ROYAL CANADIAN AIR FORCE JOURNAL

SPRING 2021 • VOL.10, NO.2

National Defence / Défense nationale

CANADIAN ARMED FORCES / FORCES ARMÉES CANADIENNES

Canada

The *ROYAL CANADIAN AIR FORCE JOURNAL* is an official publication of the Commander Royal Canadian Air Force (RCAF) and is published quarterly. It is a forum for discussing concepts, issues and ideas that are both crucial and central to air and space power. The *Journal* is dedicated to disseminating the ideas and opinions of not only RCAF personnel, but also those civilians who have an interest in issues of air and space power. Articles may cover the scope of air-force doctrine, training, leadership, lessons learned and air-force operations: past, present or future. Submissions on related subjects such as ethics, technology and air-force history are also invited. This journal is therefore dedicated to the expression of mature professional thought on the art and science of air warfare and is central to the intellectual health of the RCAF. It serves as a vehicle for the continuing education and professional development of all ranks and personnel in the RCAF as well as members from other environments, employees of government agencies and academia concerned with air-force affairs.

EDITORIAL TEAM

Published by Royal Canadian Force Aerospace Warfare Centre
ISSN 1927-7601

ASSISTANT EDITORS Adri Boodoosingh, Leah Fallis and Vickie Thobo-Carlsen

GRAPHIC DESIGN Baz Kanda

ONLINE EDITION Christine Rodych

PRODUCTION MANAGER Denis Langlois

For digital version please visit:
http://www.rcaf-arc.forces.gc.ca/en/cf-aerospace-warfare-centre/index.page
http://trenton.mil.ca/rcaf-awc/en/elibrary/journal/current-issue.asp

NOTE TO READERS

As a bilingual publication, readers should take note that where quotations are translated from their original language, we will use the term [Translation] at the end of the quote to indicate that readers can find the original text in the other language version of the *Journal.* Unless otherwise noted, photographs appearing in the Journal are attributable to the Department of National Defence and the public domain.

ROYAL CANADIAN AIR FORCE JOURNAL

AIR SPACE POWER IN FORMATION

AGILE • INTEGRATED • REACH • POWER

SUBMISSION REQUIREMENTS

The *ROYAL CANADIAN AIR FORCE JOURNAL (RCAFJ)* welcomes the submission of articles, book reviews and shorter pieces (which will be published in the Letters to the Editor, Points of Interest, Pushing the Envelope and Point/Counterpoint sections) that cover the scope of Air Force doctrine, training, leadership, lessons learned and Air Force operations: past, present or future. Submissions on related subjects such as ethics, technology and Air Force history are also invited.

JOURNAL SECTIONS

ITEM	WORD LIMIT*	DETAILS
LETTERS TO THE EDITOR	50–250	Commentary on any portion of a previous *RCAFJ*.
ARTICLES	3000–5000	Written in academic style.
BOOK REVIEWS	500–1000	Written in academic style and must include: • the book's complete title (including subtitle); • the complete names of all authors as presented on the title page; • the book's publisher, including where and when it was published; • the book's ISBN and number of pages; and • a high-resolution .jpg file (at least 300 dpi and 5 by 7 inches) of the book's cover.
POINTS OF INTEREST	250–1000	Information on any topic (including operations, exercises and anniversaries) that is of interest to the broader aerospace audience.
PUSHING THE ENVELOPE	250–2000	Forum for commentary, opinions and rebuttal on *RCAFJ* articles and/or issues that are of interest to the broader aerospace audience.
POINT/COUNTERPOINT	1500–2000	Forum to permit a specific issue of interest to the RCAF to be examined from two contrasting points of view.

* Exclusive of endnotes

AUTHORS ARE ASKED TO NOTE THE FOLLOWING GUIDELINES:

- Submissions may be made in either official language.
- Authors must include a brief (one paragraph) biographical sketch which includes current appointment/position, telephone number and email address. Please include all professional and academic designations as well as military decorations.
- Selected articles that have been peer reviewed have a  to the left of the title.
- The Senior Editor will notify contributors on the status of their submission. It may not be possible to publish all submissions.
- All text submissions must be digital, in Microsoft Word or rich text format. Files must not be password protected and must not contain macros. Files may be submitted by mail or email at the addresses provided below.
- All supporting tables, images and figures that accompany the text should be sent in separate files in the original file format (i.e., not imbedded in the text). Original vector files are preferred; high-resolution (not less than 300 dpi) .psd or .jpg files may be submitted.
- Authors are required to provide "alternate text" with detailed descriptions for all figures. The alternate text is to be labelled as such and placed below the caption.
- Copyright permissions are required for all material that is not Department of National Defence or author originated. It is the author's responsibility to obtain and submit the necessary written permissions which must include the author's/artist's name as well as the publisher's name and location. Any material not meeting these requirements may be omitted from the article.
- The Senior Editor may select images or have graphics created to accompany submissions.
- Authors should use *Oxford English* spelling. When required, reference notes should be endnotes rather than footnotes and formatted in Chicago style. For assistance refer to *The Chicago Manual of Style, 17th Edition* or RCAF AWC Production Section at RAWCProd@forces.gc.ca
- Acronyms and abbreviations should be used sparingly:
  - If they are required in the text, the term is to be written out in full the first time it is used and then followed by the abbreviated form in parentheses.
  - A list of all abbreviations (and their terms) used in the text will be included at the end of each submission.
- The Senior Editor reserves the right to edit submissions for style, grammar and length but will not make editorial changes that will affect the integrity of the argument without consulting the author.

FOR FURTHER INFORMATION OR TO MAKE A SUBMISSION PLEASE CONTACT THE SENIOR EDITOR AT:

RCAF Aerospace Warfare Centre
8 Wing / CFB Trenton
Box 1000 Stn Forces
Astra, Ontario K0K 3W0

Attn: Major Derrek Williamson RAWCRCAFJournal@forces.gc.ca

CALL FOR SUBMISSIONS

For the Winter issue: **30 October**

For the Spring issue: **30 January**

For the Summer issue: **30 April**

For the Fall issue: **30 July**

DISCLAIMER

CONTENTS

SPRING 2021

VOLUME 10 • NUMBER 2

EDITOR'S **MESSAGE**

Welcome to the 2021 spring edition of the *Royal Canadian Air Force Journal*. This issue provides multifaceted articles for the air power practitioner and enthusiast. From the first trans-Canadian flight to the tragic loss of Lancaster KB 965 in 1950, and to the art of modern navigation, there are items of interest for everyone.

History is replete with the glorious yin of achievement and technical advancement but also the yang of unfortunate events of tragic loss and destruction. Colonel John L. Orr (Retired) describes in vivid detail, both written and pictorially, one of those great successes in early Canadian aviation history in an article titled "'The Way of an Eagle in the Air' – The Canadian Air Board and the First Trans-Canada Flight." The event is not common knowledge nor often the fodder of historical discussion. It most certainly is, nevertheless, a significant piece of Canadian aviation history.

Dr. Richard Mayne provides the yang balance (to apply the above metaphor) of tragedy in his article "'We're About to Crash': The Ghosts of KB 965 and Other Lost Aircraft at Canadian Forces Station Alert, 1950–1991." This article describes one of the worst Canadian aviation losses in the Arctic, including what went wrong as well as why and how it was corrected. Within the article, Dr. Mayne also provides an incredible human-interest story of destiny, tying the Commander of the Royal Canadian Air Force to ancestors of a member of the ill-fated KB 965's crew.

"How We Think: Embracing Complexity in Canadian Armed Forces Policy," by Lieutenant-Colonel R. M. Kastrukoff, examines various contexts of problem solving. Are the military institution's processes for problem solving and innovation limiting? How does the military cope with different types of problems in terms of context? Is the operations planning process fulfilling its intended function as our primary complex problem matrix, or are there more applicable methods? The article provides insight regarding the cognitive application of contextual problem solving and complexity science.

Modern navigation is a wonder that has seen incredible advancement over a relatively brief period. As navigation technology advances, so do adversarial countermeasures. In "GPS Denial: The Implications to RCAF Operations," Captain Nelson Berry discusses the operational readiness of the RCAF in a Global

Positioning System / global navigation satellite system–denied environment and the requirements for mitigating those threats.

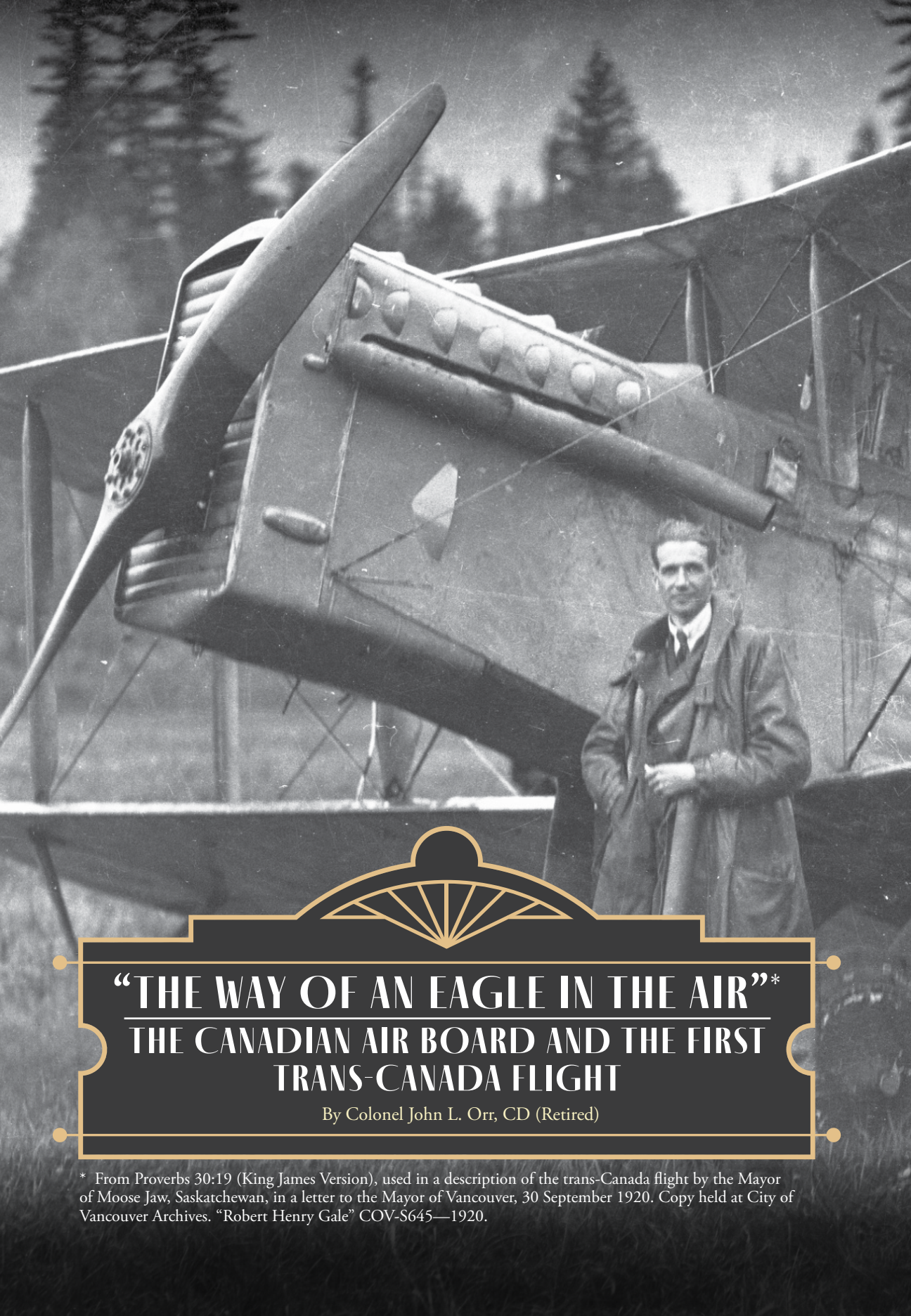
Looking for a good read to pass the time at home during the COVID-19 pandemic? The book *I Will Run Wild: The Pacific War from Pearl Harbor to Midway* may be exactly what you are looking for. Chris Buckham reviews this multi-perspective account of the Pacific conflict by author Thomas McKelvey Cleaver.

Enjoy the read.

Sic Itur Ad Astra

Major Derrek Williamson, CD, P.Log

Senior Editor



"THE WAY OF AN EAGLE IN THE AIR"*

THE CANADIAN AIR BOARD AND THE FIRST TRANS-CANADA FLIGHT

By Colonel John L. Orr, CD (Retired)

* From Proverbs 30:19 (King James Version), used in a description of the trans-Canada flight by the Mayor of Moose Jaw, Saskatchewan, in a letter to the Mayor of Vancouver, 30 September 1920. Copy held at City of Vancouver Archives. "Robert Henry Gale" COV-S645—1920.

INTRODUCTION

The first trans-Canada flight took place from 7 to 17 October 1920 and crossed the country from Halifax to Vancouver. This little-known chapter of Canada's aviation history was planned, organized and executed by an even less well-known department of the Dominion government, the short-lived Canadian Air Board (1919–1922). It was the Air Board that played the key role in the development of Canadian aviation policy, both civil and military, in the aftermath of the First World War and led, after many twists and turns, to the eventual establishment of the Royal Canadian Air Force (RCAF) in 1924.[1]

This article explains the origins of the Air Board and its impact on the preliminary development of aviation in Canada. It also describes in some detail the Board's singular operational achievement—the first trans-Canada flight of 1920.

DISCUSSION

The First World War brought in an era of rapid development in military aviation, with the result that virtually all of the combatants established their own national air services. Canada, however, did not follow suit despite the fact that "substantially more than 20,000 [Canadians]" served in the Imperial (British) Flying Services, the Royal Flying Corps (RFC), the Royal Naval Air Service (RNAS) and, after amalgamation of the flying services on 1 April 1918, the Royal Air Force (RAF).[2] Until 1918, the Canadian government stubbornly resisted appeals to establish a national air service, principally because of the responsibility to provide a four-division corps in the field as requested by the Imperial authorities.[3]

While a small number of Canadians were recruited and underwent primary flight training in Canada and the United States in 1915–16, it was not until late December 1916 that the British authorities reached an agreement with Canada to establish a flying training organization in Canada—the Royal Flying Corps, Canada (RFC [Canada]). Under direct British command, it was this formation that trained the majority of Canadian fliers for the First World War, although a significant number were trained overseas on direct entry to the RFC/RAF from the Canadian Expeditionary Force.[4]

In a parallel development, the Imperial Munitions Board (IMB), another agency under the direct control of the British government, established a "national factory," Canadian Aeroplanes Limited in Toronto, to supply the RFC (Canada) with Curtiss JN-4 (Canuck) trainers.[5]

A JN-4 C227 Canuck (USAAS #39158), operated by the United States Army Air Service in 1918, is now restored and on display at the Canada Aviation and Space Museum.

Despite the government's reluctance to embrace a national air service, by 1918, in response to increasing public pressure to form a distinctly Canadian air service overseas as well as the threat of long-range German submarines operating in the Western Atlantic, Canada had two proto–air forces: a two-squadron Canadian Air Force (CAF) located at Upper Heyford in the United Kingdom (UK) under RAF command[6] and the Royal Canadian Naval Air Service (RCNAS). In the latter case,

two seaplane stations were hastily constructed by Canada in Nova Scotia and were staffed by the United States Navy (USN) in 1918 until the RCNAS could become operational in 1919.

The upshot of all this was that, by the time of the armistice, Canada had a first-rate national aircraft-manufacturing facility, extensive flying training facilities as well as two seaplane bases and a large number of trained aircrew and technical personnel.

Among a host of post-war topics, the Reconstruction and Development Committee was directed to examine matters related to transportation, including air transportation.

In the immediate aftermath of the war, demobilization and economy were the watchwords of the day. As an Imperial unit, RAF (Canada) was quickly closed down and its principal air station, the "air side" of Camp Borden, was turned over to the Department of Militia and Defence. In a parallel development, the aircraft manufacturing facilities of Canadian Aeroplanes Limited, under the control of the IMB, were quickly disposed of. The RCNAS was disbanded on 5 December 1918, and by 11 January 1919, the USN departed Nova Scotia and the air stations, along with 12 Curtiss HS-2L flying boats and engines, were turned over to the Naval Service of Canada.

In the UK, the future of the two-squadron CAF and its wing headquarters lay in the balance. The Ministry of the Overseas Military Forces of Canada foresaw the establishment of the nucleus of a military air service as a means of ensuring that, "though small, it might provide a fully-developed organization on which might be based any future organization in Canada."[7] The argument failed to win the day in Ottawa, and the decision was eventually made to disband the CAF in 1920.[8]

All of the above placed great pressure on the Dominion government to finally "do something" with respect to the development of aviation in Canada.[9] As explained below, the result was the establishment of an air board, a new department of the Dominion government that would eventually organize and conduct the trans-Canada flight of 1920.

THE AIR BOARD OF CANADA

As a preliminary step towards the creation of the Air Board, a Cabinet-level committee, the Reconstruction and Development Committee, was established in October 1917, shortly after the formation of Sir Robert Borden's Union (coalition) government and immediately prior to the election of December 1917.[10] Among a host of post-war topics, the Reconstruction and Development committee was directed to examine matters related to transportation, including air transportation.[11] The vice-chairman of the committee was the Honourable A. K. Maclean, minister without portfolio, who also served from time to time as the acting minister of the Naval Service of Canada. In this latter capacity, he introduced the legislation creating the RCNAS in 1918, and through that came into contact with John A. Wilson[12] and Major Clarence MacLaurin.[13]

Unlike the Ministry of the Overseas Military Forces of Canada, which sought to transfer the nucleus of a military air force to Canada, Wilson and MacLaurin shared a broader vision of the

possibilities for aviation in Canada in the post-war era—a future that stressed aviation as an enabler of Dominion government responsibilities using the readily available supply of trained personnel and equipment. From Wilson's perspective, "the time had not yet come for Canada to embark on a policy of maintaining a permanent military or naval air force."[14]

Apart from the previously mentioned developments, the future of civil aviation was being planned by a sub-commission of the Paris Peace Conference. Canada, as a member of the British Empire delegation, was heavily involved in the discussions that eventually produced the International Convention on Air Navigation.[15] One of the Canadian representatives to these talks was Lieutenant-Colonel (Lt.-Col.) O. M. Biggar, the Judge Advocate-General of Canada, who would later play a key role in the implementation of post-war aviation policy as the vice-chairman of the Air Board.

