they reveal dissociable abilities.

However, critical to our purposes was an examination of the patterns of performance and self-reports of fatigue across the 6 days of participation in the air combat exercise, broken down by levels of fluid IQ. To conduct this examination, we divided our sample between those below the median score of 114 ($N = 7$) and those at-or-above the median score ($N = 11$). Indeed, the difference in fluid IQ between the below median score group ($M = 103.71$, $SD = 6.92$) versus the at-or-above median score group ($M = 117.64$, $SD = 3.78$) was significant, $t(16) = 5.56$, $p < .0001$. According to the norms derived from the

"Specifically, persons with higher fluid IQ have greater ability to maintain and manipulate information in their span of attention than persons with lower fluid IQ. Second, sleep deprivation has been shown to deplete working memory.[7] In other words, one of the symptoms of sleep loss is a reduced ability to maintain and manipulate information in span of attention."

larger adult population, the two groups could be categorized as those with "average" and "above average" fluid IQ.[4]

Our measure of working memory performance was the n-back task. Briefly, in this task subjects are presented with a sequence of letters flashed one a time on the screen for approximately 1 second. In the easy version of the task known as 1-back subjects are instructed to press the spacebar if the letter currently present on the screen matches the letter that was presented immediately prior to it. Normally, subjects perform at ceiling on 1-back because they need to maintain and update in their focus of attention only the current letter and the one presented immediately prior to it for responding accurately. Because 1-back places a low mental load on working memory capacity, we expected to see minimal decrements in performance in the course of the week, despite the buildup of fatigue. In contrast, in the more cognitively challenging version of the task known as 2-back, subjects are instructed to press the spacebar if the letter currently present on the screen matches the letter that was presented two positions earlier in the sequence. This version is more difficult than 1-back because in order to respond accurately, subjects must maintain and update in their focus of attention the current letter and the one presented two positions earlier in the sequence. Because 2-back places a higher mental load on working memory capacity, we expected to see decrements in performance in the course of the week, but especially so in the average fluid IQ group.


Photo: Cpl Isabel Lavallée-Raby

As predicted and illustrated in Figure 1, on the easy 1-back version of the n-back task, the average and above average fluid IQ groups exhibit similar patterns of performance across the 6 days. In contrast, the two groups appear to exhibit different patterns of performance on the difficult 2-back version of the n-back task across the 6 days. Specifically, whereas the performance of the above average fluid IQ group remains relatively stable across the 6 days, the performance of the average fluid IQ group tapers off starting on Day 3. It is important to note that because of our small sample size and restricted range of IQ scores, the reported statistics are descriptive and no definitive conclusion can be drawn from these data. Replication of our results based on a greater sample size is necessary before the data can be subjected to inferential statistics so that the findings can be made generalizable to the greater population of fighter pilots. Nevertheless, the pattern here is suggestive and warrants further empirical scrutiny.

Next, we examined the relationship between fluid IQ scores and self-rated mental fatigue– the fatigue dimension of greatest interest in MFI. As illustrated in Figure 2, the pattern of self-rated fatigue in the course of the 6 days did not appear to vary as a function of fluid IQ. Indeed, as was the case for mental fatigue, the pattern of self-rated physical, activity, motivation, and overall fatigue in the course of the 6 days did not appear to vary as a function of fluid IQ either.

Conclusions and Future Directions

The preliminary data presented here suggest that a pilot's fluid IQ score might be a useful tool for predicting the pattern of vulnerability in cognitive performance in the course of a sustained exercise, based on a test of working memory. Given that our results are based on a small sample size, they are in need of replication drawing on a larger sample and a wider variety of working memory tasks. In addition, whereas we have documented patterns of performance and self-ratings of fatigue in the absence of implementing countermeasures, the aforementioned recommendations outlined by ASIC require further evaluation in the field. Ideally, our next steps would involve data collection in the Canadian context of an international air combat exercise such as Maple Flag.

Furthermore, it should be noted that fluid IQ can be increased based on cognitive training. Specifically, repeated training on a difficult version of the n-back task has been shown to increase not only working memory capacity, but also fluid IQ.[8] Whether training-based increases in working memory capacity and fluid IQ are transient or permanent remains an active empirical question. In addition, our laboratory has recently shown that a condensed regimen of working memory training is associated with neural efficiency in a problem solving task, suggesting that the brain exhibits functional neuroplasticity that can be harnessed through training.[9] This suggests that if fluid IQ were proven to be a valid and reliable predictor of vulnerability to cognitive fatigue as measured by working memory tests, then it might also be possible to devise customized training regimens that could be used to train pilots in advance of sustained operations. Because successful cognitive performance in sustained air operations is influenced by a variety of factors, this would have to occur in the context of an integrated framework of training and assessment. ◆

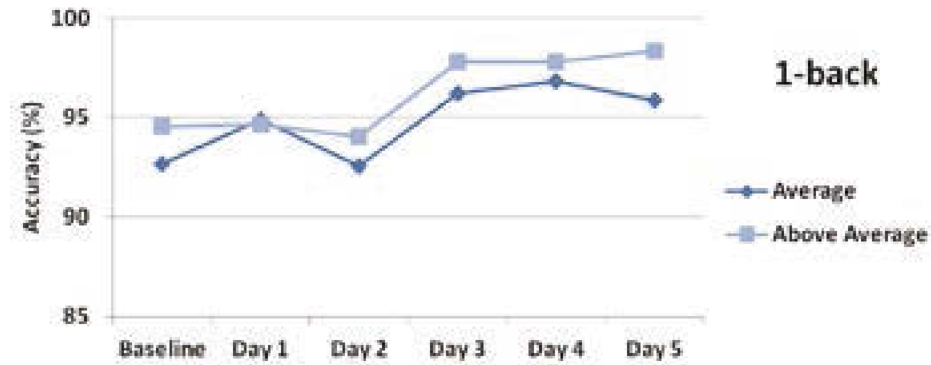

Figure 1. **Performance on the easy (1-back) and difficult (2-back) versions of the n-back task broken down by fluid IQ scores**

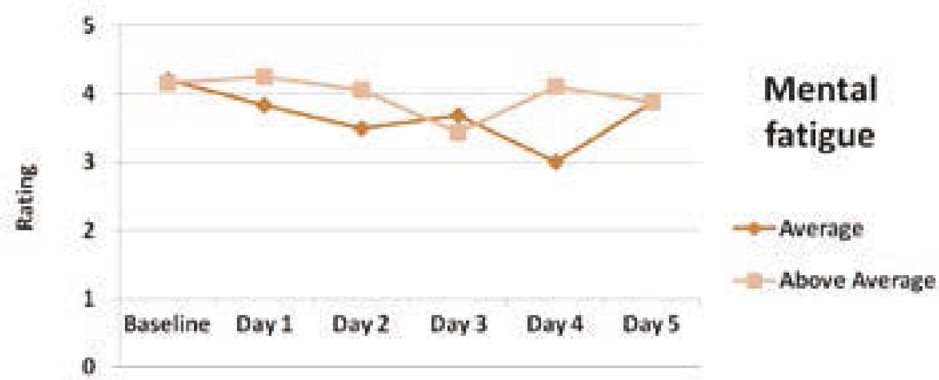

Figure 2. **Self-rated mental fatigue broken down by fluid IQ scores**

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Fatigue 101

By Major Helen Wright

Major Wright is a Flight Surgeon with an interest in human factors and flight safety. She is currently the Base Surgeon in Halifax.