Eventually, a breakthrough came when the President of the Privy Council tasked MacLaurin to write a paper regarding the establishment of a "National Canadian Air Service." The paper was submitted on 28 January 1919, and matters then began to move quite quickly.

As the Reconstruction and Development Committee carried out its deliberations, Wilson and MacLaurin engaged in what they termed "missionary work" and promoted their vision of post-war aviation at every opportunity. Eventually, a breakthrough came when the President of the Privy Council tasked MacLaurin to write a paper regarding the establishment of a "National Canadian Air Service." The paper was submitted on 28 January 1919, and matters then began to move quite quickly.[16]

In summarizing these events, Wilson stated in a personal letter of 2 May 1919 that

> after having almost given up hope of getting anything done, about a month ago [April 1919], things suddenly became lively and I was asked to draft a bill instituting an Air Board, which I did, giving it all the powers possible and making it as wide as I could possible [sic] think of. My first effort was put forward with a good deal of trepidation, but it was received very favourably by Mr. Maclean, who on this matter has proved altogether a brick, and has it in charge.[17]

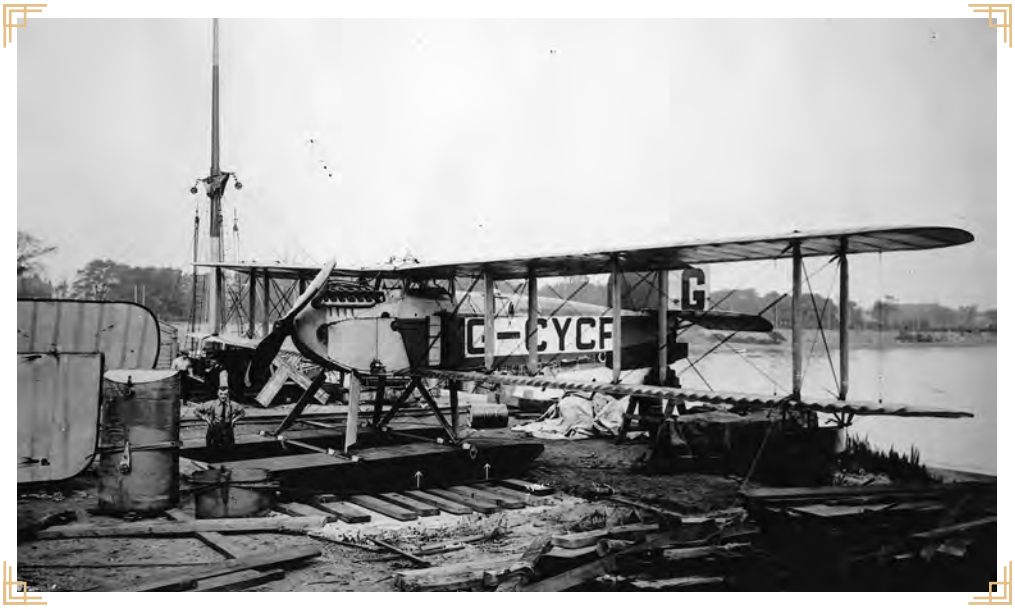
The Air Board Act was introduced by Minister Maclean on 29 April 1919 and given Royal Assent on 6 June 1919. The Air Board had the broad mandate "to supervise all matters connected to aeronautics." To accomplish this, "aeronautics" was broken down into three distinct fields: the control of commercial flying, the conduct of flying for the civil services of the government and the organization of the air defence of Canada.[18]

A Certificates Branch was assigned responsibility for the licensing of personnel, aircraft and air harbours (airfields) in support of commercial flying, and a Flying Operations Branch was

> Lt.-Col. Scott, Superintendent of the Certificates Branch, asked that at their next meeting the Air Board consider a submission for a transcontinental flight to be flown about the middle of September from Halifax to Vancouver.

established to conduct civil government flying operations. With respect to the "air defence of Canada," after considerable deliberation it was decided to recommend to the Privy Council that a non-permanent, non-professional CAF be established under the authority of the Air Board.[19] This was, for all intents and purposes, a militia organization and its limited scope reflected the severe financial constraints of the day. On 18 February 1920, the formation of the "new" CAF was promulgated by Order in Council.[20]

Meanwhile, as part of its demobilization programme, the British Air Ministry sought to facilitate the development of military air forces in the self-governing Dominions through the donation of surplus aircraft—the "Imperial Gift."[21] The Canadian Air Board intervened in the selection of aircraft types and requested more seaplanes / flying boats as opposed to landplanes—a request that was largely ignored.[22] The donated machines were packed up by Canadian personnel in the UK in late 1919 and shipped to Camp Borden, where they eventually arrived in early 1920. Included in the "Gift" were three different types of aircraft that would take part in the trans-Canada flight: a Fairey III C seaplane, Felixstowe F.3 flying boats and DH 9A landplanes.



G-CYCF Fairey III C being erected at a Vickers Canada dry dock in Montréal.
(Photo: RE 11710-3 Hitchins Collection, University of Western Ontario)

G-CYAN DH 9A aircraft flown from Winnipeg to Regina.
Air Commodore Tylee and crew await arrival of mail at St. Charles Airfield, Winnipeg. (CASM-14875)

THE FLIGHT[23]

On 12 August 1920, in a memorandum to Secretary of the Air Board Wilson, Lt.-Col. Scott, Superintendent of the Certificates Branch, asked that at their next meeting the Air Board consider a submission for a transcontinental flight to be flown about the middle of September from Halifax to Vancouver.[24]

The objectives of the flight were to "demonstrate the feasibility of such a flight from a commercial point of view; prove the possibility of a fast trip from coast to coast without undue strain on the pilots or machines; and serve as recruiting propaganda for the CAF (part of the Air Board at that time) and to stimulate an interest in aviation by commercial firms and the public generally."[25]

What was the impetus for the flight? Until now it has been hard to say, but recently, the Wing Heritage Office at 17 Wing Winnipeg forwarded to the author an undated, unsigned manuscript attributed to Air Marshal Robert Leckie that describes the trans-Canada flight. In the manuscript, Leckie explains that the Air Board was initially opposed to carrying out the trans-Canada flight in 1920, as it was not properly organized for such an endeavour. However, he then adds that the new chairman of the Air Board, the Honourable Hugh Guthrie, for reasons of his own, decided to go ahead regardless. Apparently, Guthrie felt that "something of a spectacular nature should be done to focus attention on flight, and a flight across Canada seemed to fill the bill."

The Air Board approved the trans-Canada flight and the planning began. The responsibility for this pioneering effort was to be divided between the three branches of the Air Board as follows: the Certificates Branch was to organize ground facilities from coast to coast, including air routes and refuelling arrangements; the Flying Operations Branch was to fly the first part of the flight between Halifax and Winnipeg; and the CAF was to fly the Winnipeg to Vancouver section.

There were, of course, a host of details to be taken care of. The Certificates Branch organized 10 locations with mooring facilities for the eastern half of the flight and 10 landing fields suitable

for night landings for the western half of the flight. Imperial Oil (Sarnia) was contracted to provide the fuel for the planned stops as far west as Moose Jaw, Saskatchewan, as well as for alternate locations along the route.

Other details included arrangements with the Radiotelegraph Branch of the Naval Service to provide flight following and, finally, it was decided that the aircraft would carry letters of greeting from mayors and lieutenant-governors along the route to the mayor of Vancouver and the lieutenant-governor of British Columbia.[26]

Aircraft were the next priority and, as noted above, it was planned to use relays of the Imperial Gift aircraft to carry out the trip. For the first leg, the Fairey III C seaplane would be used for a non-stop 24-hour flight from Halifax to Winnipeg to take advantage of its long range. As a backup to the Fairey, a Felixstowe F.3 flying boat would also be utilized. These aircraft were shipped from the UK to Montréal, where they were assembled at the Canadian Vickers dry dock.[27] For the flight from Winnipeg to Vancouver, four DH 9A aircraft and maintenance personnel were shipped west from Camp Borden, three aircraft to Winnipeg for assembly there and one to the Air Board station at Morley, Alberta.

When Leckie went to Montréal on 22 September to carry out a test flight at the Vickers dry dock, it became readily apparent that the aircraft could not take off with sufficient fuel for a non-stop flight to Winnipeg from Halifax.

Then the aircrew had to be selected. Lt.-Col. Leckie, as the Superintendent of the Flying Operations Branch, chose to fly the leg from Halifax to Winnipeg, while Air Commodore Tylee, Air Officer Commanding, CAF, volunteered to be a passenger from Winnipeg to Vancouver.[28]

There was no shortage of candidates to choose from for the remaining positions on the flight. Squadron Leader B. D. Hobbs of the Flying Operations Branch would join Leckie as co-pilot on the leg from Halifax to Winnipeg. Once there, the CAF would take over by flying DH 9A landplanes in relays to Vancouver. Tylee would fly from Winnipeg to Moose Jaw with Flight Lieutenant J. B. Home-Hay, then to Calgary with Flight Lieutenant C. W. Cudemore and, finally, to Vancouver with Flight Lieutenant G. A. Thompson.

As mentioned above, great reliance was placed on the Fairey III C to carry out the flight from Halifax to Winnipeg in 24 hours. Regrettably, this reliance was misplaced. When Leckie went to Montréal on 22 September to carry out a test flight at the Vickers dry dock, it became readily apparent that the aircraft could not take off with sufficient fuel for a non-stop flight to Winnipeg from Halifax. The planned legs were adjusted and the route now included a refuelling stop at Rivière-du-Loup, Quebec, where a Felixstowe F.3 would be waiting as a spare. After Rivière-du-Loup, the route west would include refuelling stops in Ottawa and Sault Ste. Marie, Ontario, before arriving in Winnipeg.[29]

G-CYBF DH 9A aircraft flown from Calgary to Vancouver via Revelstoke and Merritt. It arrived at Minoru Park on 17 October 1920. From left to right: Tylee, Mayor Gale and Thompson. (Photo: DND RE 20776-18)

After several frustrating delays, Leckie and Hobbs finally left Montréal on 29 September in the Fairey III C bound for Halifax. Heavy fog forced the seaplane down west of Fredericton, New Brunswick (NB), and the crew had to wait until 3 October before the weather cleared and they could rectify an electrical snag caused by heavy rain. As they were waiting, drifting logs in the Saint John River punctured one of the aircraft's floats. Since there were no facilities to beach the aircraft, it was necessary to suspend it under a bridge to drain the water! Finally, on 5 October, the Fairey took off for Halifax and landed at Air Board Station Dartmouth, Nova Scotia, in the afternoon, having finally reached the start line.[30]

At 0800 on 7 October, the Fairey departed Halifax with the precious bag of letters addressed to mayors and lieutenant-governors. Their destination was the first scheduled refuelling stop at Rivière-du-Loup. Alas, the problem-plagued Fairey ran into turbulent weather over the Bay of Fundy, and shortly after passing Saint John, NB, the engine cowling ripped off and struck the externally-mounted fuel pump, dousing Leckie in fuel. A forced landing was carried out on the Long Reach of the Saint John River and the Fairey was so badly damaged it could not complete the rest of the flight.

Leckie called up an ex-USN Curtiss HS-2L from Air Board Station Dartmouth, and the station superintendent, Squadron Leader A. B. Shearer, flew the Curtiss through the turbulence over the Bay of Fundy to rescue Leckie and Hobbs. The crews exchanged aircraft, and Leckie and Hobbs flew on in the HS-2L to Fredericton. They refuelled there and, at 1915, headed off to Rivière-du-Loup and landed in heavy weather at 2305. Rather than carry on that evening to Winnipeg, the crew wisely elected to spend the night in Rivière-du-Loup.

The leg from Calgary to Vancouver presented significant challenges, both from the altitude of the mountain passes and the poor weather experienced in mid-October.

The following morning, 8 October, Leckie and Hobbs left the HS-2L behind and, along with Foreman Mechanic C. W. Heath, took off for Ottawa at 0720 onboard the Felixstowe F.3, which had flown in from Montréal the day before. The seas were still running at Rivière-du-Loup, and waves were breaking over the top wing when the F.3 took off.

After reaching Ottawa at 1230, engine trouble delayed their departure to Winnipeg until 0845 the following day. In Ottawa, Captain G. O. Johnson joined the crew and acted as navigator for the rest of the flight to Winnipeg.[31] The F.3 arrived at "the Soo" (Sault Ste. Marie) at 1635, 9 October. Refuelling was completed promptly, but dense fog precluded take-off until 0730 on 10 October. Kenora, Ontario, was eventually reached at 1555, when the F.3 landed to refuel and repair a leaking radiator. The aircraft finally took off at 2015.

From Kenora, the airmen followed the Winnipeg River to Lake Winnipeg, thence southward along the Red River to a planned landing near the confluence of the Red and Assiniboine Rivers, where a crowd of nearly 5,000 was awaiting their arrival. Heavy mist precluded a landing, so Leckie landed further north on the Red River at Selkirk, Manitoba, at 2245, to the great disappointment of their supporters.

The mail bag was immediately sent on to St. Charles airfield in Winnipeg, where Tylee and his pilot, Home-Hay, were waiting with their DH 9A landplane. They took off at 0430, 11 October, heading west, with Moose Jaw as their intended destination.

Unfortunately, the DH 9A developed engine trouble just past Regina, and Home-Hay turned back and landed at Regina's municipal airport. Cudemore was summoned from Moose Jaw, and by 1100, he and Tylee were in the air on their way to Medicine Hat, Alberta, where they arrived at 1345. By this time, Thompson had also arrived from Calgary, and the two aircraft headed off at 1510 to Bowness Field, Calgary, where they touched down at 1710.

The leg from Calgary to Vancouver presented significant challenges, both from the altitude of the mountain passes and the poor weather experienced in mid-October. On 12 October, Thompson and Tylee were weathered in at Calgary. On 13 October, they eventually got away at 1155 and headed into the Rockies following the Bow River and crossed into British Columbia via Kicking Horse Pass. They crossed the Selkirks using Rogers Pass and headed west of Revelstoke, only to be turned back by heavy snowstorms. They eventually landed at the Crowle Ranch in Revelstoke at 1510.

They were delayed by another weather day on 14 October, and it was not until 15 October that the flight could continue. Take-off was at 1150 and, after crossing the Monashees via Eagle Pass, they were forced back by fog and landed at Merritt at 1315.

G-CYAG Curtiss HS-2L aircraft taxis for take-off at Canadian Air Board Station Dartmouth. This aircraft rescued Leckie and Hobbs in the Saint John River. (Photo: REGH-2123, Hitchins Collection, University of Western Ontario)

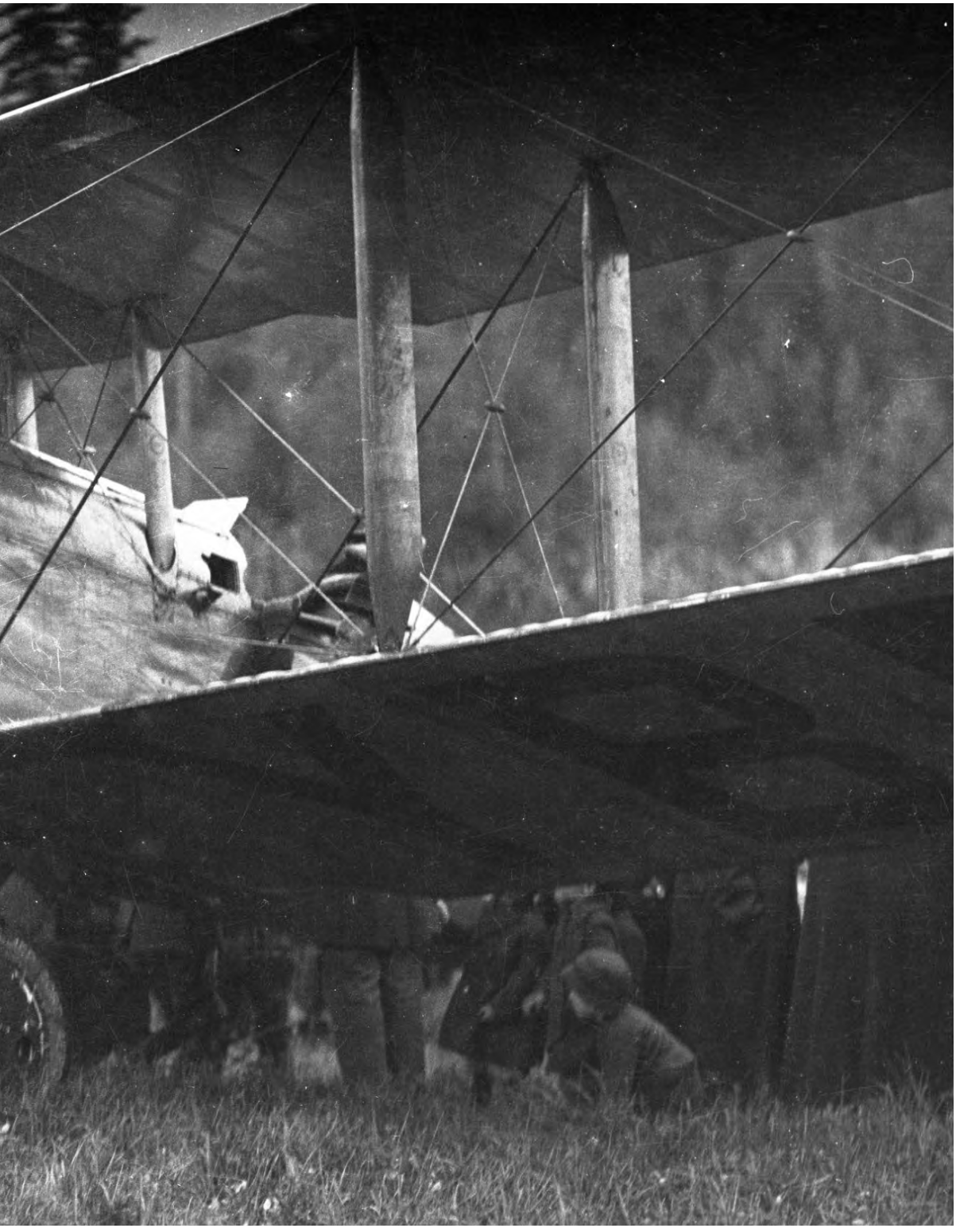
An attempt to cross the Cascades was made on 16 October, but the airmen were turned back once again. Finally, on 17 October, following a 0730 take-off, the weather in the Coquihalla Pass opened sufficiently to allow the aircraft to slip into the Fraser Valley and, at 1125, they touched down at the Minoru Park racetrack in Richmond, where they were greeted by Vancouver Mayor R. H. Gale. After handing over the letters from across the country, Tylee and Thompson were greeted by the remainder of the trans-Canada flying team, who had gone on to Vancouver by rail. Having completed the flight one way across the continent, the original plan for a return journey across Canada was wisely put in abeyance.

There was one final chapter to the trans-Canada flight. Apparently, while at a celebratory dinner in Vancouver on 19 October, the fliers were urged by Norman Yarrow to continue their flight to Victoria. Yarrow was the general manager of Yarrows Shipyard in Esquimalt, British Columbia, and, perhaps more importantly, the vice-president of the British Columbia Advisory Air Council for the Air Board. Willing to comply with Yarrow's wishes, Leckie and Tylee pressed MacLaurin, now the Air Station Superintendent at Jericho Beach in Vancouver, to provide them with a Curtiss HS-2L so they could fly on to Esquimalt and truly complete their trans-Canada flight.

On approaching Victoria, they became lost in the murky weather and flew around the San Juan Islands in the United States trying to establish their bearings.

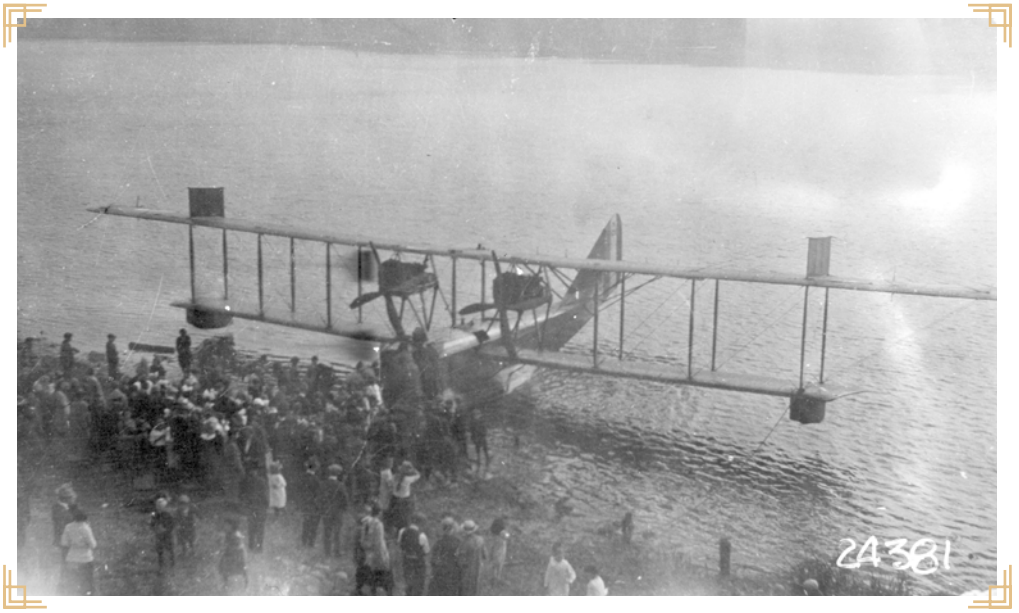
On 20 October, the dauntless aviators—accompanied by Hobbs and Thompson—took off from Vancouver. On approaching Victoria, they became lost in the murky weather and flew around the San Juan Islands in the United States trying to establish their bearings. After landing at Andrews Bay to get directions, they eventually were forced to spend the night in Friday Harbor, Washington State.

G-CYBF DH 9A aircraft flown from Calgary to Vancouver via Revelstoke and Merritt.
Air Commodore Tylee with some of his fans under the wing. (Photo: Revelstoke Museum & Archives Image 973)



Fortunately, the crew managed to complete the mission on 21 October and had lunch with Yarrow in Esquimalt. They then called on the Lieutenant-Governor of British Columbia, Colonel the Honourable Edward G. Prior, to deliver letters from the lieutenant-governors of Nova Scotia, Manitoba and Saskatchewan.

Following the visit to Government House, the trans-Canada team split up. MacLaurin flew the HS-2L from Esquimalt back to Jericho Beach on 21 October, and arrangements were made to disassemble the DH 9A aircraft in Calgary and Vancouver and ship them east; two went to the Air Board station at Morley, while the remaining aircraft was returned to Camp Borden.[32] The Felixstowe F.3 was stored in Winnipeg for the winter and was later used for aerial photography and forestry patrols in Manitoba. Leckie was summoned to return immediately to Ottawa, while Tylee remained on the West Coast to survey future training bases for the CAF on Vancouver Island.[33]



G-CYBT Felixstowe F.3 aircraft flown from Rivière-du-Loup to Winnipeg (Selkirk)
with stops at Ottawa, Sault Ste. Marie and Kenora.
Seen here at Selkirk, Manitoba. Of note, the aircraft is still wearing RAF markings. (CASM -24381)

CONCLUSION

And so, the trans-Canada flight ended. It was, without question, the major operational achievement of the Air Board before it was disbanded and absorbed by the Department of National Defence on 1 January 1923.

The flight demonstrated that despite adverse weather conditions and technical challenges, transcontinental flying in Canada could be undertaken, although the Air Board's summary report emphasized that a better ground organization would be required to support routine trans-Canada flights. Specifically, a network of well-marked airfields would have to be built, aircraft would require a means of communication with the ground and wireless directional navigational aids would

be necessary to guide aircraft to their destinations. It was also acknowledged that, since adverse weather would continue to be a deterrent to long-distance flying, accurate weather forecasts would be indispensable.

The Air Board's objective of stimulating interest in aviation in Canada proved to be successful. The trans-Canada flight created an "airmindedness" in Canadians and encouraged commercial entrepreneurs to establish fledgling regional air services, which in turn opened up the remote regions of Canada and eventually led to regular commercial passenger services.

And it was the trans-Canada flight of 1920 that showed the way ahead.

Colonel John L. Orr (Retired) joined the Royal Canadian Navy in September 1963 and graduated in 1967 from the Royal Military College of Canada. Selected for aircrew duties, he completed five operational tours on the Sea King helicopter. He attended the Canadian Forces Command and Staff College and has held a variety of command and staff appointments in Canada, NATO and the Middle East. He retired from the Canadian Armed Forces in September 2000. Since then, he has volunteered as a researcher at the Shearwater Aviation Museum, where he has concentrated his efforts on documenting the history of the Canadian Sea King helicopter, the saga of the air station at Shearwater from its establishment as United States Naval Air Station Halifax in 1918 until today and, most recently, the trans-Canada flight of 1920.

ABBREVIATIONS

CAF	Canadian Air Force
IMB	Imperial Munitions Board
LAC	Library and Archives Canada
Lt.-Col.	lieutenant-colonel
MG	Manuscript Group
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RCNAS	Royal Canadian Naval Air Service
RFC	Royal Flying Corps
RG	Record Group
RNAS	Royal Naval Air Service
USN	United States Navy

NOTES

1. Throughout this article, ranks appear in the form used in the contemporaneous records. As noted by Dr. Alec Douglas, "Royal Air Force ranks and traditional army ranks were both acceptable, and apparently used interchangeably at the whim of the holder." W. A. B. Douglas, *The Official History of the Royal Canadian Air Force: The Creation of a National Air Force, Volume II* (Toronto: University of Toronto Press, 1986): 50.

2. Because Canadians enlisted in the Imperial Flying Services as British subjects, not as "Canadians," definitive numbers are difficult to establish. The number of 20,000 comes from S. F. Wise, *The Official History of the Royal Canadian Air Force: Canadian Airmen and the First World War* (Toronto: University of Toronto Press, 1980), 1:xi; and Canada, Royal Canadian Air Force, *RCAF Logbook: A Chronological Outline of the Origin, Growth and Achievement of the Royal Canadian Air Force* (Ottawa: King's Printer, 1949), 10. A number of 13,495 Canadians is given in Order in Council 1918–1984, 19 September 1918. However, the *RCAF Logbook* gives the number as 22,000.

3. Canada, Department of External Affairs, *Documents on Canadian External Relations Vol. 1: 1909–1918* (Ottawa: Department of External Affairs, 1967): Item 83. 52; Item 219. 125; and Sydney F. Wise, "The Borden Government and the Formation of a Canadian Flying Corps, 1911–1916," in Michael S. Cross and Robert Bothwell, eds., *Policy by Other Means: Essays in Honour of C. P. Stacey* (Toronto: Clarke, Irwin, 1972), 123.

4. With the amalgamation of the RFC and RNAS to form the RAF on 1 April 1918, RFC (Canada) became RAF (Canada). The establishment of RFC (Canada) coincided with the adoption of the "Gosport system" of flying training by the British flying services. Importantly, this permitted the production of aircrew on an "industrial" basis. See John W. R. Taylor, "The CFS and Flying Training 1915–1935," *The Proceedings of the Royal Air Force Historical Society*, 11 (1993): 31. For the RFC (Canada) experience, see Group Captain H. Neubroch**,** "Wg Cdr Allen and First War Flying Training in North America 1917–18," *The Proceedings of the Royal Air Force Historical Society* 11 (1993): 40.

5. The IMB was directly answerable to the UK Ministry of Supply, although the personnel were almost all Canadians.

6. The CAF was formed by Canadian aircrew and technicians drawn from RAF units and the Canadian Expeditionary Force respectively. See Canada, Ministry of the Overseas Military Forces of Canada, "Canadian Air Force," *Report of the Ministry, Overseas Military Forces of Canada, 1918* (London: Overseas Military Forces of Canada, 1919), 349.

7. Canada, Overseas Military Forces of Canada, *Report of the Ministry, Overseas*, 349. See also William Stewart, "Missed Opportunity: Currie, Turner, and the Abortive Birth of the Canadian Air Force in the Great War," *Royal Canadian Air Force Journal* 1, no. 3 (2012): 14–25.

8. The debate regarding a "military air service" was far from over, as the issue re-emerged in the aftermath of the election victory of the Mackenzie King Government in late 1921. With the establishment of a Department of National Defence on 1 January 1923, a new Canadian Air Force emerged, although it was under the command of Major-General MacBrien, Chief of the General Staff.

9. For a detailed discussion of post-war developments in Canadian aviation policy, especially with respect to the Air Board, see William J. McAndrew, "The Evolution of Canadian Aviation Policy Following the First World War," *Journal of Canadian Studies/Revue d'études canadiennes* 16, no. 3&4, (Fall–Winter 1981): 86.

10. Canada, Library and Archives Canada (LAC), Order-in-Council 1917-3006, 23 October 1917.

11. Sir Robert Laird Borden, *Manifestos, 1916–17* (Ottawa: King's Printer, 1918), 8.

12. John A. Wilson joined the Department of the Naval Service as a civil servant in 1910 and was successively its director of stores and then assistant deputy minister, with particular responsibility for the RCNAS. He was later appointed as a member of the Air Board in 1919, representing the Naval Service of Canada, and eventually became the Secretary of the Air Board in 1920.

13. Clarence MacLaurin qualified at the Curtiss flying school in Toronto in 1915 and went on to serve in the RNAS overseas. He returned to Canada in 1918 to serve with the RCNAS and was retained as acting director by the Naval Service of Canada.

14. Canada, LAC, J. A. Wilson, letter to M. Desbarats, November 2, 1922, Manuscript Group (MG) 30 E 243, vol.1 – General correspondence relating to the development of aviation in Canada, 1915–1922.

15. Sean Seyer, "Walking the Line – The International Origins of Civil Aviation Regulation in Canada," *Scientia Canadensis* 38, no. 2 (2015): 79.

16. Canada, LAC, "Memorandum Regarding Formation of National Canadian Air Service," Major MacLaurin to President of the Privy Council of Canada, January 28, 1919, Record Group (RG) 24. Volume/box number: 3525. File number: 86-25-8. The following functions were listed for the proposed National Canadian Air Service: Mail Carrying; Forestry Protection (including aerial spotting); Fishing and Smuggling Protection; Aerial Survey Work; Conveying Police and Prospecting Parties and Inter-Communication with Districts not now served by Roads or Railways; and Patrol of Northern Wheat Route.

17. Canada, LAC, J. A. Wilson, letter to Lt.-Col. Cull, May 2, 1919, MG 30 E 243, vol. 1 – General correspondence relating to the development of aviation in Canada, 1915–1922.

18. Canada, Air Board, *Report of the Air Board for the Year 1922* (Ottawa: King's Printer, 1923), 5.

19. Canada, LAC, "The Military Policies of Canada: The Genesis of the Canadian Air Force," paper prepared by Mr. A. G. Steiger, RG 24-G-3-1-a / Volume: 20300, File: 943.009 (D4), 17.

20. Canada, LAC, Order-in-Council 1920-0395, February 18, 1920, "Military Aviation Policy"; and, for an extensive discussion of the evolution of the CAF, see James Eayrs, "The Early Years of the RCAF," in *In Defence of Canada Volume 1: From the Great War to the Great Depression* (Toronto: University of Toronto Press, 1964): 185–223. For a more concise article see Richard Mayne, "The Influence of Empire: A National Organization and the Birth of the Royal Canadian Air Force, 1918–1924," *Canadian Military Journal* 19, no. 3 (Summer 2019): 37.

21. Hugh A. Halliday, "The Imperial Gift: Air Force, Part 5," *Legion Magazine* (September 1, 2004).

22. Canada, LAC, undated itinerary at: Wilson, J. A. MG 30 E 243, vol.1 – General correspondence relating to the development of aviation in Canada, 1915–1922. In October–November 1919, Wilson made an extensive visit to the UK on behalf of the Air Board. Wilson visited various British aircraft manufacturers as well as the Air Ministry, where he met with General Trenchard, Chief of the Air Staff, and Sir Frederick Sykes, Controller General of Civil Aviation. The meetings with Trenchard by Wilson and Major D. R. MacLaren, Canadian Liaison Officer to the Air Ministry, were assessed as "not very satisfactory." Canada, LAC, Major D. R. MacLaren letter to J. A. Wilson, October 23, 1919. MG 30 E 243, vol.1 – General correspondence relating to the development of aviation in Canada, 1915–1922.

23. Except where noted, this account is based on the record of the flight in Wing Commander F. H. Hitchins, *Air Board, Canadian Air Force and Royal Canadian Air Force* (Ottawa: University of Ottawa, 1972), 41–53.

24. Canada, LAC, Lt.-Col. Scott, Superintendent, Certificates Branch, memorandum to J. A. Wilson, Secretary Air Board, August 12, 1920. Flight - Trans-Canada, 1920, RG 24-E-1-a. Volume/box number: 4888. File number: 1008-1-35. File Part 1–3.

25. Hitchins, *Air Board*, 42.

26. Canada, LAC, Secretary, Maritime Branch, Canadian Air Force Association, letter to Air Officer Commanding, Canadian Air Force, September 15, 1920. Flight - Trans-Canada, 1920, RG 24-E-1-a. Volume/box number: 4888. File number: 1008-1-35. File Part 1–3.

27. Patrick J. Campbell, *At the End of the Final Line – A Brief History of Aircraft Manufacturing at Canadian Vickers and Canadair from 1923–1984* (Ste-Anne-de-Bellevue, Quebec: Shoreline, 2006), 13.

28. Tylee was born in Quebec and spent a considerable part of his youth in Boston. He graduated from the Massachusetts Institute of Technology (MIT) as an electrical engineer in 1907. He joined the Curtiss School in Toronto in 1915 and received his Royal Aero Club certificate in January 1916 in the UK. He served overseas with the RFC and specialized in the flying training system in both the UK and Canada. He eventually became the acting commander of RAF (Canada) in early 1919 as that formation disbanded. In January 1920, he was elected as the president of the Aero Club of Canada before assuming the appointment of Air Officer Commanding, Canadian Air Force.

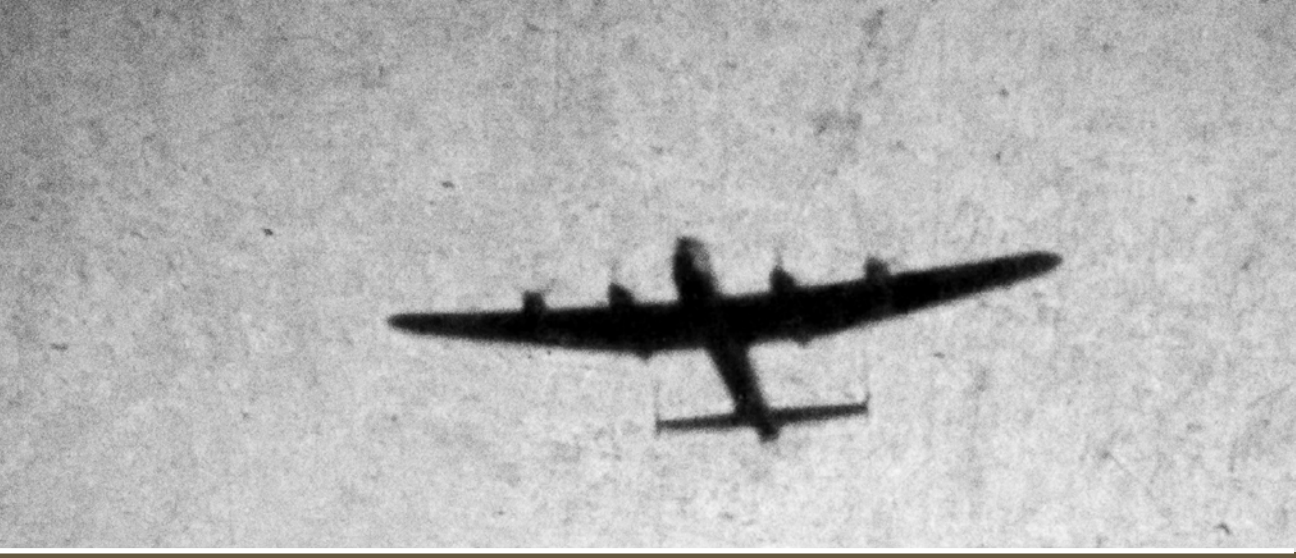
29. Canada, LAC, Vice-Chairman Air Board, letter to Lt.-Col. Leckie, Superintendent of Flying Operations, Air Board, September 28, 1920. Flight - Trans-Canada, 1920, RG 24-E-1-a. Volume/box number: 4888. File number: 1008-1-35. File Part 1–3. In a letter to Leckie, the vice-chairman of the Air Board, O. M. Biggar, expressed his concern regarding the intention to fly "straight through" to Winnipeg.