Photo: Sgt Matthew McGregor

Fatigue can affect a hockey player's reaction time, speed, focus and overall game performance. The Vancouver Canucks have one of the most grueling travel schedules in the NHL, not only total time spent travelling, but also crossing time zones. In order to better cope, the team hired fatigue professionals to optimize their game performance. This included having the players wear a wrist monitor to track quality, timing and quantity of sleep. This information was used to carefully plan training and travel schedules (within the constraints of the game schedule). The Canucks and other sports teams also use sleep management techniques such as artificial light to drive player's circadian rhythm. Numerous studies of different competitive sports suggest that peak performance can only occur when an athlete's overall sleep and sleep habits are optimal.

The same thing holds for most of us in our jobs. We also face constraints such as travel, crossing time zones, and shift work – and our own peak performance also depends on optimizing schedules and sleep. The Center for Disease Control and Prevention (CDC) estimates that 30% of civilians do not get enough sleep; this percentage is much higher for those that work shift work. Research indicates that chronic fatigue costs billions of dollars in lost productivity in North America. For instance, studies have shown that workers waste more time at a simple task, such as checking email, when they are fatigued; a study from Singapore University indicated that an extra 8.4 minutes is wasted on email for every hour of sleep missed or interrupted the night before. One classic fatigue study indicates that when we move the clocks forward one hour in the Spring for daylight savings time (causing the population to get one less hour of sleep) there is a 7% increase in the number of car accidents the following Monday morning (Saskatchewan has no seasonal time change and there is no change in their accident rate).

Fatigue is a particularly important problem in safety-related work such as operating a motor vehicle, maintenance work, or piloting an aircraft, in which the consequences of fatigue can be disastrous. Fatigue is widely recognized as a significant safety hazard, whether you are aircrew, a maintainer or play a supporting role in air operations, people's safety and operational effectiveness are at stake. Fatigue can be just as dangerous as using alcohol or drugs. Fatigue can cause loss of concentration, misjudgment, slow reaction time – one can even fall asleep on the job. Being tired can also make you moody, irritable and may cause you to take risks you would not otherwise take.

Some Fatigue Facts:

- One can not train to do with less sleep
- It is not possible to force alertness – fatigue is not a motivation issue
- It is hard to self-evaluate if fatigue is influencing your own performance
- One can not store sleep
- 20% of adults get less than 6 hours/night (average 6.8 hours/night)
- Caffeine does not cancel fatigue
- Physical fitness is not protective against fatigue

Fatigue is caused by a complex interaction of many factors. Defining fatigue is challenging due to the diversity of influencing factors. Causes of fatigue can range from boredom to circadian rhythm disruption to heavy physical exertion. The consequence of fatigue is the impact it has on a person's ability to perform tasks. Fatigue prevents normal functioning.

"Fatigue is widely recognized as a significant safety hazard, whether you are aircrew, a maintainer or play a supporting role in air operations, people's safety and operational effectiveness are at stake."

Causes of Fatigue

Acute vs. Chronic Fatigue

Fatigue may happen acutely in a relatively short time (hours) after a significant physical or mental activity. It may also be chronic, occurring gradually over several days or weeks. Chronic fatigue occurs when one does not get sufficient sleep over a prolonged period of time (as with sleep apnea, jet lag, or shift work) or when one works repeated long shifts (physical or mental activity) with insufficient rest.

Lack of Sleep

How much sleep one needs varies from person to person, but most people require seven to nine hours of sleep a night. Eight hours a night is a good rule of thumb to aim for. Getting less than this over several days will accumulate into a sleep "debt". Losing two hours of sleep a night for four days can cause fatigue equivalent to missing a whole night's sleep.

Duration of Work

Studies completed in operational settings suggests that more time awake, more time on task and more successive duty shifts, without adequate sleep, each increase fatigue and risk.

Circadian Rhythm: Humans run on a 24-hour clock. We are preset to sleep at night and be awake during the day. When working shifts, either in a regular or irregular pattern, you are likely to feel tired since you are out of phase with your body's natural sleeping and waking rhythms. Working when your physiology is set for sleep can reduce the quality sleep. This has been shown to affect shift workers: six hours of sleep during the day is not equivalent to six hours of sleep at night.

The same natural 24-hour cycle influences physiological processes such as hormone production, digestion, temperature and sleepiness. There are two times during the day when you're likely to feel sleepy: in the early morning between midnight and 6 am, and in the mid-afternoon. One important sleep hormone is melatonin. Levels of melatonin are influenced by light exposure, which in turn influences sleep.

Sleep Cycles: When sleeping, we cycle from a light sleep to a deep dreaming sleep and back to a light sleep. How long each cycle runs varies from person to person, but it's usually somewhere from 60 to 90 minutes. It's the deepest sleep that you need to recover best from fatigue.

Working Conditions: Fatigue and its symptoms can be made worse by working conditions. Stress, high pressure, long shifts, and even physical circumstances like poor lighting, noise, and poor weather can add to fatigue. Not taking breaks during your shift will also increase your feelings of fatigue.

Work/Home/Life Balance: The demands of shift work with your family and social life can also be stressful and make it difficult to get the sleep you need for optimal functioning.

"...shift work can contribute to serious health hazards..."

Consequences of Fatigue

Fatigue leads to a decrease in your ability to carry out tasks and is a serious safety hazard. Studies have demonstrated significant impairment in a person's ability to carry out tasks that require manual dexterity, concentration, and higher-order intellectual processing – features which are found in all tasks associated with air operations. Research has found that losing just one night of sleep can impair your performance almost as much as having too much alcohol to legally drive. Your reaction time is slower and you have trouble concentrating or remembering things. There's a much greater risk that you'll make a safety-critical error.

Consequences of fatigue include sleepiness, difficulty concentrating, apathy, a feeling of isolation, annoyance, increased reaction time to a stimulus, slowing of higher-level mental functioning, decreased vigilance, memory problems, task fixation, and increased errors while performing tasks.

Studies show that **fatigued individuals consistently underestimated how tired they were,** so a tired individual truly does not realize the extent of their impairment. Experience, motivation, medication, coffee or will power does not eliminate fatigue or its effects.

Even those accustomed to shift work can face problems trying to balance the need for more sleep with the need to spend time with friends and family at "normal" times of day. Many people who work shifts feel socially isolated which adds to the stress and overall feeling of fatigue.

Over years, shift work can contribute to serious health problems such as heart disease or gastrointestinal problems.

Being fatigued can have an effect on many aspects of your life that you might not expect. Fatigue can influence mood swings, frustration levels, weight gain, motivation, etc. These can have a negative influence on more than your work performance. Your family and other obligations can suffer. And it is not just at work that being fatigued can be dangerous: fatigue puts you at risk of a car accident when driving home after a long shift.

Fatigue is different than many other workplace hazards (such as exposures to toxic substances, dust, noise, etc.) because it is affected by all your activities, not only those that are work related. The system, supervisor and employee share responsibility for fatigue avoidance. You have a big role to play in the fight against fatigue. ◆

Photo: Sgt Gaétan Racine

Fatigue Awareness

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

By Linda Werfelman

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

They presented their recommendations in a December 2011 report released by the U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. The proposals – in the form of a prioritized list – were developed during a March 2011 workshop aimed at addressing fatigue in aviation maintenance ("Top 10 Anti-Fatigue Actions").

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

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

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

Top 10 Anti-Fatigue Actions

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

Source: U.S. Federal Aviation Administration

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

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

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

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

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

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

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

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

> **"Increased awareness of the problem is likely to fuel efforts to develop a means of measuring fatigue ..."**

Fatigue Risk Management System

The workshop delegates also called for action to support and regulate fatigue risk management systems (FRMSs) in aviation maintenance (see, "Finding a Foothold").