30. Air Board Station Dartmouth was located at the Baker Point site originally established as United States Naval Air Station Halifax in the latter half of 1918.

31. Hitchins, *Air Board*, 49. In the Flying Operations Branch report on the flight, Leckie observed that the section of the route from Lake Nipissing to Georgian Bay presented the greatest difficulty in navigation because of the innumerable small lakes and islands that made it difficult to maintain the correct course along the French River.

32. The fourth DH 9A had crashed at Winnipeg on October 1 prior to taking part in the trans-Canada flight.

33. "Plan Training Station in B. C.," *The Daily Colonist* (Victoria, BC), October 24, 1920, 1.



"WE'RE ABOUT TO CRASH":

THE GHOSTS OF KB 965 AND OTHER LOST AIRCRAFT AT CANADIAN FORCES STATION ALERT, 1950–1991

By Dr. Richard Mayne, CD

"We're about to crash, look out below," were the ominous last words uttered by Wing Commander David Thomas French, Distinguished Flying Cross, before his Lancaster aircraft— identified as KB 965—slammed into the Arctic tundra in a horrific explosion just outside of the weather station at Alert, Nunavut (then known as the Northwest Territories), on July 31, 1950.[1]

It was not the only incident to strike this remote segment of Northern Canada, as there was another significant air crash in the 1950s as well as some minor incidents that demonstrated the dangers of air operations in Arctic environments during this period. In fact, the worst was yet to come several decades later, as in October 1991, a CC130 Hercules ploughed into the ground 16 kilometres short of the Canadian Forces Station (CFS). The latter crash did not kill as many people as did that of KB 965, but it was the harrowing 32-hour experience of the survivors prior to their rescue that captured the attention of the press and even television producers, who created a movie about the incident starring actor Richard Chamberlain. This aircraft, known as "Boxtop 22," is an important part of the Royal Canadian Air Force's (RCAF's) history in the North and was commemorated during the crash's 25th anniversary in 2016.

One such twist of fate occurred in 2018, when the Commander of the RCAF, LGen Al Meinzinger, crossed paths with brothers David and Nick Brand.

However, in some measure, this comparatively recent incident has overshadowed the heart-rending and somewhat forgotten story of the crash of KB 965, which was going to have its 70th anniversary commemorated in 2020 at CFS Alert, with members of the crew's extended family in attendance. Unfortunately, COVID-19 put an end, or at least a postponement, to these plans. As such, this article is designed to focus not only on the story of KB 965 but is also intended to bring attention to the human elements of these types of incidents as well as the importance of commemoration of this particular crash to the RCAF and to the families of the victims—not to mention the amazing coincidences that can sometimes surround such events.

One such twist of fate occurred in 2018, when the Commander of the RCAF, Lieutenant-General (LGen) Al Meinzinger, was on leave and visiting one of his cousins in Blackwaterfoot, Scotland. During a morning walk, they crossed paths with brothers David and Nick Brand, proprietors of a local hotel that was once owned by LGen Meinzinger's relatives and is located between the family's farm and his cousin's home. After a friendly conversation on the doorstep of the hotel, mostly "about how improbable it was to see other Canadians in the small village" of only 500 people, the Commander learned that the Brands had a direct family connection to the RCAF. Their grandfather, Flying Officer (F/O) J. E. McCutcheon, was KB 965's second radio operator and, as such, was one of the victims of the crash.[2]

As related in a CBC News article, LGen Meinzinger recalled how "it was an absolute chance encounter, a bit of serendipity, I suppose." For the Brand brothers, it was a particularly memorable moment and, as one of them noted: "As soon as I mentioned my grandfather, [LGen Meinzinger]

said that the Canadian Air Force is thankful for everything the fallen guys have done and [the RCAF makes] an effort to preserve those memories."[3] Before parting ways, the Brands asked the Commander if he would be able to provide them with a picture of their grandfather's grave, which is located at CFS Alert along with the other eight victims of the crash. Accessing this remote station is not easy, but the Commander asked his Deputy Commander, Major-General B. F. Frawley, who was heading to Alert on other business, to take a picture of F/O McCutcheon's final resting place. As LGen Meinzinger would recount later, "It was the least I could do. … Their grandfather was on a mission. … He was doing his duty and gave his life to Canada wearing an RCAF uniform."

The Brands asked the Commander if he would be able to provide them with a picture of their grandfather's grave, which is located at CFS Alert.

Deputy Commander Frawley, proving he has a gift for photography, captured a remarkable image of the site, which has the distinction of being the world's most northerly cemetery. With a poetic touch, CBC journalist Alex Brockman perfectly described how this photograph encompassed the "late-night sun, the ocean and a distant mountain range [and] showed the rugged isolation that surrounds the base."[4] Certainly, the family was impressed, as, having only previously

The flight crew of Lancaster 965 is shown in this photo, taken shortly before the crash. Flying Officer James McCutcheon is pictured in the centre, fifth from the left. (Photo: Library and Archives Canada)

seen some vintage black and white images of the gravesite, David Brand reacted to these modern photographs by noting: "I just thought right away, 'Wow, what a beautiful place up there.' … It moved me a lot to realize my grandfather is buried in a beautiful place. … We wouldn't have those photos at all if [LGen Meinzinger] hadn't made that happen. I'm pretty thankful for that."

This simple gesture brought these brothers to the top of the world, figuratively, where they were able to connect with the grandfather they never had a chance to meet. As one of them observed: "I feel it's sort of my time to re-explore and get to know my grandfather. … If General Meinzinger hadn't stopped by that day, I don't know if I'd really have gone looking into it, and there's a lot more to learn."[5] Indeed, the tale of KB 965 is an important one and, therefore, worth telling in full. Before understanding the details of the crash itself, however, it is essential to put a human face on this tragedy, and F/O McCutcheon's is a good one with which to start.

James Everett McCutcheon was born in Huntingdon, Quebec, on May 26, 1925, but his true hometown was Cornwall, Ontario. His father worked as a foreman for Courtaulds Limited, which made viscose filament yarn, carpet and other fabric goods. His mother, who was of Irish descent, maintained the household.[6] The family belonged to the Church of England. Like most boys his age in the 1930s, young James enjoyed an active life that consisted of making model aircraft and participating in sports like basketball, track and field, volleyball, rugby and hockey.[7] Having developed an interest in the military at an early age, he also joined the Army Cadets, where he rose to the rank of regimental sergeant.

The RCAF saw McCutcheon as a good addition to the war effort, as it was observed that he "has the stuff to succeed in some aircrew category."

By 1943, the steely-blue-eyed, brown-haired McCutcheon was old enough to go to war, and he joined the RCAF almost immediately. His original preferences were to become a pilot or navigator but, wanting to make a difference, he informed the recruiting officer that he was not "fussy" if the RCAF wanted him to be an air gunner. A young man in good health whose only vice was smoking a couple of cigarettes per day, the RCAF saw McCutcheon as a good addition to the war effort, as it was observed that he "has the stuff to succeed in some aircrew category."[8]

His war experience was impressive, as after his training (which qualified him as a wireless air gunner) he was posted overseas for 11 months flying in a four-engine Halifax heavy bomber as part of an operational training unit. His time overseas was far from uneventful, as he survived a forced landing in the freezing-cold Irish Sea on January 27, 1945, after which he spent an hour floating in a dinghy awaiting rescue. Having been treated for hypothermia, McCutcheon then served out the rest of his service until his release on August 29, 1945, at which point he went home with the Defence Medal and War Medal 1939–45, as well as the Canadian Volunteer Service Medal and Clasp to his name.[9]

Destiny had set him on an unfortunate path, which led to him boarding a doomed aircraft on the last day of July 1950.

McCutcheon had grown both literally and figuratively over the course of the war. Now twenty-six pounds heavier and standing at just under six feet (three inches taller than when he first joined the cadets in 1939), McCutcheon had left Canada a boy and returned a veteran.[10] As with many other Canadians, he had to reacclimatize to civilian life, and his release papers observed that he planned to pick up where he had left off. It was noted that "this young man is considered to have ability to learn. He had in mind before enlisting to study medicine as his career and now wishes to carry out these plans."[11]

Presumably setting down that path, he enrolled in the University of Ottawa in 1947, and he married Patricia Joan Denneny one year later. Having kept one foot in a military environment by working as an air cadet instructor at the local Kiwanis squadron, McCutcheon threw caution to the wind and decided to re-enroll in the RCAF on May 28, 1949, as a radio officer. He did well. Having ended up as part of 103 Search and Rescue Flight between July 29 and December 7, 1949, then No. 2 Operational Training Unit five days later, McCutcheon's performance reports were favourable. In one it was observed that he "has the enthusiasm of youth and was popular," while another reported that he was "a comparatively new Air Force Officer who shows considerable promise both as a radio officer as a generally good all round officer."[12] Of course, the problem with this career selection is that destiny had set him on an unfortunate path, which led to him boarding a doomed aircraft on the last day of July 1950.

Lancaster 965 in the air shortly before the crash. (Photo: Alert Historical Collection)

The station was first settled in the early 1950s as a weather station of the Joint Arctic Weather Station (JAWS) System. On Sept. 1, 1958, Alert began its operational role as a signals intelligence unit of the Canadian Forces.

As one of the modified wartime Avro Lancasters that the RCAF had either kept or pressed back into service to meet its immediate post-war needs in the late 1940s, KB 965 was at Thule, Greenland, preparing to conduct ice reconnaissance.[13] In this instance, KB 965 was to check ice conditions along the route of a small United States Navy (USN) and United States (US) Coast Guard group that was heading to Alert to replenish the weather station there. It was a common mission, so the six other RCAF members joining McCutcheon—the pilot, Wing Commander French; co-pilot F/O T. D. Martin; the first radio operator, Flight Lieutenant (F/L) J. L. Swinton; the first navigator, F/L L. N. McLean; the second navigator, F/O J. R. G. Dube; and the crew chief, Leading Aircraftman R. L. Sprange—were not worried and expected a routine fight.

Just prior to boarding, however, an incident occurred that would seal the fate of the entire crew.

Also boarding with McCutcheon (who, as mentioned earlier, was KB 965's second radio operator) were two civilians.[14] The first was an American, C. J. Hubbard, who was the head of the Arctic section of the US Weather Bureau. Dr. D. W. Kirk, a 28-year-old native of Toronto and a member of the geographical bureau of the Canadian Federal Mines Department, was the other civilian on-board. Once again capturing the human side of this tragedy, Kirk was about to be cut down in the prime of his academic career as, after attending North Toronto Collegiate, the University of Toronto and then Northwestern University in Chicago for his PhD, he was preparing to see his thesis—which focused on a geographical survey of Western Ontario—published by the University of Toronto Press. He and Hubbard boarded KB 965 to serve as ice observers.[15]

Just prior to boarding, however, an incident occurred that would seal the fate of the entire crew. Suspecting that ice conditions were bad and that there was a real possibility the supply ships would not get through, Hubbard approached the pilot and asked if they would be able to drop packets containing some bare essentials (mail, tools, fresh meat and equipment parts) to the weather stations at Alert and Eureka.[16] These types of drops were common and, as such, French agreed to the request. With that, two packets were loaded onto the aircraft and KB 965 took to the air.

In a matter of seconds, KB 965 went nose down at a 45 degree angle and crashed in a horrible yet spectacular explosion.

After an uneventful transit, KB 965 was first spotted north-east of the station heading in a westerly direction. Having circled overhead, KB 965 then approached to make its drop from the east at an estimated altitude of 500 to 800 feet [152 to 244 metres]. The weather, while not ideal, was suitable; the sky was overcast with visibility of a half to one mile [0.8 to 1.6 km] in light snow and a calm wind.

Witnesses on the ground would relate the horror of what happened next. Watching the crew push the supply packet out the side door of the aircraft, those looking on stood helpless as they saw it fouled on the elevators of the tail section, its parachute partially open and trailing approximately 10 feet [3 metres] behind the aircraft. In a matter of seconds, KB 965 went nose down at a 45 degree angle and crashed in a horrible yet spectacular explosion. The scene left the witnesses stunned; one of them even reported that he had seen the body of a crew member thrown high in the air and clear of the wreckage.[17] The station was in complete shock. Worse yet, without a workable airfield (it was under construction at the time), they did not have equipment to extinguish the blaze; therefore,

Explosion of Lancaster 965 at Alert. (Photo: Peter Johnson)

they had to wait an hour until it went out on its own before they could approach the wreckage.

The first task that fell to the station, specifically to F/O J. M. Fraser along with a small team, was the grim work of identifying the victims. With bad weather approaching, but aided by 24 hours of daylight in the North at that time of year, Fraser was told to complete this work as quickly as possible and not to wait for the Royal Canadian Mounted Police to arrive. Beginning at 1900 hours on August 4, the team was done by 0430 the next day.

The report of their findings is a difficult read and there is no need to include the details here. Most of the deceased were identified by personal items such as rings and other jewelry, cigarette lighters, remnants of clothing with initials or names written on them, a watch case with a service number on it, business cards, or log papers that somehow survived the fireball. The identification of the final body to be accounted for was only achieved through the process of elimination.[18] The next concern for the RCAF was recovering the remains. As with all lost personnel, it was essential that the crew be treated with the utmost respect and dignity. In this Northern latitude, the task also included the need for a sentry to be posted to keep polar bears away from the crash site.

Stories of the crew's family members are equally heartbreaking, and none more so than that of the wife of the 24-year-old McCutcheon, who now faced the reality that she was a widow with one young daughter and another on the way.

Stories of the crew's family members are equally heartbreaking, and none more so than that of the wife of the 24-year-old McCutcheon, who now faced the reality that she was a widow with one young daughter and another on the way. That yet-to-be born daughter, it is interesting to note, eventually would become the mother of the same Brand brothers who, as mentioned earlier, the RCAF Commander would meet in Scotland 68 years later.[19]

Getting the KB 965 crew's remains home to their families was not going to be easy due to the hazards of Arctic flying and the absence of a working runway at the station. In fact, the RCAF was uncertain about what to do, until it was determined that a skilled flying boat pilot might be able to land in either Alert's inner harbour or on Lower Dumbell Lake. It was a risky proposition either way, but the RCAF thought the matter too important and had confidence in the pilot who, it was noted, was indeed a knowledgeable Northern flyer and was particularly experienced in handling a flying boat.

Unfortunately, the efforts of the Consolidated Canso that was sent from 103 Rescue Unit in Greenwood, Nova Scotia, did not turn out well. Having landed successfully to drop off an investigative team to look into the cause of the crash, the conditions at Alert proved too challenging.

In January 2015, Governor General and Commander-in-Chief of Canada David Johnston laid a wreath at the Boxtop 22 memorial, commemorating the crash of a CC130 Hercules and the loss of five lives. In the background are the graves of nine men who died during the crash of a Lancaster aircraft in 1950.

The Canso struck ice on the take-off run in Dumbell Bay, which resulted in fairly significant damage to the aft portion of the aircraft. Without any possibility for immediate repairs to be made at Alert, the aircraft was temporarily marooned in the high Arctic.[20]

Fortunately for the Canso, the US Coast Guard cutter *Eastwind* and the USN's Wind Class ice breaker *United States Ship Edisto* (both of which made up the task force group that was originally supposed to supply the station) immediately offered to help. This was no small measure. Upon hearing about the crash and regardless of conditions expected en route, the commander of this small task force immediately decided to proceed to Alert as soon as preparations to sail were completed—a somewhat ironic turn of events considering KB 965 was originally sent to perform ice reconnaissance for this very task force.[21] The task force group's presence was immediately felt upon arrival. Thanks to the ingenuity of the *Eastwind*'s crew, the Canso was made temporarily airworthy, an event that brought high praise from the RCAF's Chief of the Air Staff, since this difficult repair was "performed under arduous [Arctic] conditions."[22]

The likelihood of pilot error being the cause was quickly ruled out.

These vessels also played a key role in the funeral preparations and arrangements for the crew of KB 965, as due to the issues with the damaged Canso, the RCAF made the decision to bury the victims at Alert. The workshops of the *Eastwind* and *Edisto* constructed the coffins and fabricated the national flags that would cover them as well as produced the crosses and name plates to mark the graves. There was more. Both ships' companies were instrumental in ensuring that the victims of the KB 965 crash received full military honours at a ceremony on August 10, including colour bearers and an honour guard. Even more impressive was the memorial service provided by the USN staff chaplain attached to the task force, Lieutenant (Junior Grade) Ralph W. Hopkins. This padre went so far as to prepare an order of service specifically designed to provide the next of

kin with a sense of closure and to serve as a keepsake, so that they would know the utmost respect had been extended to their loved ones. It was a thoughtful gesture, as these family members would never get to visit Alert.[23]

In the background of these essential acts of remembrance, there was another group, led by F/L J. C. Hall, which was responsible for looking into exactly what had caused the crash. Word around the station that the parachute of the packet had been seen wrapped around the starboard tail section of KB 965 gave the lead investigator a good idea of what the cause was. However, as with all RCAF crash investigations, due diligence was required, and Hall looked into other common causes, such as pilot error and mechanical failure of the aircraft itself.

The trouble with this simple explanation is that it came with worrisome conclusions showing that it was an entirely avoidable accident.

With regard to the first possibility, the investigation found that both men at the controls that day had plenty of experience. Wing Commander French, in particular, was not only Commanding Officer of 405 Squadron, but he also had considerable wartime experience that began in 1940, which included time as a training instructor on Harvard, Tiger Moth and Fleet Aircraft as well as combat time flying a Wellington medium bomber and Halifax aircraft while serving with the RCAF's 6 Group in Bomber Command.[24] In fact, French was a war hero who had been awarded a Distinguished Flying Cross for the way he handled himself in stressful situations. His citation for this decoration reads as follows:

> In air operations this officer has displayed a high degree of skill, courage and determination. He has taken part in a large number of sorties against dangerous and difficult targets and the results obtained are an excellent tribute to his fine fighting qualities. He is an ideal leader whose example has impressed all.[25]

Like most wartime pilots who remained in or rejoined the RCAF after hostilities ceased, French was an extremely competent pilot. Although his Lancaster experience did not start until eight months before the crash, he still had amassed 108 hours in this type of aircraft. In total, he had 1,521 hours of flying time and, as a result, the likelihood of pilot error being the cause was quickly ruled out.[26]

Technical problems with the aircraft were also considered highly improbable despite KB 965 having had an incident earlier in the month where the port outer engine started streaming white smoke and fluid. With that engine feathered, KB 965 landed safely and mechanics soon traced the issue to a loss of glycol due to a blow-off valve on the engine coming loose from a coolant header tank. More to the point, however, a member of the ground crew from Thule informed the investigators that he had given KB 965 a complete inspection shortly before the flight and found no issues with the aircraft. So too had a safety officer who had looked at KB 965 independently. This led the RCAF to the conclusion that "both the captain and 2nd pilot were experienced Lancaster pilots and there is no reason to suspect any technical failure."[27]

The wreckage from Lancaster 965 still sits near CFS Alert.

It was at this juncture that the investigators turned back to what witnesses maintained was the obvious cause of the accident: namely, the dropping of the packet out the side door of the aircraft. The trouble with this simple explanation, however, is that it came with worrisome conclusions showing that it was an entirely avoidable accident.

A careful review of the testimony from various witnesses identified that the crash of KB 965 was set in motion as soon as the jeep containing the two packs destined for Alert and Eureka drove up to the aircraft. For the ground crew, this was the first they had heard that there was to be a drop made. Moreover, their accounts identify that there was some confusion among the aircrew, largely because the co-pilot, Martin, was dissatisfied with the static line that was supposed to activate the parachute when the packet was well clear of the aircraft. He felt it was not long enough and wanted extra length added. It was unclear whether this was done, but one of the safety-equipment technicians on the scene felt uncomfortable with this query and actually offered to go along on the flight to help with the drop. For unknown reasons, he was not taken up on his offer.

Worse yet, the confusion only seemed to follow the flight crew into the air, as another witness found it strange that the exit door was only partially open at the time of the drop, while the individual operating the radio at Alert testified that there was uncertainty within the aircraft. The pilot was heard saying: "Sorry, I thought they dropped but they had a little trouble and they are getting ready now. There goes the first one."[28] This opened a range of possibilities, as one expert noted the following:

> Several things could happen. If the static line was too short or if when the chute was attached [someone pulled] too hard on the static line after he snapped it to the chute, also if [it] was hampered by cargo being stacked too close to the doorway and interfering with the static line. In all these instances there would be a danger of the chute opening.[29]

Other testimony also seemed to focus on the static line being the most likely cause of the crash, especially since one individual claimed that the chute appeared to be open already when the pack exited the aircraft. These observations raised a key and direct question: Did the crew have enough training to perform this evolution? The answer, which became apparent the deeper the investigation probed, was disturbing.

While there was a clearly defined verbal procedure for this evolution, there were absolutely no written instructions on how to do so. Instead, crew members learned by word of mouth, which sometimes came in the form of a quick briefing just before a given flight and drop. As difficult as it may be to understand because of the RCAF's current flight-safety culture, the investigation took an even more troubling turn. It was soon discovered that few people fully understood the dangers involved with these types of drops from Lancasters because—as former strategic bombers—they were not built for this purpose.

A British officer on exchange provided further disturbing evidence when he related that the RAF had actually prohibited the practice of dropping supplies out the side door of Lancasters 11 months earlier.

This fact became very apparent in the expert testimony of Corporal Thomas Patrick McMannon, the flight-safety technician at Greenwood. After being asked if the dropping of supplies from a Lancaster could still be done routinely without endangering the crew if carried out by a qualified safety-equipment technician, he gave the following, officially recorded, jaw-dropping response: "No. There is, to my mind, a very great danger due mainly to the elements incurred during the release. This method of dropping should only be made in extreme emergencies and only then by trained personnel."[30]

As stunning as McMannon's comment was, a British officer on exchange serving at Thule provided further disturbing evidence when he related that the Royal Air Force (RAF) had actually prohibited the practice of dropping supplies out the side door of Lancasters 11 months earlier due to an incident where a Lincoln aircraft (an advanced variant of the Lancaster) crashed during a Battle of Britain parade. In that instance, a replica paratrooper being used in the ceremony got fouled in similar fashion to the KB 965 incident. Of course, news of the RAF's recent decision paled in comparison to what was perhaps the saddest fact, which was that there had been no need to drop the pack out of the aft door of KB 965 at all. Lancasters were more than capable of dropping such packs from their bomb bays, and the release equipment to do so was readily available for use in KB 965. Why it was not employed in this instance was never explained, other than that there was a sense the crews were starting to see these drops as being so routine that there was no need to use the bomb-bay equipment.[31]

In the end, the causes of KB 965's crash were attributed to following four main factors:

1. The accident was primarily the result of Lancaster crews not having experience in handling parachute packs for dropping.
2. The actual cause of this particular accident was the parachute and packet fouling the right elevator with the parachute over the top and the packet below it.
3. An experienced safety technician was not on-board to direct the dropping of supplies.
4. Difficulty was experienced in making the drop.

These, in turn, led to the following primary recommendations:

1. The dropping of supplies out of side doors of all Lancasters is prohibited, except in cases of emergency and, only then, when a safety technician is on-board.
2. There should be consideration given to removing the rear turret on reconnaissance Lancasters to provide a safe exit location for drops.
3. The RCAF takes charge of having permanent markers put up for victims of the crash.[32]

Some good, therefore, came out of the crash of KB 965, as these recommendations undoubtedly helped save future lives.

These lights guiding them to safety were made from coffee cans containing toilet-paper rolls soaked in diesel fuel and set on fire.

However, this would not be the last incident at CFS Alert. For instance, over the winter of 1952, a C47 transiting from Ice Island to Thule ran into trouble and radioed the station to ask to use the recently completed runway for an emergency landing. Details of this incident are not well documented and, as such, it is difficult to determine what parts are true and which are the stuff of legend. As the story goes, however, personnel at Alert desperately wanted to help this crippled aircraft, especially since it was flying on only one engine and was low on fuel.

Without a control tower, hangar or—more importantly—landing lights (which was a real problem since the station was in perpetual darkness at this time of year), the pilots simply received instructions to "hang on." After an hour of circling, however, they realized what the station personnel were trying to do, as a line of haphazardly erected landing lights slowly began to illuminate the runway. Providing this story is true, one can only imagine how these pilots felt when they learned that these lights guiding them to safety in this barren, Arctic terrain, and to which they were trusting their lives, were made from coffee cans containing toilet-paper rolls soaked in diesel fuel and set on fire.[33]

There is no doubt that the next incident at Alert really did occur, as there is still evidence of it beside the current runway. This crash, which happened later in 1952, involved an American C-54 that was providing aviation fuel to the station as part Operation NAVELEX. The crew of four survived the hard landing, but the aircraft was deemed a write-off.

Accounts from the survivors need to be read in full to truly appreciate the human will to survive as well as the self-sacrifices made so that others could live.

Other stories include one about a Piper Cub that arrived at Alert in 1956 with damaged landing gear and was subsequently repaired using parts from KB 965's wreck. There is another tale of a Piper Super Cub that apparently crash-landed 34 kilometres from the base, where it reportedly remains to this day.[34] However, none of these incidents nor some other minor ones had come close to the scale of the KB 965 disaster until the crash of Boxtop 22 on October 30, 1991.

The events that surround Boxtop 22 have been well covered in the literature as well as in a recent spate of articles covering the crash's 25th anniversary, so only a brief summary is required here. In effect, the crash of Boxtop 22, a CC130 Hercules from 435 Squadron that was transporting fuel and passengers to CFS Alert, was a tragic incident that led to the deaths of five members of the Canadian Armed Forces. Thirteen of those who were on-board survived the ordeal, and their survival—combined with the efforts of their rescuers—is a remarkable story of bravery and endurance in an extreme environment.

Major Todd Murphy and United States Air Force Brigadier General Jack Briggs II read the script on one of nine crosses erected to remember the nine crew members whose lives were lost during a 1950 Lancaster crash at Alert.

Parade to mark the 25th anniversary of the crash of Operation BOXTOP Flight 22 at Canadian Forces Station Alert on June 15, 2016.

Accounts from the survivors need to be read in full to truly appreciate the human will to survive as well as the self-sacrifices made so that others could live. The latter reference is largely to the heroic actions of the aircraft's commander, Captain John Couch, who gave up his own winter clothing to keep others warm before he succumbed to hypothermia. It is a remarkable tale that included search-and-rescue technicians parachuting into a hostile Arctic situation as well as a ground team from the station that had to navigate around a huge gorge in complete darkness, which turned the painfully close proximity of the aircraft into a harrowing and hellish trek that had to be experienced to be believed.[35]

Like KB 965, Boxtop 22 also has a memorial cairn at Alert, which was the scene of a moving memorial service in 2016. Another memorial service followed at the National Air Force Museum of Canada in Trenton, Ontario, where an additional marker was dedicated. Indicating the importance of such efforts, LGen Mike Hood, former Commander of the RCAF, rightfully concluded that

> For the Canadian public … Boxtop 22 has faded from memory in the 25 years since the crash. That's why it's so important for us to place this cairn here in Trenton. … It will stay here as a permanent reminder of those terrible hours in Canada's high Arctic and I hope it will be an enduring reminder to Canadians of those who did not return, those who survived and those who fought valiantly to bring the survivors home. I hope it will be a place of memory and healing for you and a way to ensure you or your loved ones will be forever remembered.[36]

KB 965 was also commemorated, but unlike Boxtop 22, the memories of that crash are in danger of being forgotten. In some measure, the seeds of such a fate were sown almost immediately after the crash. Although the Board of Inquiry recommended that the RCAF should take the lead on the matter, the cairn at Alert to commemorate the crash was actually the product of a campaign initiated by C. J. Hubbard's widow, who—as an American—got the support of the US Weather Bureau, the USN and US Coast Guard to mark the tragedy. Thanks largely to the efforts of Mrs. Hubbard and US authorities, a plaque styled by nationally renowned American painter

and sculptor Dwight Shepler was dedicated during a service by a USN chaplain on August 26, 1953.[37] It was described as a remarkable ceremony, although one that was cut short and conducted under the "midnight sun" in 23° Fahrenheit [-5° Celsius] temperature with a storm approaching the station.

While this event did go well, there were some early criticisms from the Canadian Department of External Affairs, which, while admitting this case was not its turf, voiced concerns that the RCAF was not doing enough and, in the process, risked the possibility "that it would become predominately an American ceremony."[38] To avoid a potential diplomatic misstep, External Affairs went even further by noting "it would be desirable to ensure that the ceremony is primarily a Canadian operation and that the RCAF is adequately represented."[39] This was not, however, the RCAF's fault, as the deputy minister of National Defence had made it known to the Air Force that he "feared that the erection of a cairn at Alert would be taken as a precedent for similar memorials all over Canada at the sites of fatal crashes of RCAF aircraft."[40]

Remembering these individuals is therefore essential, as it not only puts human faces on these efforts, but also demonstrates their sacrifices to link Canada to its own Arctic region.

The deputy minister's position was to some degree understandable, as throughout the RCAF's existence, it had experienced hundreds of deadly crashes across Canada, and it was impossible, both financially and organizationally, to mark each one. Yet, one point that External Affairs also emphasized was that there was something special about where KB 965 had crashed and the sacrifice that its crew had made. A 1953 article by the US Weather Bureau captured this sentiment well, as it noted the cairn was located in a unique region of the world "where it will doubtless stand for centuries in memory of the tremendous sacrifices made by those who have pioneered the Arctic to increase man's knowledge of the geography, climate, and day-to-day weather of little known polar areas, and as a monument to international goodwill and cooperation between Canada and the United States."[41]

A CC130J Hercules aircraft prepares to depart Canadian Forces Station Alert.

This attribute was indeed effective, but even more poignant was the simple yet powerful inscription on the cairn itself, which related that "in a supply mission to the Arctic Weather Station at Alert those aboard a Royal Canadian Air Force Lancaster were killed 31 July 1950. The task in which they gave their lives continues."[42]

This work does indeed continue. Beginning with a 1922 survey by R. A. Logan on the viability of Canadian Arctic Flying Operations, the Air Force has had a proud tradition and history in the North. But as KB 965 and Boxtop 22 identify, those efforts have, at times, come with a price—one that has cost some their lives. Remembering these individuals is therefore essential, as it not only puts human faces on these efforts, but also demonstrates their sacrifices to link Canada to its own Arctic region. This connection must not be forgotten, as it represents a pivotal exercise in nation building.

The placement of memorials and markers and the kind act of helping connect a single family with its own personal ties to Canada's North (as LGen Meinzinger did with the Brand brothers) represent the human condition and desire to understand the meaning and significance of our collective past. Simply put, such efforts are not only important to the RCAF's history and sense of identity but also to the nation as a whole and its proud past.

Dr. Richard Mayne, CD, received his Bachelor of Arts from the University of Toronto, Master of Arts from Sir Wilfrid Laurier University and a PhD in military history from Queen's University. Having served 17 years as a naval reserve officer in the Canadian Armed Forces (including nine years at the Directorate of History and Heritage in Ottawa), he now works as a civilian for the Department of National Defence as the Chief Historian and Director of RCAF History and Heritage. He has authored, co-authored and co-edited a number of publications on various aspects of Canadian military history and defence issues. He sits on the board of directors of a number of organizations related to defence and aviation issues, including serving as the deputy chair of the RCAF Heritage Fund.

ABBREVIATIONS

AMP	Air Member for Personnel
CFS	Canadian Forces Station
F/L	flight lieutenant
F/O	flying officer
G/C	Group Captain
LAC	Library and Archives Canada
LGen	lieutenant-general
RCAF	Royal Canadian Air Force
RG	Record Group

NOTES

1. Proceedings of Court of Inquiry, August 1950, Library and Archives Canada (LAC), R112 vol. 31242, file 093-KB965, pt. 1.1.

2. LGen Al Meinzinger, email message to author, May 22, 2019. The author is extremely grateful to LGen Meinzinger for recounting the details of his trip to Scotland.

3. Alex Brockman, "Forever on Guard," CBC News, December 28, 2018, https://newsinteractives.cbc.ca/longform/a-memory-of-sacrifice.

4. Brockman, "Forever on Guard."

5. Brockman, "Forever on Guard."

6. Canadian Armed Forces Information Form and Application, February 28, 1949, James Everett McCutcheon, LAC, Record Group (RG) 24, Personnel file 30483; and RCAF Attestation Paper, May 6, 1943, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483.

7. RCAF Attestation Paper, May 6, 1943.

8. Royal Canadian Air Force, May 13, 1943, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483; and Recruiting Centre, October 19, 1943, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483.

9. Honours and Awards, n.d., James Everett McCutcheon, LAC, RG 24, Personnel file, 30483; and Medical Board Proceedings, n.d. (circa 1945), James Everett McCutcheon, LAC, Personnel file, 30483.

10. Attestation papers, June 19, 1941, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483; and Canadian Armed Forces Information Form and Application, February 28, 1949.

11. Department of Veterans Affairs, August 29, 1945, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483.

12. James Everett McCutcheon, LAC, RG 24, Personnel file, 30483; Canadian Armed Forces Information Form and Application, February 28, 1949; Performance Report, December 15, 1949 and April 5, 1950, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483; and Declaration of Entitlement to Marriage, James Everett McCutcheon, LAC, RG 24, Personnel file, 30483.

13. For more information on RCAF post-war Lancasters see Hugh Halliday, "Lancasters Hit Civvy Street, Air Force, part 39," *Legion: Canada's Military History Magazine*, June 19, 2010, https://legionmagazine.com/en/2010/06/lancasters-hit-civvy-street-air-force-part-39/.

14. Group Captain (G/C) F. R. West to Air Member for Personnel (AMP), September 8, 1950, LAC, R112 vol. 31242, file 093-KB 965 pt. 1.

15. Proceedings of Court of Inquiry, August 1950, LAC, R112 vol. 31242, file 093-KB965 pt.1.1; "4 Ontarians Among 9 Dead in Polar Crash," *Globe and Mail*, August 2, 1950 (copy held at CFS Alert historical collection); and G/C F. R. West to AMP, September 8, 1950.

16. J. F. Allan, Summary of Accident investigation No. 2622, December 15, 1950, LAC, R112, vol. 31242, file 093-KB 965 pt. 1; and G/C F. R. West to AMP, September 8, 1950.

17. Witness Seldon M. Dow, Radio Operator Department of Transport, Proceedings of Court of Inquiry, August 1950, LAC, R112 vol. 31242, file 093-KB965 pt.1.1; Witness Charles Clifton, Proceedings

of Court of Inquiry, August 1950, LAC, R112 vol. 31242, file 093-KB965 pt.1.1; and G/C F. R. West to AMP, September 8, 1950.