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

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

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

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

The second goal is to reduce fatigue-related errors.

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

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

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

Better Data

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

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

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

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

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

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

2010 Survey

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

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

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

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

Photo: Sgt Gaétan Racine

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

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

Note

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

Photo: Sgt Matthew McGregor

An Overview of RCAF Fatigue Issues and Selected Countermeasures

By Michel Paul, Defence Scientist, Defence Research and Development Canada, Toronto

Co-Authors: Colonel Colin Keiver, Director Air Contracted Force Generation, Ottawa
Lieutenant-Colonel Jason Stark, Commanding Officer 429 Squadron, 8 Wing Trenton

During the recent air campaign over Libya (Ops Aleta and Libeccio), our air transport aircrews supporting that campaign experienced some very serious fatigue-related flight safety incidents (FSI) which could easily have been accidents and were secondary to poor mission scheduling. In the case of a J-model CC130, they reached "top of climb" in a very hypoxic state, because cabin pressurization activation was overlooked in the checklist. In the case of a CC177 they had 3 FSIs in one mission: on day 2, hot brakes from a checklist oversight (with modelled fatigue levels resulting in cognitive effectiveness of 68.5%, in excess of equivalence to intoxication with alcohol to blood alcohol content (BAC) of 0.08%); on day 7, mis-identified an airfield during approach to landing (cognitive effectiveness of 45.3%, which is off the scale for BAC equivalence in the performance band where no one can function well on any task) and on day 10, a flap over-speed on landing (cognitive effectiveness of 68% (again equivalent to BAC in excess of 0.08%). Recently, a USAF C-17 was so fatigued they actually landed at the wrong airfield in spite of the runway being only 3,400 feet long instead of the 11,500 foot runway four miles to the south. Apparently, USAF crews are also vulnerable to flying poor mission schedules.

> **"Our experience modeling RCAF missions to determine aircrew mission cognitive effectiveness with the Fatigue Avoidance Scheduling Tool (FAST™) leads us to conclude that current crew duty/crew rest regulations are at times too liberal (allowing missions that result in worrisome levels of cognitive effectiveness) and at other times too conservative (will not allow missions that would actually be safe to fly)."**

Generally, crew duty/crew rest regulations are based on operational experience but not on the foundational science that addresses the interaction of fatigue and circadian processes and theirs effects on performance[1]. The current rules are an attempt to give crews time to recover between flights and often have provisions to compensate crews for long crew days. However, they are not normally prescriptive for behaviour prior to missions, and they treat time of day equally throughout the 24-hour clock.

More recently, in most jurisdictions, there is recognition that aircrew performance during normal daylight hours is usually quite good. However, there is an evolving awareness that during night ops, people are working when melatonin produced by the body is released into their blood which facilitates sleep and induces drowsiness, thus impairing night performance, unless they are adapted to night operations.

For example, the latest FAA policy recognizes that during the WOCL (Window Of Circadian Low – about midnight to 0600 h) performance can be significantly impacted relative to daytime performance. Recently, there is also recognition that there is a complex interaction between "time of day" and "sleep opportunities" and "quality of the sleep environment" and "performance". However, new modeling software (such as FAST™) takes the mystery out of the equation since it recognizes the complex interactions between "work", "sleep" and "time of day".

Before illustrating the FAST™ models for the 2 RCAF missions referred to above, the following brief overview of the FAST™ modeling program is provided (see figure 1).

- The vertical axis on the left side of the FAST™ graphs represents human cognitive performance effectiveness as a percentage of optimal performance (100%). The oscillating line in the diagram represents average performance (cognitive effectiveness) as determined by time of day, biological rhythms, time spent awake, and amount of sleep. This line is thin and black during periods spent awake, thin and gray during sleep periods and is a bold black line during work periods.
- The dotted line, which is below the cognitive effectiveness curve and follows a similar oscillating pattern as the cognitive effectiveness curve, represents the 10th percentile confidence interval.
- The green band (from 90% to 100%) represents acceptable cognitive performance effectiveness for workers conducting safety sensitive jobs (flying, driving, weapons operation, command and control, etc.).
- The yellow performance band (from 65% to 90% cognitive effectiveness) indicates caution. Personnel engaged in skilled performance activities such as aviation should not be allowed to operate within this performance band.
- The pink performance band (below 65%) represents seriously impaired performance effectiveness, for example what might be expected after 2 days and a night of sleep deprivation. Under these conditions, no one can be expected to function well on any task.
- A value of 77% cognitive effectiveness corresponds to performance with a blood alcohol content (BAC) of 0.05% (legally impaired in some jurisdictions). A value of 70% cognitive effectiveness corresponds to a BAC of 0.08% (legally impaired in most jurisdictions). These BAC equivalency levels associated with sleep deprivation/fatigue are based on three important studies[2-4].
- The abscissa (x-axis) illustrates periods of work (red bars), sleep (blue bars), darkness (gray bars) and time of day in hours.
- The grey triangles labelled located just above the abscissa are event markers indicating the key waypoints of this mission (including latitude and longitude to reflect the photoperiod (read sunrise and sundown times) to reconcile circadian stresses as a function of changing time zones.
- Red triangles flag flight safety incidents.

Figure 1 model illustrates the mission schedule flown by CC177 crew and reflects the worst aircrew cognitive effectiveness levels we have seen over the 10 years we have been modeling RCAF Air Operations. It is hardly surprising that there are 3 flight safety incidents flagged in this model (see red triangles, C1, C2, and C3 which correspond to hot brakes from a checklist oversight, misidentified airfield on final approach to landing, and flap over-speed on landing respectively). These dangerous levels of aircrew performance can be, and must be, avoided by better flight scheduling and better aircrew sleep hygiene.

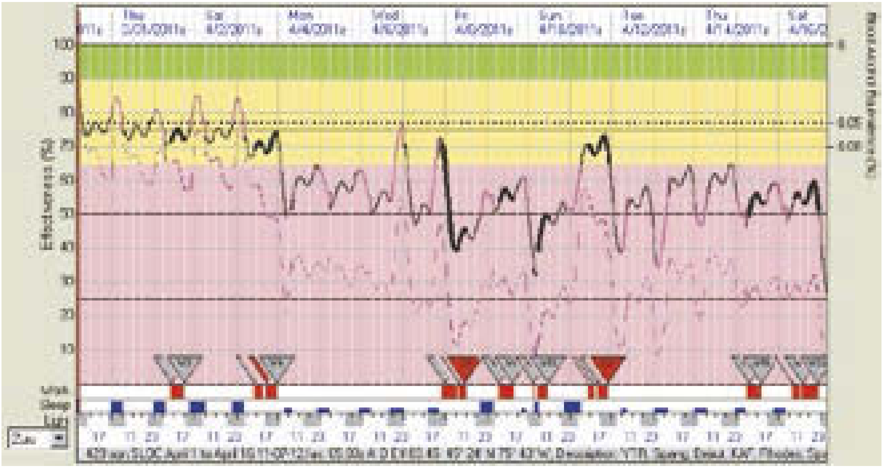

Figure 1. Model of Dangerous CC177 Mission Schedule*

Narrative from the Aircraft Commander

On arrival to OLBA April 3rd, had hot brakes due to an oversight in the approach briefing phase. This could be fatigue related as I have about 1000 hours on the airframe and 2400 total military hours with an additional 1200 civilian hours.