18. F/O J. M. Fraser, Memo, Identification of remains found in the wreck of Lancaster 965. Proceedings of Court of Inquiry, August 1950.

19. Brockman, "Forever on Guard."

20. Proceedings of Court of Inquiry, August 1950; J. W. Burton to Air Vice-Marshal J. L. Plant (AMP), September 19, 1950, LAC, R112 vol. 31242, file 093-KB 965 pt. 1; and Message, August 1, 1950, LAC, R112 vol. 31242, file 093-KB 965 pt. 1. The damage to the Canso was significant, as it was reported that the aircraft's skin "was ripped and damaged in three places; the keel was broken 2 feet aft of the tunnel hatch; 4 ribs or keel formers and 12 stringers or longerons were broken."

21. Proceedings of Court of Inquiry, August 1950.

22. Air Marshal Wilf Curtis to Admiral O'Neil, October 10, 1950, LAC, R112 vol. 31242, file 093-KB 965 pt. 1.

23. J. C. Hall to Commanding Officer (CO) Greenwood, August 30, 1950, LAC, R112 vol. 31242, file 093-KB 965 pt. 1; and Investigating Officer to the CO, Mercy trip to Alert, August 30, 1950; LAC, R112 vol. 31242, file 093-KB 965 pt. 1.

24. J. F. Allan, Summary of Accident investigation No. 2622, December 15, 1950, LAC, R112, vol. 31242, file 093-KB 965 pt. 1.

25. Hugh Halliday, email to author, May 10, 2019. I am grateful to Hugh Halliday for this information.

26. J. F. Allan, Summary of Accident investigation.

27. Report on flying accident or forced landing, July 6, 1950, LAC, RG 12, Vol. 594, file 1650-78; Witness Flight Sergeant George Allan Green, Ground servicing at Thule, Proceedings of Court of Inquiry, August 1950, LAC, R112 Vol. 31242, file 093-KB965 pt.1.1; and G/C F. R. West to AMP, September 8,1950.

28. Issac Van der Noven, truck driver for US Weather Bureau at Thule; Witness Aircraftman 1 J. J. Macdonald, employed as Safety Equipment Technician at Greenwood, NS; Witness Sam Griggs, mechanic at Alert part of US Weather Bureau; and Witness Stanley Whiteman, Radio Operator from US Weather Bureau stationed at Alert, Proceedings of Court of Inquiry, August 1950, LAC, R112 Vol. 31242, file 093-KB965 pt.1.1.

29. Witness Willlis Morgan, air strip supervisor employed by US Weather Bureau, Proceedings of Court of Inquiry, August 1950, LAC, R112 Vol. 31242, file 093-KB965 pt.1.1.

30. Witness Corporal Thomas Patrick McMannon, flight-safety technician at Greenwood, Proceedings of Court of Inquiry, August 1950.

31. Witness Flight Sergeant George Allan Green, Ground servicing at Thule, Proceedings of Court of Inquiry, August 1950.

32. Proceedings of Court of Inquiry, August 1950.

33. David R. Gray, *Alert: Beyond the Inuit Lands: The Story of Canadian Forces Station Alert* (Ottawa: Borealis Press, 1997), 98.

34. Gray, *Alert: Beyond the Inuit Lands*, 98.

35. For a complete account of the crash of Boxtop 22 see Robert Mason Lee, *Death and Deliverance: The Haunting True Story of the Hercules Crash at the North Pole* (n.p.: Macfarlane Walter & Ross, 1992); and Michael Thomas, "Remembering the Crash of Boxtop Flight 22," RCAF News Article, October 30, 2017, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=remembering-the-crash-of-boxtop-flight-22/ig9v1k0t.

36. Joanna Calder, "Boxtop 22 Commemorative Cairn: 'A Place of Memory and Healing,'" RCAF News, November 8, 2016, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=boxtop-22-commemorative-cairn-a-place-of-memory-and-healing/iv9iz9zw.

37. Controller Andrew Thomson to H. T. W. Blockley, April 10, 1953, LAC, RG 12, Vol. 594, file 1650-78; and "Memorial Service at Scene of Crash," *Weather Bureau Topics* 12, no. 8 (September 1953).

38. M. H. Werhop, Under Secretary of State for External Affairs, March 11, 1953, LAC, RG 12, Vol 594, file 1650-78.

39. M. H. Werhop, Under Secretary of State for External Affairs, March 11, 1953, LAC, RG 12, Vol 594, file 1650-78.

40. Andrew Thomas to Mrs. Charles Hubbard, 29 August 1951, LAC, RG 12, Vol 594, file 165078.

41. "Memorial Service at Scene of Crash." This article notes that "the monument itself, a truncated pyramid of fieldstone, was erected by Willis G. (Blow Torch) Morgan, a gentleman of considerable Arctic fame, and his associate, Herbert Dewey."

42. J. Glenn Dyer, Arctic Operations Project, to Andrew Thomas, March 31, 1953, LAC, RG 12, Vol 594, file 1650-78; and J. Glenn Dyer, Arctic Operations Project, to Chaplain Preston Oliver, March 31, 1953, LAC, RG 12, Vol 594, file 1650-78.

How We Think: Embracing Complexity in Canadian Armed Forces Policy

By Lieutenant-Colonel R. M. Kastrukoff, CD, MAS

Introduction

At present, the Canadian Armed Forces (CAF) is systemically unable to solve complex problems—instead, the planning methodologies provided in the CAF are better suited to non-complex problem contexts. Institutionally incorporating methodologies for solving complex problems will provide a capability to improve many long-standing CAF issues.

Multiple problem contexts exist in the military. In a 2007 *Harvard Business Review* article, David J. Snowden and Mary E. Boone break problems down into five broad categories: simple, complicated, complex, chaotic and disordered.[1] They suggest that each of these different contexts requires a different type of response—yet, in the military, we do not have processes suited for the complex context. This article argues that, by limiting its methods for considering problems, the CAF is missing certain innovations and effective solutions. First, I will define and explore some differences between complex problems and other types of problems. Next, CAF problem-solving processes will be discussed as they relate to complex problems. Finally, some key pieces of complex problem-solving methodologies will be briefly explored before discussing some key areas requiring institutional change prior to the widespread acceptance of emergent and complex solutions.

“By limiting its methods for considering problems, the CAF is missing certain innovations and effective solutions.

In *Handbook on Complexity and Public Policy*, Eve Mitleton-Kelly—the Director of the Complexity Research Group at the London School of Economics—notes that “complex problems that appear intractable may often be the result of inadequate or inappropriate approaches.”[2] She continues on to highlight that understanding the problem space, multiple dimensions and “co-evolving dynamics of critical clusters” then allows the connectivity, interdependence, feedback and most importantly emergence to be understood.[3] In the same publication, Robert Geyer and Paul Cairney suggest that breaking down all problems into component parts is “fatally flawed because complex systems are greater than the sum of their parts” and the interactions between elements “cannot simply be attributed to individual parts of a system.”[4]

How We Think

While introducing their categories of problem contexts, Snowden and Boone suggested that “managers rely on common leadership approaches that work well in one set of circumstances but fall short in others.”[5] The CAF does use different methods to solve problems—for instance, the operations planning process (OPP), commander’s intuition, analysis by experts and more recently some limited forays into design thinking. These processes are well-suited for some problem contexts, but not for others—most notably complex problems. Table 1 provides a summary of Snowden and Boone’s category definitions.

Problem Context	Characterized by	Decision Reached by	Domain of
Simple	Stability; clear cause and effect.	Self-evident, undisputed and simple consensus.	Known knowns and best practices.
Complicated	Multiple right answers; clear cause and effect, but not visible to all.	Fulsome analysis by experts.	Known unknowns, analysis and expertise.
Complex	Unknown "right" answers. Constant flux. More than sum of parts.	Complex system management, heterogeneous stakeholders, interdisciplinary analysis and ecosystem-based inputs.	Unknown unknowns as well as emergent and evolving solutions.
Chaotic	Constantly shifting cause and effect with no manageable pattern; turbulence.	Leader's instinct and no/minimal input. Immediate triage so that problem can change from chaotic to complex.	Unknowables, rapid response and decisive action to establish order.
Disordered	Unclear which of the other four contexts is dominant.	Converting to another problem context.	Experience and intuition.

Table 1. Summary of problem contexts from Snowden and Boone.[6]

> **"There is a connection between the parts in complex problems, and those connections are lost in any reductionist strategy.**

From the table, we can see that simple, complicated, chaotic and disordered problem contexts already have suitable processes in the CAF using standard operating procedures for simple problems; the OPP for complicated problems; and commander's experience for both disordered and chaotic problems. However, there is a gap for complex problems; a gap that often sees the OPP imposed to break down a problem when the context in fact calls for the opposite. In their book *Nudge*, Richard H. Thaler and Cass R. Sunstein comment that, as the number of choices increases, "people are likely to adopt simplifying strategies" and select certain structures to help make decisions.[7] However, these structures affect outcomes. There is a connection between the parts in complex problems, and those connections are lost in any reductionist strategy. Therefore, the key to complexity is to model, analyse and evaluate the feedback cycles between aspects of

the problems to find emergent properties or "behaviour that results from the interaction between elements."[8] These interactions are not likely to be fully predictable. Anne-Marie Grisogono suggests that it is "impossible to be sure of exactly what conditions to set and actions to take to achieve specified desired outcomes while also averting unwanted outcomes."[9] The result of all these aspects of complexity is an inability to determine a sole right answer from the initial problem conditions. This inability drives an iterative problem-solving methodology, thereby making it increasingly important to select the right *method* because the right *answer* is not possible at the start.

Iterating towards a solution means that the initial solutions will fail in part or in full. This adds a layer of social complexity to the problem-solving process, as failure is not always seen as the key factor that it is for innovation, especially in a military hierarchy. Jim Price and Philip Haynes state that not only is failure always a possibility, but recent discussion suggests that failure is an emergent process of a system and that most things do in fact fail.[10] The acceptance of failure, rapid iteration and complexity must be supported at command ranks for real solutions to complex problems to be implemented successfully.

The complex problem context also requires "more interactive communication than any of the other domains."[11] Dissent as well as diversity of opinion must be encouraged and further incorporated into solutions. While discussing development for courses of action (COAs), Therese Heltberg and Kåre Sveistrup Dahl highlight that "most militaries today harbour an inherent tension" between innovation and the "highly codified hierarchical structures" of the organization.[12] The culture produced by these hierarchies tends to be conservative and "reliant on linear-thinking doctrines [with] a factual notion of knowledge" that privileges previous experience.[13] This leads to an undervaluing of iteration, communication downward in the problem definition stage and ultimately failed attempts to resolve complex problems. During problem-definition efforts, Heltberg and Dahl's research showed that ideas from military brainstorming sessions were not blended together into new solutions; conversely, each idea remains unchanged and, while they may or may not be added into the solution, the ideas are not transformed in the exchange between participants as was the intent of a brainstorm, thereby resulting in a "brickstorm" instead.[14] Heltberg and Dahl continue:

> **"The default therefore becomes the status quo, and convergent ideas are laid on top of that status quo while divergent ideas are shunned.**

> Most military tools of analysis … aim at reducing complexity to enable decision making, and they rely on a perception of knowledge as definite. This is underpinned by an organizational culture which largely supposes that there is right and there is wrong, and that commanders are supposed to possess superior or more extensive knowledge than their subordinates.[15]

In training, this arises as the directing-staff solution that CAF members are eager to know at the end of any exercise. Heltberg and Dahl reason that this directing-staff solution "hampers

curiosity" and leads to divergent ideas being rejected early in the process.[16] The default therefore becomes the status quo, and convergent ideas are laid on top of that status quo while divergent ideas are shunned. Challenging the status quo can easily be tied to challenging leadership and, in such a rigid hierarchy, will either disappear through indoctrination or through the departure of members that cannot conform.

This inflexible, linear hierarchy extends into military problem-solving processes. The OPP in particular is "loaded with precision and certainty … and [hindered] by certain analytical and decision-making templates," including factor analysis, war gaming and decision matrices.[17] Precision and certainty are imposed where none exists in a complex problem.

Rethinking the Thinking Process

Once the CAF has accepted that a new methodology is required to handle complex problem contexts, it will need to implement that new process. This will not be like implementing a new military capability because it is not just changing how CAF personnel fight, but how they fundamentally think about a problem space. At this point, it is instructive to use an example of a complex problem space as well as a complex problem-solving methodology to see how they interact practically with the current CAF command processes. For instance, the retention of fighter pilots in the Royal Canadian Air Force (RCAF) is a complex problem. An advantage of a complex problem is that there does not need to be one single starting place; the connections and interactions between parts of the problem mean that any place can be used as a start to build the initial picture and interactions. Michael Givel comments that "emergent phenomena are sensitive to the initial policy situation … and are influenced by numerous negative or positive feedback loops,"[18] which suggests that describing the initial situation, then identifying these negative and positive feedback loops are the first steps. Figure 1 illustrates some initial conditions and feedback loops for the RCAF fighter pilot–retention problem.

Figure 1 is an important step taken to set the initial conditions of the problem and identify some of the interactions and feedback loops, but it is not to be considered final. As Sebastian Thrun, co-founder of Udacity, notes, "iteration is key to innovation; … you need to believe that the answers can't be known in advance and thus embrace 'emergence' as the vehicle of solving."[19] Once we have this initial representation of the starting conditions, we can use methodologies from complexity science to take the next step. In his TED Talk, ecologist Eric Berlow suggests that we can target a critical node for influence then look one, two or three degrees away to find the most opportune areas to influence.[20] In Figure 1, there are four key negative feedback loops affecting the sustainable health of the fighter force: the yearly flying hours; the transition from fighter pilots to experienced fighter pilots; and the transitions from experienced to retiring pilots in both the "pilot" and "system" streams.[21] The scope of this paper does not include a detailed explanation of the fighter pilot–retention problem space, but instead focuses on the problem-solving process. To that end, we can take Figure 1 as the initial definition of the problem, identify some key areas of potential influence and move on to the next stage: stakeholder engagement.

Thaler and Sunstein suggest that "social influences come in two basic categories": first, information and what people already think or do; and second, peer pressure and going "along with the crowd to avoid their wrath or curry their favor."[22] Givel adds that policymaking occurs simultaneously at different levels of government and that these policy attempts are interconnected, further informing the required stakeholder engagements.[23] Finally, Price and Haynes describe how "there must be a degree of heterogeneity … in backgrounds, perspectives, heuristics and mental models"

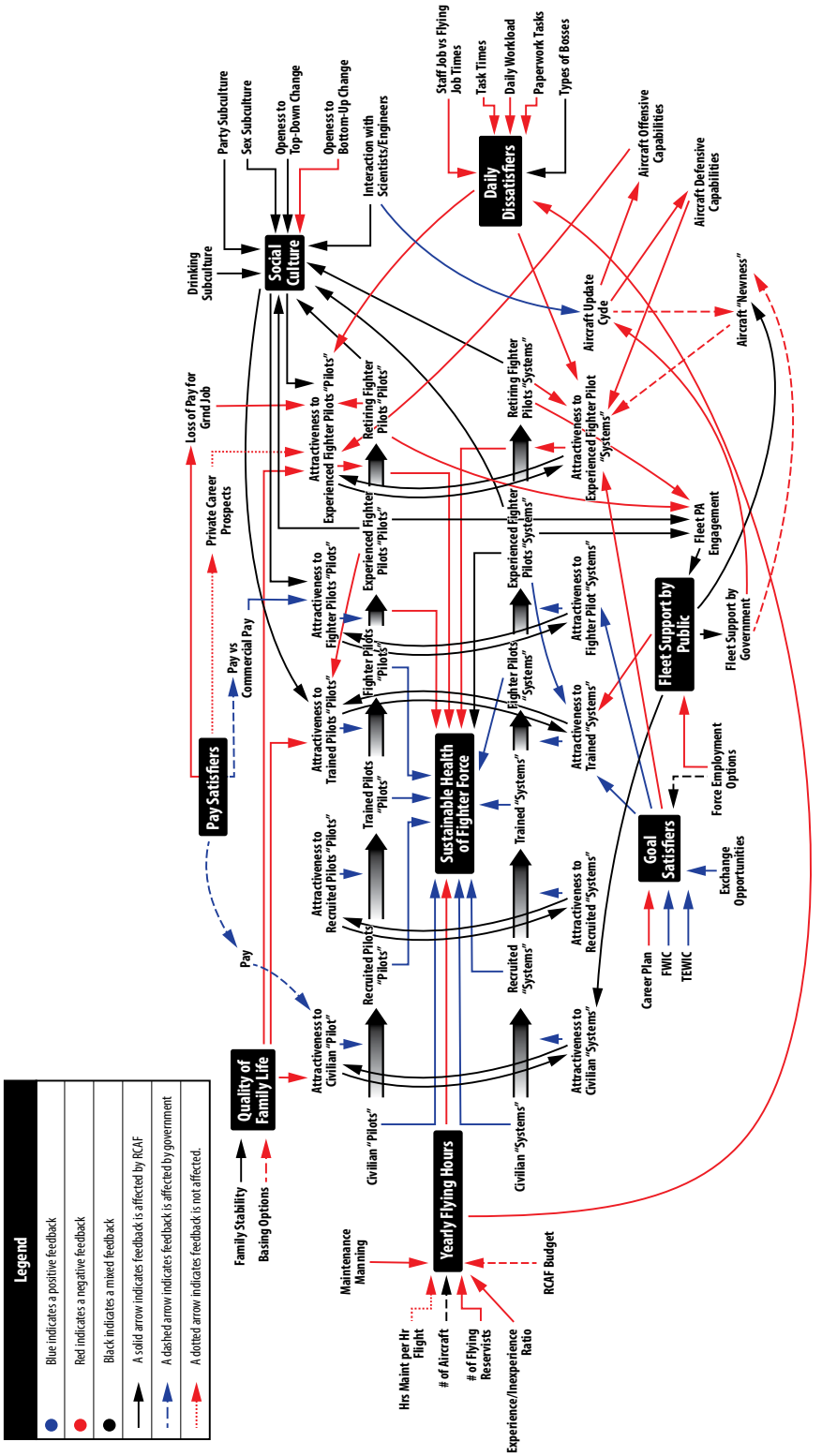


Figure 1. Causal loop diagram showing the feedback loops in the RCAF fighter pilot–retention problem.

A Royal Canadian Air Force CF188 Hornet pilot gets in the CF188 before heading out on a combat training flight during Operation REASSURANCE.

> **"Once the confluence of negative effects is found by properly identifying key interactions, any one of those interactions can be targeted and resolved as a simple or complicated problem.**

for novelty to emerge in solutions.[24] This does not provide an exhaustive list of personnel required for the problem-solving team in contrast to the complicated problem context, where the OPP defines relatively easily which experts need to be on the team after an initial orientation to the problem. All levels of complex problem solving are iterative, from the description of the problem and the problem space to the composition of the team. By growing and shrinking the team as well as targeting diversity, engagement and influencers, problem solvers will have the interactions necessary to provide emergent solutions. This is not an easy process to accept into a hierarchical military, as it does not lend itself well to specific timelines, specific outputs and eventual decision briefs to a single commander who has authority over the entire problem set or solutions recommended. But these small (or large) influences in different areas of the problem ecosystem have been proven successful.

In an Amsterdam airport, "authorities etched the image of a black housefly into each urinal … [resulting in] reduced spillage by 80 percent" and, "by rearranging the cafeteria, [designers were] able to increase or decrease the consumption of many food items by as much as 25 percent."[25] Thaler and Sunstein define those who organize "the context in which people make decisions" as "choice architects."[26] This is the role of the stakeholders to the RCAF fighter pilot–retention problem

as well. The goal is not to impose a policy that forces a standard operating procedure to keep pilots *choosing* to stay in the RCAF, nor is a panel of experts able to define precisely and for all time the appropriate steps for retention; instead, the situation is a complex ecosystem of feedback loops that evolve over time and can be influenced at certain nodes to shift the entire feedback cycle by priming "people into certain forms of behavior."[27] An easy example from Figure 1 is the transition from experienced pilots to retiring pilots impacted by multiple negative feedback loops involving the transition from flying airplanes to completing staff tours. This change takes pilots away from what they joined to do (fly) and reduces their pay all at the same time as their prospects in the commercial industry positively explode. Small nudges to the timing of staff jobs or larger nudges to pay-scale growth rates both are capable of reducing the negative effects of this transition point. Once the confluence of negative effects is found by properly identifying key interactions, any one of those interactions can be targeted and resolved as a simple or complicated problem.

It is critical, however, to understand how this process differs from the reductionist view. In a reductionist strategy, a single interaction is identified, and a targeted solution is then implemented in isolation. In a complex problem, the same interaction point may be identified using a different type of initial analysis, and the same action may occur at the same interaction point—but prior to implementation, the complex problem solver will again look at the first-, second- and third-order effects of the change to see how the proposed action will affect those related factors as well. Next, the solvers may add additional inputs elsewhere in the ecosystem to balance out potential consequences down the line. The paradigm shifts from finding the *right* answer to a complicated problem to finding the *balanced* answer to a complex problem.

In a more prescriptive version, David Benjamin and David Komlos suggest a ten-step process to "crack complexity." While this is not the only methodology available in complexity science, it is useful as an initial, more linear step to help the CAF transition away from the OPP to an alternate method more suited to complex problem contexts. The ten steps are

1. acknowledge the complexity;
2. construct a really, really good question;
3. target a requisite variety of solvers;
4. localize the solvers;
5. eliminate the noise;
6. agree on the right agenda;
7. put people on a collision course;
8. advance iteratively and emergently;
9. change how people interact; and
10. translate clarity and insights into action.[28]

The process sounds simple enough, but there are many challenges involved in complex problem solving. Even acknowledging the complexity of the problem can be a challenge since it involves not just stating that the problem is complex, but it is also understanding the implications

for the solutions: complex problems won't have a single solution; the time to find and implement solutions will remain unknown for some time; and there's no guarantee that the solutions brought to decision makers will actually work, while there contrastingly *is* a guarantee that some, if not many, of those solutions will fail. Short tour lengths, the structure of personnel evaluation reports and the desire to be seen as "decisive" in the CAF all run counter to the paradigm required to successfully solve complex problems. Using the fighter force–retention problem as an example, stakeholder interaction was largely managed on personal time, many iterations occurred in the background prior to the recommendations being brought forward to the chain of command and, even with eventual chain-of-command support, the implementation has been stymied by cultural momentum that runs counter to the recommendations—in fact, the same cultural momentum that is causing many of the negative feedback loops identified in Figure 1. This outcome suggests that the institution is not yet ready to accept an alternate problem-solving paradigm and that complex problems will continue to be treated as complicated problems for some time. But there remains hope that this could change: There is increasing movement with younger personnel towards complexity, and some in the higher ranks are exploring the roots of innovation that also link to complexity. These two groups are not yet enough to tip the scales fully, but they may be enough to nudge the institution into accepting a new problem-solving methodology for complex problems.

Conclusion

The CAF remains unable to solve complex problems because it does not use any of the available methodologies from complexity science in its processes.[29] As Zweibelson notes, "we implicitly do this and thus agree as an institution that our military content is less significant than our preferred military form."[30] Zweibelson continues to state that the OPP creates a pseudoscientific approach staged entirely in a positivist construct that uses none of the lessons learned in the last few decades through complexity science. Furthermore, the evolution of military thinking to include complexity science is hampered by the knowledge that this mindset shift would "disrupt a significant portion of traditional military education, training, doctrine and schooling."[31] However, complexity demands an alternate methodology if the CAF is to see any substantive gains in this area. The example of personnel retention is but one of many complex issues, as the list also includes how we respond to insurgencies or operations below the threshold of war, sexual harassment, succession planning and many other personnel and financial problems. The commander of the Canadian Joint Operations Command (CJOC) has begun an institutional conversation about "how we fight" in the CAF, but any fight is defined by how members plan, train and equip, which are in turn defined by how they think. Currently and institutionally, members cannot properly consider complexity. Heltberg and Dahl contend that, if members can institutionally become more self-aware, they will be able to "instil a cognitive flexibility into [the CAF's] deeply rooted, institutional default modes of thinking" that will expand the CAF's possibilities and increase its potential for "comprehensive and surprising" solutions to emerge.[32]

> **"Simple answers can emerge from a complex problem.**

This institutional transition will not be easy. Grisogono suggests that implementing any new approach within an organizational culture is difficult, but that difficulty grows significantly if the organization has not yet "learned to value these essential characteristics, which might easily (if superficially) be seen as contrary to traditional doctrine."[33] Yet the same processes described

above can be used to resolve this complex problem of solving complex problems within the CAF as well. Communication in heterogeneous groups, iterations and small nudges can all help transition the CAF into an institution that is keener and more capable of handling complexity. Finally, it is critical to highlight that a complex problem set does not imply that the solutions are too complex to implement. Simple answers can emerge from a complex problem. As Berlow succinctly notes, "we're discovering in nature that simplicity often lies on the other side of complexity."[34]

Lieutenant-Colonel (LCol) R. M. Kastrukoff joined as a pilot in 2004 and currently serves as the Senior Staff Officer Fighter and acting Deputy Director Fleet Readiness at 1 Canadian Air Division. LCol Kastrukoff has flown the CF188 Hornet for Operation PODIUM as well as NORAD operations. He was also a liaison officer during Operation ATHENA and a flight instructor for fighter lead-in training in Cold Lake. LCol Kastrukoff has a master's degree in aeronautical science as well as a bachelor's degree in physics and computer science, and this article is drawn from his final paper for the Joint Command and Staff Programme.

ABBREVIATIONS

CAF	Canadian Armed Forces
COA	course of action
FWIC	Fighter Weapons Instructor Course
OPP	operations planning process
PA	public affairs
RCAF	Royal Canadian Air Force
TED	technology, entertainment, design
TEWIC	Tactical Electronic Warfare Instructor Course

NOTES

1. David J. Snowden and Mary E. Boone, "A Leader's Framework for Decision Making," *Harvard Business Review* (November 2007).

2. Eve Mitleton-Kelly, "Effective Policy Making: Addressing Apparently Intractable Problems," in *Handbook on Complexity and Public Policy*, ed. Robert Geyer and Paul Cairney (Cheltenham: Edward Elgar Publishing, 2015), 126.

3. Mitleton-Kelly, "Effective Policy Making," 126.

4. Robert Geyer and Paul Cairney, *Handbook on Complexity and Public Policy* (Cheltenham: Edward Elgar Publishing, 2015), 2.

5. Snowden and Boone, "A Leader's Framework for Decision Making."

6. Snowden and Boone, "A Leader's Framework for Decision Making."

7. Richard H. Thaler and Cass R. Sunstein, *Nudge* (New York: Penguin Group, 2009), 102.

8. Geyer and Cairney, *Handbook on Complexity*, 2.

9. Anne-Marie Grisogono, "On the Roles of Design in Defence," in *Design Thinking: Applications for the Australian Defence Force, Joint Studies Paper Series No. 3*, ed. Aaron P. Jackson (Canberra: ADC Publications, 2019), 73.

10. Jim Price and Philip Haynes, "The Policymaker's Complexity Toolkit," in *Handbook on Complexity and Public Policy,* ed. Robert Geyer and Paul Cairney (Cheltenham: Edward Elgar Publishing, 2015), 105.

11. Snowden and Boone, "A Leader's Framework for Decision Making."

12. Therese Heltberg and Kåre Sveistrup Dahl, "Course of Action Development – Brainstorm or Brickstorm?," *Scandinavian Journal of Military Studies 2, no. 1* (2019): 165, https://doi.org/10.31374/sjms.30.

13. Heltberg and Dahl, "Course of Action Development," 165.

14. Heltberg and Dahl, "Course of Action Development," 166.

15. Heltberg and Dahl, "Course of Action Development," 169.

16. Heltberg and Dahl, "Course of Action Development," 170.

17. Heltberg and Dahl, "Course of Action Development," 172.

18. Michael Givel, "'What's the Big Deal?': Complexity versus Traditional US Policy Approaches," in *Handbook on Complexity and Public Policy,* ed. Robert Geyer and Paul Cairney (Cheltenham: Edward Elgar Publishing, 2015), 65.

19. Sebastian Thrun, quoted in David Benjamin and David Komlos, *Cracking Complexity: The Breakthrough Formula for Solving Just About Anything* (London: Nicholas Brealey Publishing, 2019), 122.

20. Eric Berlow, *Simplifying Complexity* (TED, July 2010), video, 3:27, https://www.ted.com/talks/eric_berlow_simplifying_complexity/up-next?language=en#t-175636.

21. The terms "pilot" and "system" denote two streams of common personality types seen in fighter pilots: The "pilot" personality refers to the fly-by-the-seat-of-your-pants group likely to gather for post-mission beers at the mess. The "system" personality refers to the group of personnel who never flew prior to joining the Air Force, do not fly outside of work and have more technical backgrounds and bents.

22. Thaler and Sunstein, *Nudge*, 62.

23. Givel, "What's the Big Deal?," 75.

24. Price and Haynes, "The Policymaker's Complexity Toolkit," 104.

25. Thaler and Sunstein, *Nudge*, 15, 14.

26. Thaler and Sunstein, *Nudge*, 15.

27. Thaler and Sunstein, *Nudge*, 77.

28. All steps were sourced from Benjamin and Komlos, *Cracking Complexity*, 8.

29. Some use of design thinking at the outskirts of CAF thinking is emerging, but it is not yet used in day-to-day decisions or tactical/operational-level thinking.

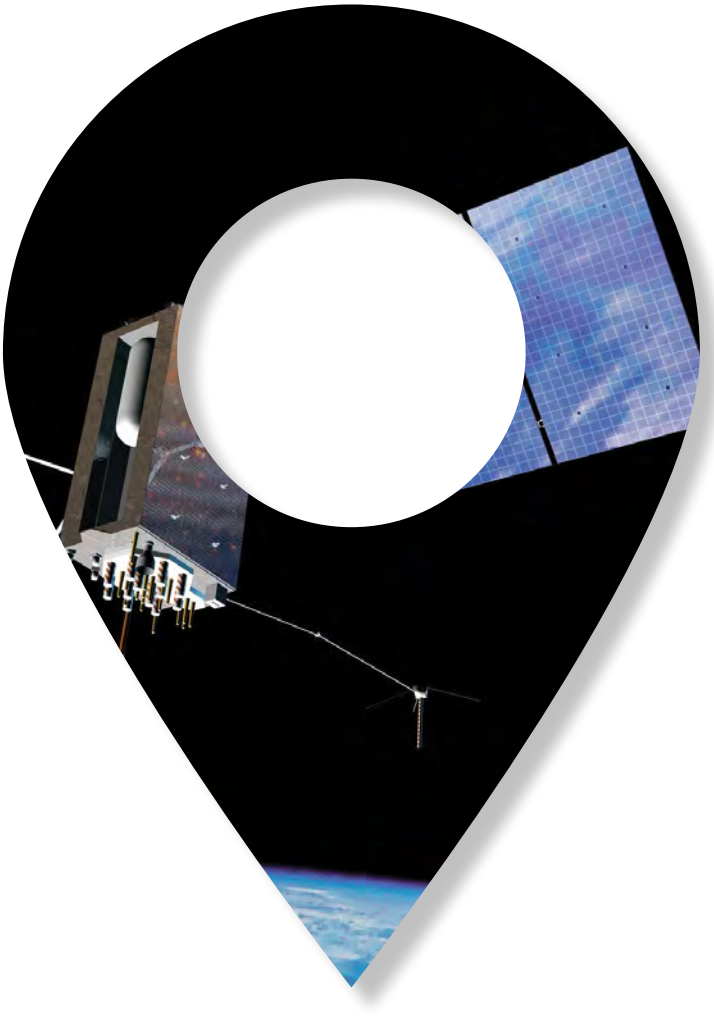
30. Ben Zweibelson, "Fostering Deep Insight through Substantive Play," in *Design Thinking: Applications for the Australian Defence Force, Joint Studies Paper Series No. 3*, ed. Aaron P. Jackson (Canberra: ADC Publications, 2019), 115.

31. Zweibelson, "Fostering Deep Insight," 115.

32. Heltberg and Dahl, "Course of Action Development," 174.

33. Grisogono, "On the Roles of Design in Defence," 86.

34. Berlow, *Simplifying Complexity*.



GPS Denial: The Implications to RCAF Operations

By Captain Nelson Berry

The art of navigation has changed drastically over the last two decades with the prevalence of smartphones and increased access to global navigation satellite systems (GNSSs), specifically the United States–owned Global Positioning System (GPS).[1] The GPS network has become entangled in almost every facet of society, from stock exchange timing synchronization to locating lost keys to consumer electronics.[2] Similarly, a growing reliance can be seen within militaries around the world using GPS for targeting, munitions guidance, logistics systems as well as positioning, navigation and timing.[3] *Strong, Secure, Engaged: Canada's Defence Policy* recognizes the increasing global interest in acquiring capabilities to disrupt GPS and other space-based systems. More specifically, it outlines that "Canada requires an agile, well-educated, flexible, diverse and combat-ready military capable of conducting a wide range of operations at home and internationally."[4] In that regard, the Royal Canadian Air Force (RCAF) lacks the operational readiness to effectively operate in a GPS/GNSS-denied environment due to a deficiency in aircrew training and flexible equipment relative to the present threat vectors posed by jamming, spoofing and antisatellite (ASAT) capabilities. This article will review these threat vectors as they are currently employed globally. Afterwards, it will provide an overview of the current equipment and training programmes of several RCAF aircraft and finally close by describing a handful of innovative navigation solutions.

"CANADA REQUIRES AN AGILE, WELL-EDUCATED, FLEXIBLE, DIVERSE AND COMBAT-READY MILITARY CAPABLE OF CONDUCTING A WIDE RANGE OF OPERATIONS AT HOME AND INTERNATIONALLY."

Technological advancements have changed the threat environment and provided an increasing number of inexpensive and effective avenues for adversarial conflict.[5] Electronic warfare forms the majority of the threat vectors for GPS/GNSSs, with jamming and spoofing being among the most common instances of electronic attack (EA).[6] In addition to EA threats within the realm of electronic warfare, GPS/GNSS satellites remain physically vulnerable to both kinetic and non-kinetic ASAT threats.[7] Jamming is easily accomplished as a result of the low power output of the GPS/GNSS carrier signal.[8] Conceptually, jamming achieves the effect of denial by filling the commonly known carrier frequencies with more background noise so users cannot receive the signal.[9] Due to the basic nature of this EA, commercial jammers have become available for public use through websites like Amazon and eBay. Consequently, jamming interference can be a result of intentional attacks from an adversary or unintentional interference from local populations.[10] Furthermore, jamming can be deployed at great ranges (exceeding 200 kilometres), which impacts decision-making processes to determine geographic locations when deploying forces.[11] The jamming threat vector is therefore a multifaceted space that offers several different problems for military planners to solve.