Next event occurred on arrival to ETAD on the 8th April where I misidentified an airfield (EDFH Frankfurt Hahn) that was not our intended arrival airport. Distance between the 2 airports is 30 miles; it was a clear VFR day. Continued to follow ATC vector and descent instruction but due to the misidentification I descended to the next altitude very quickly so that I could carry out an approach to that misidentified airfield. End result was being low and loud due to aircraft configuration, and after some embarrassment, landing at the proper airport. Next event occurred on arrival to OAKN on 11th April, 10-15 knot flap over-speed on selection of 3/4 flaps for landing. Remainder of mission was uneventful.

Narrative by Aircraft Commander

Crew entered 4-hr standby at 0600L (1000z) on 21 Mar 11. Crew was alerted to depart at 1700L (2100z) on 21 Mar 11. We departed CFB Trenton at 2100L (2359z) on 21 Mar with the intention of arriving at Prestwick, Scotland at 1100L (1100z) the following day. However, due to snow showers at CFB Bagotville, the crew was unable to depart and entered crew rest at 0100L (0400z) on 22 Mar.

8 Wing Ops was called and informed that the crew would be ready to depart at 1500L (1800z) after getting 12 hours crew rest. The crew was told to anticipate that departure and timed their rest in order to be ready. Around 1000L (1300z), I received emails and phone calls regarding changes in mission that required my immediate attention and technically interrupting my crew rest. I did have 8 hours uninterrupted but the work started my crew day at 1100L (1400z). I received direction from three sources: 8 Wing Ops, AOC Winnipeg, and 436 Sqn Ops. Our takeoff was delayed until 1859L (2159z) which was already 6 hours into the crew day. Due to severe turbulence throughout the Atlantic, the crew had to divert to Halifax in order to fly south of the area of turbulence as we crossed the Atlantic for Prestwick. We landed 0848L (0848z), and took over an hour to secure the aircraft and get to the hotel. Our crew duty day was 18 hours.

We entered crew rest at 1000L (1000z) and slept throughout the day. We were told to expect a 24 Mar, 0100L (0100z) departure to return to CFB Trenton. Around 2100L (2100z), I received emails and phone calls changing the mission to a 0730L (0730z) departure on 24 Mar. My crew had rested for the early morning departure and therefore found it difficult to properly rest for the 6.5 hour change in itinerary. Due to our sleep/rest cycle, none of my crew was able to sleep through the night and we were quite tired. We started our day at 0430L (0430z). We departed for CFB Trenton, arrived in Goose Bay, and diverted to CFB Greenwood to pick up another load destined for NAS Sigonella. We arrived at CFB Greenwood at 1401L (1701z), but continued to work and load the aircraft in preparation for the next day. We arrived at the hotel at 1700L (2000z) and entered crew rest. The total day was 15.5 hours. However, if you account for our planned itinerary departure, which we were crew-rested for, it was a 21 hour day. At this point, I began to see signs of exhaustion in our crew, but since we didn't technically have two days >16 hours, I did not ask for 36 hours of rest. We had 24 hours to rest at CFB Greenwood, however, our sleep/rest cycle was still set to East Coast time so the crew was awake and active at 1000L (1300z).

We began 25 Mar at 1700L (2000z) to depart CFB Greenwood. Again, I received phone calls and emails that dealt with mission changes while in crew rest. Also, a fourth controlling agency was introduced (the ALCE in Prestwick,

Figure 2 illustrates a mission flown by a CC130J crew. This illustrates modeled performance over 11 separate flights. Except for the first two flights (Trenton to Bagotville and Bagotville to Halifax), the op tempo of this mission produced very deleterious levels of cognitive effectiveness in that about 82% of the time of all 11 flights were spent at performance levels equivalent to being very intoxicated with blood alcohol levels off the scale (see right hand vertical axis). During the last 6 flights, modeled performance was especially worrisome and ranged from 48% to 60%. The red triangle flags the flight safety incident on March 27th (approximately 1712 hrs zulu) where a checklist item was overlooked thus producing a hypoxic cabin altitude.

This model reflects the 2nd worst performance we have modeled from CF air transport operations. These levels of performance can easily result in accidents, and can be avoided by better scheduling.

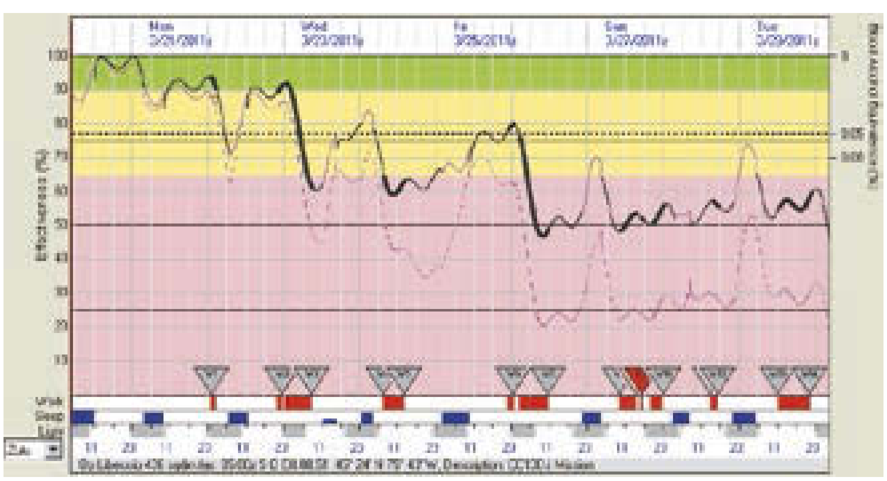

Figure 2. Model of Dangerous CC130 Mission Schedule*

Scotland) which led to more confusion about who was controlling our mission/itinerary. After arriving at the airfield, we found out that we were to download the equipment on the aircraft that was loaded the previous day and divert into CFB Bagotville prior to departing for RAF Kinloss. We made an on-time departure at 1950L (2250z) and arrived at CFB Bagotville. There were snow showers there but we got a break in the snow, de-iced and departed at 2331L (0231z). We landed in RAF Kinloss at 1136L (1136z), but due to lack of availability of MAMS personnel, we had to load the aircraft. We arrived at the hotel and entered crew rest at 1400L (1400z). Our crew day was 18 hours, however, due to our sleep/rest cycle the crew had been awake and active for ~25 hours.

We began 27 Mar at 0700L (0600z) after 16 hours of crew rest. Again, I dealt with itinerary changes while in crew rest. We departed RAF Kinloss for NAS Sigonella on our fourth long itinerary day in a row. In my opinion, this was a contributing factor in our flight safety incident that occurred between NAS Sigonella and Trapani AB. During this leg, the co-pilot skipped a checklist step (turning on the Flight Deck and Cargo Compartment AC) which led to a cabin altitude of >10,000 ft. Passing 10,000 ft, I checked that the aircraft was pressurizing and noted that the cabin was pressurizing but the cabin altitude was higher than usual and decided to check it again at level off. Before we leveled, we received the Cabin Altitude High ACAWS. After going on oxygen, an emergency descent, and a bit of trouble shooting, the co-pilot error was discovered. The aircraft pressurized normally and we continued the mission. After landing at Trapani AB, I reported the Flight Safety. My co-pilot continued to make checklist type errors and stated that he was tired throughout the day. While on the ground in Trapani, our mission changed 4 times and we were finally told to depart for Prestwick, Scotland. We told 8 Wing Ops that we couldn't make Prestwick due to duty day (planned landing at 19+ hours of crew day) and that we would prefer to stay at Trapani. We were told that there were no rooms available in Trapani and we needed to depart. We decided on Frankfurt-Hahn (it was previously our destination and had coordinated parking/rooms). We arrived at 0158L (2358z) and entered crew rest at 0330L (0130z). Our crew day was 19.5 hours.

On our flight into Frankfurt-Hahn, we had a long discussion about crew rest requirements and how we were feeling. The crew was very tired at this point. We decided to take a short day the next day and changed our itinerary to fly to Prestwick, Scotland. We began 28 Mar at 1530L (1330z) and departed at 1648L (1448z). We landed at 1806L (1706z) and entered crew rest at 2000L (1900z).

"The biggest feedback I can give is that there needs to be one central source that manages crew rest in concert with mission requirements. "

We began 29 Mar at 0900L (0800z). Again, I received phone calls/emails during crew rest. Originally we were to depart at 1100L (1000z) but that was changed to 1300L (1200z). We were forced to stop in Goose Bay to get fuel (due to winds) and arrived at CFB Trenton at 1809 L (2209z). We departed the base and ended our day at 1930L (2330z). Our final crew day was 15.5 hours.

My biggest issue was the constant interruption of crew rest. The controlling agencies disregarded the crews need for 8 hours of uninterrupted sleep. This was a contributing factor for the Flight Safety incident that occurred. Second was the constant change in our sleep/rest cycle. On two of the days, the crew was awake and active for over 24 hours. Third was that we never understood who was controlling the mission. We had 4 agencies telling us four different pieces of information.

Overall, I feel that the mission was safely executed. This way the controlling agency knows when a crew should be unreachable. Secondly, if there is any chance that an itinerary could change while crews are resting (which was the norm in this case), then they should be put on Standby status vice being told to be ready for a set departure time. Crews handle standby status differently and can manage their sleep/rest cycle to be ready to execute a mission at any time. If a crew is told of a departure time, then rest is managed so that they can maximize it for that particular departure time. Any slip in departure will result in awake/active times of greater than 24 hours.

The very best aircrew fatigue countermeasure is optimal mission scheduling that will not unnecessarily compromise aircrew performance. To facilitate optimal mission scheduling, we have recommended that the RCAF acquire FAST™ software. The idea is to merge FAST™ with the recently acquired new scheduling software (Airlift Planning Tool or APT), where FAST™ would communicate in background with APT. The scheduler would develop mission schedules normally and then hit a 'hot key' to bring up the schedule in FAST™ automatically. This would allow the scheduler to identify times in the schedule when modeled performance would be below acceptable levels. This would provide an opportunity to optimize the schedule (and thus limit unnecessary aircrew fatigue) before a squadron is tasked to execute the mission. When foreign policy imperatives that drive military taskings dictate high priority immediate response, and there is no room to optimize and/or delay the mission, FAST™ software would identify specific times in the itinerary when performance would be impaired, which is preferable to being unaware of the problem, or worse, ignoring it. In this case, the Flight Surgeon community can use countermeasures to facilitate aircrew sleep, for example with melatonin or zopiclone, during times when sleep has to occur during physiologic day or sustain alertness e.g., with caffeinated gum – StayAlert™. At present, other alertness medications such as modafinil or dexaphetamine are not approved for use in RCAF operations. Similarly, optimum shift schedules and the pharmaceutical fatigue countermeasures can be used to support aircraft maintainers, and Air Operations Centre personnel.

In response to significant operational fatigue problems over the last 15 years (mainly Bosnia and Afghanistan), the RCAF has invested heavily in fatigue research [1,5-14]. The most recent fatigue countermeasure project was focused on circadian phase shifting.

Circadian Phase Shifting

This involves the manipulation of circadian rhythms, either forwards or backwards, to counter jetlag and shiftlag. The two modalities employed to phase shift are 1) appropriately timed ingestion of melatonin to overlap with the body's production of melatonin and 2) appropriately timed light treatment during physiologic night (i.e., when the body is producing melatonin) since light treatment will transform physiologic night into physiologic day by suppressing the body's production of melatonin. Another important factor is avoidance of light at a time when exposure to light will be counterproductive to the desired phase shift. Part of the Air Force's investment in fatigue research was to fund a comprehensive project to optimize our ability to shift circadian rhythms. This project has been very successful. Three of our four circadian publications were awarded three international awards for "Best of Sleep Medicine" for each of 2009, 2010, and 2011 [12,13,15]. The main output from this work was to optimize Phase Response Curves (PRCs) for each of light and melatonin. These PRCs can be used to generate phase shifting treatments, 2 of which are illustrated below.

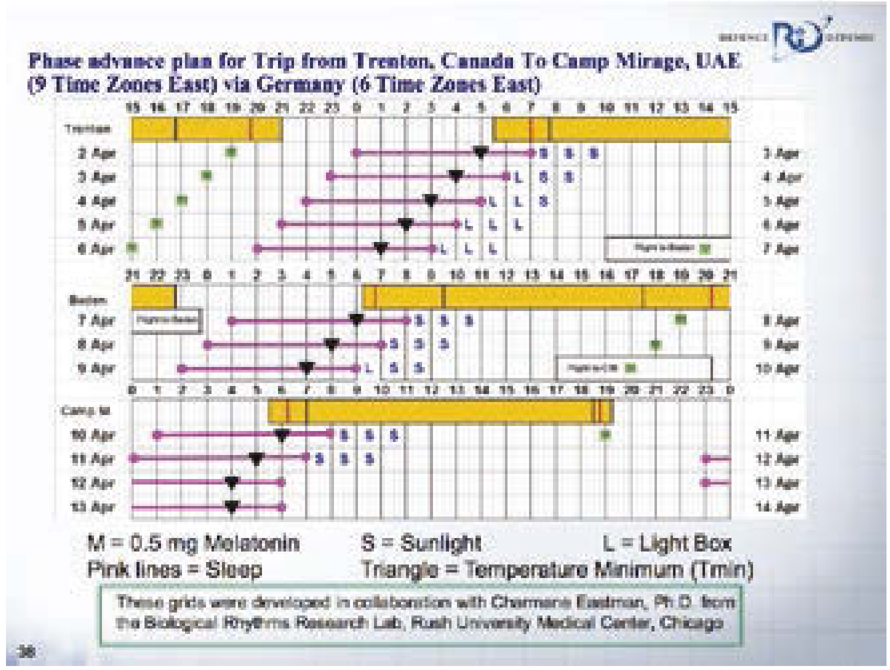

Figure 3. Model of Phase Advance Plan*

The phase shifting treatment in Figure 3 Model above is to phase advance aircrew from Trenton to Camp Mirage. The yellow horizontal bands represent the photoperiod (read daylight hours) in Trenton and the 2 destinations en route to Camp Mirage. The red vertical bar within each yellow band represents sunrise and sunset in each of the 3 locations, thus illustrating when sunlight can be accessed and when a light treatment device has to be used when the sun is not up.

This phase advance treatment involves a 0.5 mg dose of melatonin taken about 2 hours before the onset of the body's melatonin rhythm. Thus, on the first night of treatment the melatonin dose is taken at 1900 hours for someone who has a normal bedtime of 2300 to 2400 with a 7 to 8 hour time in bed. Upon arising the individual undergoing this treatment would seek out bright light for 3 hours. This would yield about an hour of phase advance for each day of treatment. Thus, to remain on the "sweet spots" of the PRCs for light and melatonin, treatment times and bedtimes will advance by 1 hour for each subject's day of treatment. The black triangle is the time at which the body temperature reaches its daily minimum and is a marker for keeping track of the direction and magnitude of the phase shift from day to day. An individual following this treatment would arrive in Camp Mirage about an hour out of synch with the local photoperiod. He/she would need a day to recover from the flight and would continue treatment for the first day in Camp Mirage thus being able to report to Ops the following day completely on local time with no jetlag.

"The main liability of phase advance treatments is that aircrew would be systematically depriving themselves of quality time with their families. "

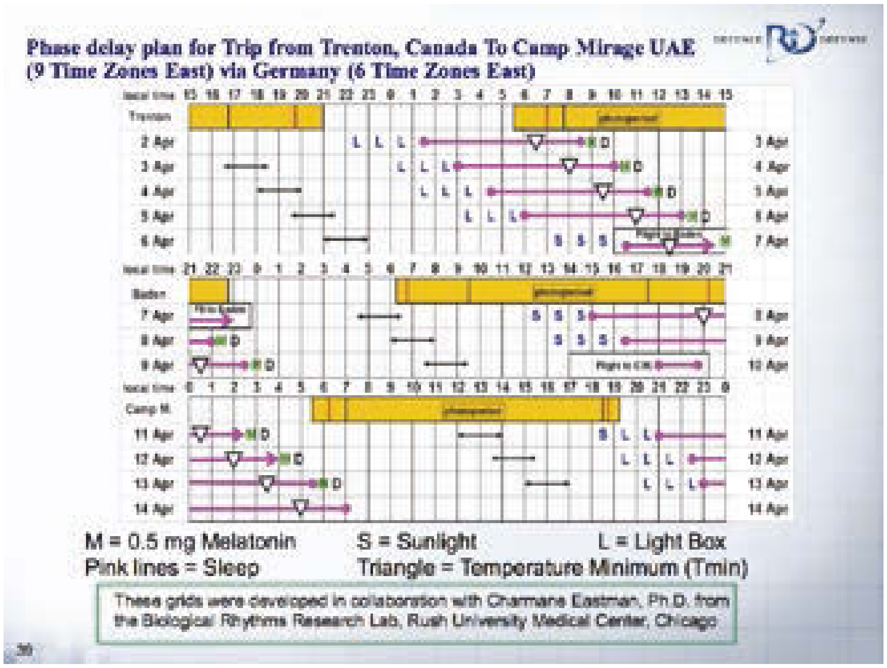

Figure 4. Model of Phase Delay Plan*

By going to bed earlier and earlier each successive day, while at home in the last 5 days before deployment. For those who want more time with their families immediately before deploying, an alternative approach is to shift the long way around the clock (i.e., phase delay of 15 hours versus phase advance by 9 hours) as shown in Figure 4. Since the body is normally 50% more effective at phase delay than phase advance the phase delay option for Camp Mirage would only take an additional day of treatment in Camp mirage before being free of any residual jetlag.

The phase delay treatment figure 4 involves light at night and melatonin in the morning upon awakening, where the individual being treated would remain in dim light (D=dark) after the morning melatonin dose. In the above treatment schedule, the small black arrows represent ideal timings for naps to more easily stay awake during the nightly light treatment.

Circadian desynchrony that is inherent in rapid deployment across multiple time zones or in shiftlag. To counter jetlag and shiftlag, Flight Surgeons can recommend appropriately-timed ingestion of specific melatonin formulations, and appropriately-timed light treatment, as well as avoidance of light at certain times. Since generating the treatment grids above is labour and time intensive, in the near future, we are expecting to develop an application that will allow individuals to input their departure and destination locations and travel dates to receive comprehensive phase shifting treatments for either phase advance of phase delay.

Recent operations have demonstrated that the RCAF has not mastered the art of Air Mobility across time zones mission scheduling. Crews are being exposed to unsafe situations that could be mitigated through scheduling and science. There will always be the missions that require the 150% effort and in these situations smart scheduling and FAST will clearly identify the flight safety risk assumed by HHQ. Authorizing the mission would then place the assumption of risk at the level of Commanders vice Aircraft Commanders. In this era of reduced crew experience and fiscal constraints, it is imperative that we work smart and efficiently with the precious resources we have.

Currently, the Air Force is looking into modifying scheduling by utilizing a fatigue-modelling tool such as FAST in conjunction with operational scheduling software. The RCAF aeromedical community has promulgated a Flight Surgeon Guideline [16] to provide guidance to Flight Surgeons in managing fatigue from a medical perspective, including screening for underlying medical conditions which contribute to fatigue, and prescribing countermeasures to assist with sleep, alertness and circadian phase shifting. ◆

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Photo: MCpl David Hardwick

HPMA Approach to Decision Making

By Captain Scott Anningson

Capt Anningson is a pilot instructing the Human Performance in Military Aviation (HPMA) and Instrument Check Pilot Courses at the Air Force Standards Advanced Performance Centre, 1 Canadian Air Division, Winnipeg, Manitoba. He currently flies the CT-142 Dash 8.

The first and most important step to good decision making (and effective performance) is to define and communicate the objective. Clearly defined goals help people focus on the task at hand. When personnel have the big picture, they are more likely to realize which tasks align with the goal and get the proper attention. It is important to verify whether or not any task or activity do in fact support the high-level goal. Otherwise, you're wasting valuable time and energy. (Probably money too.)

Decision Making at all levels – strategic, operational, and tactical – has more impact on performance than any other factor.[1] We have all made "bad" decisions. We often ask ourselves how we could have made such a poor decision in light of the facts that were present. It's very easy to identify errors in the decision making process after they occur. However, effective threat and error management is about trying to prevent them in the first place. Important and complex tasks are usually approached in a logical step-by-step manner (i.e., checklists, SOPs, etc.). This reduces the potential for error. The same applies to mental tasks like decision-making, especially in a group. In fact, highly effective performers and organizations use a systematic approach to decision making.

The AIPA Decision Making Model. The RCAF HPMA "AIPA" model outlines a decision making process.

AWARENESS: Knowing what is happening, who is doing what or what is the goal.

IMPLICATIONS: Knowing what it means to you or what can happen. Knowing how it affects safety. Knowing how it affects the goal or big picture.

PLAN: Based on Awareness and Implications (aka Situational Awareness), come up with a course of action or plan and contingency plans (Plan A, plan B, etc.). Clearly define tasks, roles, responsibilities and priorities.

ACT: Act on the selected plan, making sure it is being implemented correctly and it is working. Revise as necessary by going through the AIPA model again.

The adoption of a common model allows us to:

- Use a common language when discussing decisions with others
- Breakdown the decision process into observable components. This allows instructors, supervisors, and team members to identify where decision-based errors may have occurred and work to correct them; and
- Improve our own decision making by making this logical approach a habit

> "Three critical resources must be well managed for the AIPA decision process to work: knowledge, attention and time."

Critical Resource #1 – Knowledge. Our ability to make effective decisions depends on the accuracy of our understanding of the situation. Sometimes it is referred to as the 'mental model'). We rely on 2 types of knowledge that influence the decision-making process. First, the long-term knowledge or prerequisite knowledge is all the expertise, experience or bias we bring with us into a situation. This comes from our training, education, trade or culture. Second, we rely on our situational knowledge. That relates to how we understand or even know what is happening or going on around us. Situational knowledge leans heavily on our second critical resource – Attention.

Critical Resource #2 – Attention. If we are not paying proper attention to a goal or task, it is not being controlled. If it is not being controlled, error is virtually inevitable and failure likely. People get into trouble when they stop attending to important goals and tasks.

Critical Resource #3 – Time. If you have lots of time and only small amounts of information to process, the decision-making process might be quite easy. On the other hand, in an emergency situation where time is critical, the amount of information you can process is severely limited. Effective management of time is crucial to effective performance. You may need to build or find time. Following good checklists or good SOPs can save time. They are based on predetermined outcomes and decisions that work.

SUMMARY

With a systematic approach, there is less chance for error. It can also help reduce the amount of time to reach the "right" decision. The circular nature of the AIPA is an error-correcting or feedback model of decision making. Utilizing the process over and over again helps you adapt to changes. The quality of decision making skills is the critical element that distinguishes highly competent performers from less effective performers. AIPA is a method of systematically and logically making decisions. It can also be used to troubleshoot poor decisions. Hopefully, this process will help you become "self-regulating", actively analyzing and improving your own and your team's performance. ◆

Quick Recap of AIPA Process

MANAGE 3 CRITICAL RESOURCES

Time The amount of time available

Attention Where our attention is focused or should be focused

Knowledge The knowledge we possess plus our understanding of the current situation

MAKE DECISIONS

Maximize **Awareness** of what is going on, the potential hazards, and goals

Think through the **Implications** of the situation and possible courses of action

Formulate a **Plan** based on the first two steps (revising/adapting as necessary)

Act on that plan.

KEEP THE PROCESS GOING

Reference:

1. Orasunu, J. (1993). *Decision-making in the cockpit*. In Wiener, E. et al (Eds.). Cockpit Resource Management. Toronto: Academic Press

Photo: Cpl Pierre Habib

On Track

IFR QUESTIONS ANSWERED BY THE RCAF ICP SCHOOL

This article is the first instalment of a continuing *Flight Comment* contribution from the RCAF Instrument Check Pilot 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 question comes from a recent ICP School student: When air traffic control (ATC) gives the clearance, "Cleared on course", is the pilot expected to fly direct to the next waypoint on the flight plan or fly the filed course inbound to that point.

The answer comes from Captain Joshua Fry, USAF exchange officer and ICP School Course Director:

- One of the smaller and often overlooked pilot responsibilities during an IFR departure is executing the proper transition from your assigned departure routing to your filed flight plan routing.
- When you file your flight plan, you usually begin with a navaid located on the departure aerodrome or navaid or waypoint located nearby. Your second point is then the next point on an airway emanating from the first point, a point on a new airway that you intend to join, or an off-airway waypoint or navaid. In the latter two cases, the absence of an airway your flight plan indicates that you'll fly direct to your second point from your first.
- In all cases, you've filed a distinct course inbound to your second point – either an airway or a direct course.
- Frequently, your IFR departure clearance will leave you in the runway's departure corridor for a few miles (i.e., "Fly runway heading"). Otherwise, you may perform a Standard Instrument Departure (SID) or extended radar vectors to avoid obstacles, steer clear of traffic, or abate noise. Eventually, you'll reach a SID termination point or receive some sort of instruction from ATC to transition to your flight plan routing. In the latter case, ATC will usually provide one of two clearances: (1) "Proceed direct [POINT]" or (2) "Cleared on course". The first of these options is pretty straight forward; the second, not so much.

- According to the Federal Aviation Administration (FAA) and Transport Canada, the definition of "on course" is "route centreline". When your clearance is "Cleared on course," you must be careful not to simply proceed from your present position directly to the next point on your flight plan. "Cleared on course" directs the pilot to intercept the flight plan *routing* as filed, and this routing includes a distinct course inbound to each point on the flight plan as stated above. You should remember from your early IFR training that the proper method for intercepting a course is "tail to desired track + 45" for outbound and "desired to the head + 30" for inbound. These procedures are detailed in the A-GA-148.
- Figure 1. You departed aerodrome HOME via Runway 36. You filed "OME ABC" (C) on your flight plan. If you received the clearance "Cleared direct ABC," you would fly direct to ABC (A). However, if you received the clearance "Cleared on course", you are expected to properly intercept the course between OME and ABC (B), which is the course you filed with your flight plan (C).

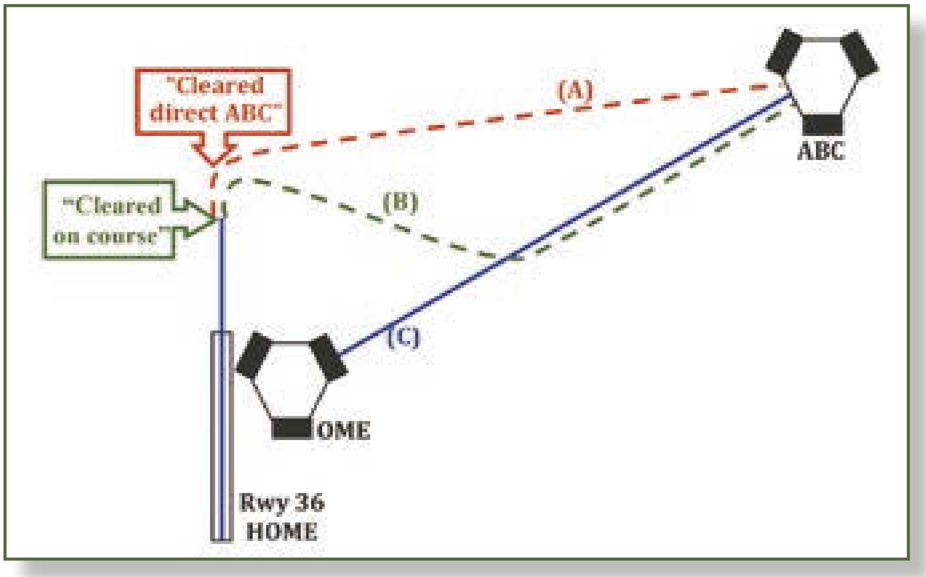

Figure 1

- The easiest thing to do when you receive the clearance "Cleared on course" is to simply reply with: "Request present position direct [POINT]." The controller will probably reply with: "Approved as requested." If not, at least the controller's intentions will be clear: intercept your flight plan route centreline! ◆

Photo: Sgt Gaétan Racine

From the Investigator

TYPE: CH149 *Cormorant* (149910) "C" Category

LOCATION: Greenwood, NS

DATE: 16 November 2012

A technician was carrying out a torque check and nut replacement of the bolted connection between the main gearbox (MGB) upper case and main case when a lock-ring stud failed in overload. Additionally, several other lock-ring studs at the bolted connection had likely been overtorqued and, consequently, the MGB was declared unserviceable and returned to the original equipment manufacturer (OEM) for repair. The torque check was part of an on going recurring inspection detailed in an OEM-issued Mandatory Service Bulletin and was being conducted on aircraft CH149910 during a periodic 300 hour inspection.

The preliminary investigation determined that a number of errors contributed to the lock-ring stud failure, including misidentification of the MGB main case and inadvertent confusion between metric and imperial torque units. The investigation also revealed that similar errors had occurred on other MGBs. The continuing investigation will focus on human factors and the interrelationships between engineering and maintenance. ◆

From the Investigator

TYPE: SAR Tech – "C" Category

LOCATION: Cloud Lake, Greenwood, NS

DATE: 09 January 2013

The accident occurred during a daytime training mission when a SAR Tech received serious injuries upon landing in a confined area following a CC130 aircraft static line parachute jump.

The SAR Tech exited cleanly from the aircraft and commenced flying to the confined area under a normal parachute canopy. He completed his control and manoeuvring check, disconnected his reserve static line snap shackle and completed three sequential spiral turns. He subsequently completed a penetration check and another spiral turn while continuing to descend. Next, at low altitude, he conducted an aggressive 180 degree left turn to enter the confined area via a gap in the trees along the shoreline.

One second after completing the turn, the SAR Tech impacted the ground with considerable forward speed. Two other SAR Techs, who were already in the confined area, ran to the injured SAR Tech to provide medical aid. He was then flown to the Shearwater aerodrome in a CH149 helicopter and transported by ambulance to the Queen Elizabeth II Hospital in Halifax. He sustained "C" category injuries.

The investigation determined that the parachute was serviceable and that the operation of the CC130 aircraft did not contribute to the accident. The investigation is focussed on parachute training, training documentation and the individual actions of the injured SAR Tech. ◆

Epilogue

TYPE: Schweizer 2-33A Glider (C-FXGX) – "B" Category

LOCATION: Oliver Airport, BC

DATE: 15 April 2012

The training mission's focus, as part of the Air Cadet spring gliding familiarization program, was to aid the pilot to accumulate sufficient flight time to qualify as a familiarization pilot. The tow launch, release, upper air sequences and circuit rejoin for runway 36 were flown as briefed. To correct down to the ideal altitude, the pilot deployed the spoilers on the downwind leg and later initiated a brief forward slip on the base leg. After having recovered from the slip, the pilot realized that the aircraft was sinking below the proper approach angle and, therefore, angled the glider in towards the runway to shorten the circuit. The steep glide path lead the pilot to believe that the glider was flying through an area of high sink rather than the result of the still deployed spoilers. During the turn to final, the pilot judged that the altitude was insufficient to reach the field, became anxious and decided to conduct an off-field landing. The Launch Control Officer recognized that the glider's spoilers were still deployed and immediately made a radio call instructing the pilot to close them. Despite hearing the instruction, the pilot did not take any action due to the focuss on modifying the circuit and preparing for the off-field landing.

The glider came to rest in an orchard just outside the airfield perimeter and sustained "B" Category damage; there were no injuries.

The investigation found that the pilot did not adjust the spoilers after having initially deployed them on the circuit's downwind leg. Neither glider mechanical deficiencies nor weather conditions were contributory to the accident.

The safety recommendation is aimed at amending the Air Cadet Gliding Program Manual to implement an in-flight check of the spoiler setting as a final step in the approach and landing procedures. ◆

Epilogue

TYPE: CC130 *Hercules* (130617) – "C" Category

LOCATION: 8 Wing Trenton, ON

DATE: 01 July 2012

Early in the morning of 1 Jul 12 (0212Z), contracted personnel working on a CC150 Airbus in 10 Hangar heard a loud noise and noticed that the Hercules in the adjacent Bay 5 was rocking from side to side. Upon closer inspection, they noted that the left main wing jack had collapsed and damaged the left main landing gear door. The right main wing jack had come off its jacking pad and penetrated approximately 17 to 20 inches into the wing. No fuel cells were ruptured. The right nose jack also came off its jacking fitting and torsional deformation of the airframe was noted on the aircraft fuselage skin near the left nose jacking position.

The aircraft had been on jacks for four days prior to the occurrence. There were no injuries as no one was working on the aircraft at the time.

The investigation determined that the dimensions of key jack components (tension post and bolts) did not meet engineering design requirements. This resulted in three bolts attaching the tension post to the lift unit having only three threads engaged vice the six to seven threads engaged on a jack that is built to specifications. Furthermore, an incorrect jack levelling procedure exacerbated the weakened bolt thread engagement that then allowed the lift unit casting threads to strip under overload, triggering the collapse.

The safety recommendations focus on ensuring parts used are in accordance with design specifications and on developing a correct jack leveling procedure. ◆

Epilogue

TYPE: SAR Tech – "C" Category
LOCATION: Bagotville Aerodrome, QC
DATE: 18 April 2011

During a daytime training free fall parachute jump at the Bagotville aerodrome, a SAR Tech was seriously injured upon landing.

The accident investigation determined that the SAR Tech had a clean exit from the CH146 helicopter at 3,200 feet above ground level (AGL) and that he commenced flying to the designated open-area landing zone under a normal parachute canopy. While in descent he completed his orientation, canopy and slider check, and a control and maneuverability check. He disconnected his reserve static-line snap hook and then completed a stall check, omitting to complete a penetration check. The penetration check is used to assess the wind direction, speed and the parachutist's ability to fly forward into wind. At the time of the accident, the winds were from the west gusting to approximately 20 knots, which was below the 25 knot wind limit of the parachute.

The SAR Tech flew a base leg starting at 500 feet AGL and he turned final at 150 feet AGL, 150 feet below the recommended altitude. A video of his final descent showed that at approximately 40 feet AGL he applied his brake lines to arrest his descent and that he was also aligned to land 40 degrees out of wind. Three seconds prior to touchdown, he began to drift slowly backwards and then, by performing a parachute landing fall, he attempted to land upright on his feet instead of distributing the touchdown impact across his body.

The investigation determined that the parachute was serviceable and that the SAR Tech was current in accordance with 1 Canadian Air Division orders even though it had been 219 days since his last parachute jump. A review of the video showed that the SAR Tech applied his brake lines higher than the appropriate height and with insufficient forward speed to develop the high lift needed to arrest his rate of descent so close to the ground. This resulted in excessive sink and a C category injury.

The missed penetration check, weak wind awareness, and early application of brake lines indicated that the SAR Tech's parachuting skills had deteriorated since his last jump. In response to this accident the RCAF proposed several changes to SAR Tech parachute currency orders, most importantly increasing the frequency of SAR Tech training jumps. ◆

THE BACK PAGE

March 2013 Flight Safety Workshop

DFS hosted in March 2013 its annual Flight Safety Workshop in Ottawa. Major-General Hood, the Assistant Chief of the Air Force, took some time out of his busy schedule to address the RCAF's Flight Safety team. Here are excerpts from his speech:

"Flight Safety and flying supervision is the bread of everything we do in this business. Both have critical roles in how we do our missions and how safely we do them. A common concern across the Air Force is experience levels (or lack thereof). We can control many things in the RCAF but one thing we cannot is demographics. We currently have an excess of inexperience. We are a much younger RCAF than we have ever been. Luckily, we do not have issues with experience levels of the folks we put in key roles such as Flight Safety. In my time as both a Squadron Commander and a Wing Commander, the most important section I had was my Flight Safety team. They provided me an honest and unbiased opinion on the state of the operation I was leading, and for that I was very thankful.

Last year there were 3,237 "D" and "E" category incidents. From my perspective that's 3,237 opportunities for great learning to take place so that we avoid those 10-15 more serious occurrences. The best way to learn from these incidents and reduce them is through effective supervision. Although supervisors today may be less experienced than those I enjoyed earlier in my career, I am constantly impressed by their leadership. There are many tools at supervisors' hands, whether they are flight authorization, how they manage their folks or the missions they are undertaking, that we can control and mitigate the likelihood of occurrences from happening to the greatest extent.

Finally, we cannot fight the experience levels of the RCAF, but it's something we are going to have to deal with. We are going to deal with this issue as best we can at the strategic level but at the Wing levels the work you do is key, that active feedback loop that you provide to us. ***Thank you."***

Photo: Cpl Vincent Carbonneau

The Assistant Chief of the Air Force, Major-General Michael Hood, fields questions during the Flight Safety Workshop.

Photo: Cpl Vincent Carbonneau

The Chief Investigator, Lieutenant-Colonel Paul Dittmann, reviews the outstanding items from previous meetings.

Photo: Cpl Vincent Carbonneau

The Flight Safety Workshop gathered 60 delegates coming from DFS, 1 Cdn Air Div, the Wings, the Cadets and various units and contracted organizations supporting our operations.