Spoofing, however, is a more intentional and sophisticated vector of EA. The idea behind spoofing is to mimic or simulate legitimate GPS/GNSS carrier signals to alter the positioning, navigation and timing of the receiving unit in a discrete manner.[12] Spoofing can be more difficult to detect because the system effects are so subtle. Though spoofing has traditionally been more sophisticated, the advancement of technology and economies of scale have allowed for spoofing

IN 2018, FOR EXAMPLE, A RUSSIAN SATELLITE WAS CAUSE FOR CONCERN WHEN IT WAS OBSERVED MAKING ABNORMAL MANOEUVRES IN CLOSE PROXIMITY TO OTHER SATELLITES.

to become affordable.[13] As a result of being a targeted vector of EA, spoofing is more likely to be encountered against a near-peer or peer-plus adversary.[14] In addition to the electromagnetic threat vectors of spoofing and jamming, ASAT has recently become a bigger player in disrupting space-based services.[15]

GPS/GNSS constellations operate in the space environment among many other orbiting satellites and services. As such, it can be assumed that any discussion on ASAT capabilities and potential outcomes would apply to and greatly impact GPS/GNSS services. ASAT capabilities have become more prevalent as the technological gap and financial barrier to enter space have decreased over the years. The capability itself is rather self-explanatory; it encompasses any capability that exists to counter satellites in orbit, either through kinetic or non-kinetic means.[16] Recently, India has demonstrated such capabilities by launching a rocket and downing one of its own obsolete satellites.[17] These kinetic ASAT capabilities become particularly problematic from a space-debris standpoint. Space debris is an overarching term for various rocks, dust, nuts, bolts, dead satellites and everything in between; these objects stay in orbit for a long time and act as projectiles, endangering other assets within the same orbital band.[18] As such, a kinetic attack is not a likely threat as it would deny the use of space to both the adversary and their intended targets.[19] On the other hand, non-kinetic ASAT refers to those capabilities that interfere with satellites in orbit. This can include lasers designed to dazzle or degrade a satellite's sensors, signal-listening devices for intelligence gathering, or even autonomous satellites designed to latch onto and drag target satellites out of orbit to burn up in the earth's atmosphere.[20] In 2018, for example, a Russian satellite was cause for concern when it was observed making abnormal manoeuvres in close proximity to other satellites.[21] Non-kinetic ASAT is limited only by the creativity of the potential adversary and the technology available to them.


Photo: Government of India

The Defence Research and Development Organisation (DRDO) successfully launched the ballistic missile defence interceptor missile in an antisatellite missile test (Mission Shakti) engaging an Indian orbiting target satellite in low earth orbit in a hit-to-kill mode from Dr. A.P.J. Abdul Kalam Island, Odisha, on March 27, 2019.

With a general overview of potential GPS/GNSS threat vectors covered, it is time to consider the equipment and training systems available within the RCAF and assess their effectiveness for

mitigating various threat vectors. Due to a wide range of RCAF aircraft, a representative selection across tactical airlift, fighter and maritime environments was chosen: the CC130J Hercules, CF188 Hornet and CP140M Aurora, respectively. Various literature builds a basic concept of taking a layered approach to ensure a robust navigation capability for air assets.[22] Traditionally, this approach has been accomplished by pairing a GPS/GNSS receiving system closely with an inertial navigation unit (INU), which measures the changes in aircraft attitude using advanced accelerometers to determine its position based off of a known origin position. The theory is that, while the GPS is working, the user can cross-reference the accuracy of their INU and update it as necessary—yet, if their GPS experiences interference or loses connection with enough satellites, the user has a backup system that is already monitoring their position and trajectory.[23]

A CC130J Hercules from 436 Transport Squadron, sitting on the tarmac.

The RCAF has endeavoured to include a navigation solution on all three of these platforms that combines inertial navigation and GPS.[24] The embedded GPS/INU (EGI) system is a single-system solution that embeds GPS/GNSS receivers alongside ring laser, gyro-based inertial navigation systems. Several factors play a key role in determining these systems' resilience to EAs (e.g., jamming or spoofing). First, the system must run an alignment process when powered on. Depending on the system, this involves determining the best satellites to receive information from, receiving that information and determining its position by triangulating the signals. Military navigation systems typically use GPS encryption called P and Y codes; these encrypted signals provide increased resilience against EA and a more accurate position.[25] This alignment process is a point of vulnerability for the system, as alignment is typically accomplished before the system switches to encrypted signals. This is compounded by the vulnerability of an aircraft being stationary during pre-flight checks, which is when EGI alignment typically takes place.[26]

The primary component of accuracy lies in the GPS/GNSS signal strength received. Even with the increased resilience provided by encrypted military signals, a high-power jammer would still interfere with the signal.[27] In this scenario, the inertial part of the EGI system would become the primary navigation source. Though this remains a fairly accurate form of navigation, it must be monitored closely as it tends to drift, increasing the positional error over time.[28] Therefore, aircrews must be comfortable operating under GPS/GNSS denial using navigational tools with comparatively lower accuracy.

The training programmes for the C130J, CF188 and CP140M were reviewed using their respective qualification standards (QSs) and training plans (TPs). A search for degraded navigation, GPS denial and related terms was conducted to assess whether the topic was acknowledged and taught to prospective students. It is important to note that—due to the prevalence of GPS/GNSS usage—when GPS is denied, it is often not identified as a jamming or spoofing scenario, but instead as a "degraded navigation" scenario.[29] Across all three QSs, only the CP140M Aurora QS acknowledged degraded navigation skill requirements.[30] Though recognized within this QS, it appeared in the context of a catch-all statement rather than a direction for robust curriculum development.

A CP140M Aurora long-range patrol aircraft being prepared for departure on its first intelligence-gathering mission over Iraq during Operation IMPACT on October 30, 2014.

Upon further investigation of the three fleets' TPs, it was discovered that there is some mention of degraded navigation. In the case of the CF188 Hornet, the current TP was not accessible, and the older version that was accessed only briefly mentioned using "watch, map, ground" techniques in the event of a successful GPS jamming scenario.[31] Watch, map, ground is a common navigation technique using visual reference to the ground and cross-referencing specific map features completely independent of GPS/GNSS. However, this skill was mentioned as part of a single training mission that was focused more on developing other skills first. The CC130J did not fare much better: Within the TP for this fleet, degraded navigation is mentioned, but it does not appear on any of the specific flights. It is summed up in an hour and a half–long classroom lesson during the second week of the course.[32] Finally, the CP140M Aurora TP mentioned degraded navigation as a performance objective for air combat systems officer students.[33] The degraded navigation skills covered in this document recognize navigation degradation, assess potential impacts to the mission and discuss how to take corrective action. However, it does not outline the detailed procedures for achieving these skills.[34] Among all these training documents across the three fleets, it appears that—though degraded navigation is acknowledged—there is no emphasis on developing the associated skills to deal with it.[35]

As previously discussed, layered approaches are essential in mitigating the various EA and ASAT threat vectors. Though the RCAF has a limited layered approach using the EGI system, adding additional layers with innovative navigation solutions will allow the RCAF to operate persistently within the discussed threat environment.[36] What follows is a brief overview of a handful of emerging technologies.

An industry-wide look at emerging technologies is not possible due to time constraints; instead, celestial navigation systems, enhanced long-range navigation (eLORAN) and controlled radiation pattern antennae will be discussed due to their relative simplicity in mitigating GPS/GNSS denial. Celestial navigation historically relied on fixing one's position by obtaining bearings from stars using a sextant.[37] This highly technical process could take quite a while and would yield relative accuracy within a couple of miles. An innovative version of celestial navigation has been increasingly researched for lunar navigation and navigation by the United States Navy.[38] With the

new celestial navigation systems, computers with advanced sensors can locate themselves using the same techniques as before in mere seconds. Furthering this technology is the ability for computers to filter out sunlight to see star constellations during the day.[39] One disadvantage is the potential for cloud cover, but this could be mitigated for aircraft by increasing altitude, within reason. This is just one innovative solution for navigation sources in a GPS/GNSS-denied environment.

ADDRESSING TRAINING SHORTCOMINGS WILL BE A MORE DIFFICULT PROBLEM TO SOLVE.

Long-range navigation (LORAN) is a navigation technology previously employed by navies and merchant ship traffic around the world using high-frequency (HF) radio signals and triangulation to determine positions.[40] The United States Navy upgraded the system in the early 2000s to the eLORAN system, then swiftly shifted to a reliance on GPS.[41] This would provide an independent navigation backup and mitigate the risk of navigational errors during an EA on GPS/GNSS.[42] eLORAN would remain susceptible to jamming, but it would be difficult for an adversary to jam both GPS/GNSSs and HF frequency bands. The use of eLORAN would strengthen navigation capabilities and create difficult resource allocation problems for adversarial forces.

Finally, perhaps one of the more promising innovations is controlled reception pattern antennae. These antennae operate by constantly assessing the direction of any received signals.[43] As GPS/GNSS signals come directly down on top of an aircraft from space, any signal outside that profile can be assessed as interference and blocked out.[44] This approach is effective for all EA threat vectors discussed here, but would still be susceptible to ASAT threats or space-based EA.

LORAN tower station on Sand-Johnson Island in 1963.

This article has provided an overview of the prominent threat vectors towards GPS/GNSSs; a review and analysis of select RCAF assets; and a brief introduction to some of the innovative technologies to mitigate the threat vectors. Two main questions remain: Is the RCAF's equipment sufficient for the imposing threats to GPS/GNSSs? Are aircrews being trained to a standard that leaves them comfortable and confident in their INU-only navigation? Regarding the latter question, the aforementioned thesis still stands: the RCAF lacks the operational readiness to effectively operate in a GPS/GNSS-denied environment. Without the permissive use of GPS/GNSSs, the RCAF is unable to deliver air power effectively, which negates the purpose of having an air force. From a systems perspective, the RCAF EGI system is not in itself a bad system, but it could absolutely benefit from a tertiary source of navigation to help reduce the drift error inherent in inertial navigation systems. This would provide a multi-source navigation solution and reduce GPS/GNSS dependency for operations.

An air-to-air left side view of an F-15 Eagle aircraft releasing an antisatellite missile during a test.

(Photo: National Archives, US)

Addressing training shortcomings will be a more difficult problem to solve. Degraded navigation receives little recognition within training documents, nor do they acknowledge deliberate EA as a cause for this degradation. Even if one assumed that all allocated syllabus time was spent discussing EA vectors and GPS/GNSS denial, the subject would woefully lack the time emphasis required. Furthermore, squadron-level training is difficult to capture here; there could be an extensive push by keen aviators at the squadron level to develop these skills which could go undocumented. However, if the initial training does not provide an emphasis on GPS/GNSS denial, then it is unlikely that aircrew are as aware as they should be about these types of threats.

Though there are holes in the information available, some stark conclusions can be drawn: GPS/GNSS denial is a real threat that can be accomplished with relative ease. The RCAF will be operating in environments where this threat exists. A tertiary source of navigation on-board RCAF aircraft provides a more resilient navigation capability and allows aircrew to operate more effectively. Finally, due to limited emphasis within the training system, aircrew are uncomfortable operating without the high-accuracy-navigation solution of GPS. It is therefore recommended that the RCAF conduct an audit of navigation equipment and aircrew training to determine a tertiary navigation source for increased navigation accuracy and to assess the degraded navigation / GPS denial skill competency at the squadron level. The ultimate goal would be to create a robust three-layered navigation system across all fleets and begin force-generating competent aircrew capable of operating without the use of GPS.

Captain Nelson Berry is an Air Combat Systems Officer currently employed as a Tactical Coordinator (A Category) on the CP140M Aurora at 407 Long Range Patrol Squadron in Comox, British Columbia. In 2013, he graduated from Simon Fraser University with a bachelor's degree in sociology. Notably, he has deployed on Operation IMPACT in 2017 and Operation CARIBBE in 2018, 2019 and 2021. Captain Berry enjoys traveling and meeting new people, and he is hoping COVID-19 travel restrictions will be lifted in the near future.

ABBREVIATIONS

ASAT	antisatellite
CAF	Canadian Armed Forces
EA	electronic attack
EGI	embedded GPS/INU
GNSS	global navigation satellite system
INU	inertial navigation unit
RCAF	Royal Canadian Air Force
TP	training plan

NOTES

1. Jim Bennett, "Early Navigational Cultures," in *Navigation: A Very Short Introduction* (Oxford: Oxford University Press, February 2017), https://www.veryshortintroductions.com/view/10.1093/actrade/9780198733713.001.0001/actrade-9780198733713-chapter-1.

2. Matteo Luccio, "Access Denied: Anti-Jam Technology Mitigates Navigation Warfare Threats," *GPS World*, December 10, 2019, https://www.gpsworld.com/access-denied-anti-jam-technology-mitigates-navigation-warfare-threats/.

3. Major Nathan Burgess, "Denied! The NAVWAR Threat and Its Impact on Operations," *InForm*, no. 35 (September 2017).

4. Canada, Department of National Defence (DND), *Strong, Secure, Engaged: Canada's Defence Policy* (Ottawa: DND, 2017), 57, http://publications.gc.ca/collections/collection_2017/mdn-dnd/D2-386-2017-eng.pdf.

5. Jordan Rozsa, "Improving Standoff Bombing Capacity in the Face of Anti-Access Area Denial Threats" (dissertation, Pardee RAND Graduate School, September 2015), xi, https://search.proquest.com/docview/1749886070?accountid=10524; and Alison Brown et al., "Jammer and Interference Location System – Design and Initial Test Results," in *Proceedings of the 12th International Technical Meeting of the Satellite Division of the Institute of Navigation* (Nashville: Institute of Navigation, September 1999), 137.

6. Ahmad Alhosban, "Electronic Warfare in NAVWAR: Impact of Electronic Attacks on GNSS / GBAS Approach Service Types C and D Landing Systems and Their Proposed Electronic Protection Measures (EPM)," *Hadmérnök* 14, no. 2 (2019): 247; Tegg Westbrook, "The Global Positioning System and Military Jamming: The Geographies of Electronic Warfare," *Journal of Strategic Security* 12, no. 2 (2019), 1–2, https://doi.org/10.5038/1944-0472.12.2.1720; and Neal MacDonald, "Preparing for Artillery Operations in a GPS Denied Environment," *Fires* (May–June 2019): 35.

7. Alexandra Stickings, "The Normalisation of Anti-Satellite Capabilities," *Air and Space Power Review* 22, no. 2 (2019): 33.

8. Alhosban, "Electronic Warfare in NAVWAR," 231.

9. Luccio, "Access Denied."

10. Elena Simona Lohan et al., "GNSS Navigation Threats Management On-Board of Aircraft," *INCAS Bulletin* 11, no. 3 (July–September 2019): 114; and Luccio, "Access Denied." Unintentional interference is often found around airports with major highways running nearby. Further, truck drivers may purchase GPS jammers to circumvent their parent companies from tracking them, thereby allowing the drivers to travel over company policy limits.

11. Westbrook, "The Global Positioning System," 10; and Lohan et al., "GNSS Navigation Threats Management," 6.

12. Yang Liu et al., "Impact Assessment of GNSS Spoofing Attacks on INS/GNSS Integrated Navigation System," *Sensors* 18, no. 5 (May 2018): 1.

13. Liu et al., "Impact Assessment of GNSS Spoofing Attacks," 1; and Luccio, "Access Denied."

14. Neil Gerein and Peter Soar, "Navigation Warfare: GNSS Denied – Threat and Mitigation," Military Embedded Systems, December 2, 2015, https://militaryembedded.com/radar-ew/sensors/navigation-denied-241-threat-mitigation; and Burgess, "Denied! The NAVWAR Threat."

15. Stickings, "The Normalisation of Anti-Satellite Capabilities," 32.

16. Stickings, "The Normalisation of Anti-Satellite Capabilities," 33.

17. Stickings, "The Normalisation of Anti-Satellite Capabilities," 33.

18. Canada, DND, *Royal Canadian Air Force Doctrine Note 17/01: Space Power* (Ottawa: DND, June 27, 2017), 7.

19. RCAF Director General Space, brief to Air and Space Power Operations Course (ASPOC) 1903.

20. Canada, DND, *Royal Canadian Air Force Doctrine Note 17/01: Space Power*; and Stickings, "The Normalisation of Anti-Satellite Capabilities," 35.

21. Mike Wall, "'Very Abnormal' Russian Satellite Doesn't Seem So Threatening, Experts Say," Space.com, August 16, 2018, https://www.space.com/41511-weird-russian-satellite-not-so-abnormal.html; and "Mysterious Satellite Sparks Concerns That Russia Has Developed a Space Weapon," IFLScience, https://www.iflscience.com/space/mysterious-satellite-sparks-concerns-russia-has-developed-space-weapon/.

22. Specifically, Luccio, "Access Denied"; Burgess, "Denied! The NAVWAR Threat"; and Kenneth A. Fisher and John F. Raquet, "Precision Position, Navigation and Timing Without the Global Positioning System," *Air and Space Power Journal* 25, no. 2 (2011): 24–33.

23. G. Satheesh Reddy and V. K. Saraswat, "Advanced Navigation System for Aircraft Applications," *Defence Science Journal* 63, no. 2 (March 2013): 131.

24. CC130J, CF188 and CP140M operators, in discussion with ASPOC 1903 students, January 28, 2020.

25. Chris Hegarty, Edward Powers and Blair Fonville, "Accounting for Timing Biases Between GPS, Modernized GPS, and Galileo Signals," in *36th Annual Precise Time and Time Interval (PTTI) Meeting* (San Diego: Institute of Navigation, January 2005), 308.

26. Desmond Schmidt et al., "A Survey and Analysis of the GNSS Spoofing Threat and Countermeasures," *ACM Computing Surveys* 48, no. 4 (May 2016): 6–7.

27. Lester de Abreu Faria, Caio Augusto de Melo Silvestre and Marcelino Aparecido Feitosa Correia, "GPS-Dependent Systems: Vulnerabilities to Electromagnetic Attacks," *Journal of Aerospace Technology and Management* 8, no. 4 (October–December 2016): 1, https://doi.org/10.5028/jatm.v8i4.632.

28. Gianluca Falco et al., "Performance Analysis of Constrained Loosely Coupled GPS/INS Integrated Solutions," *Sensors* 12 (2012): 16,000, https://doi.org/10.3390/s121115983.

29. ASPOC 1903 flying members, in discussion with author.

30. Canada, DND, *Qualification: ALNY CP140 Block III MITE 120551 CP140* LRP Tactical Coordinator *B* (Ottawa: 1 Canadian Air Division, 2015); Canada, DND, *ADKH (Unique Specialty) 100627 CF188 Fighter Pilot* (Ottawa: 1 Canadian Air Division, 2018); and Canada, DND, *Qualification AKWN Mite Crse ID 117944 CC-130J Combat Ready First Officer* (Ottawa: 1 Canadian Air Division, 2014). Note that TPs and qualification standards may be controlled goods and therefore inaccessible to some readers.

31. Canada, DND, *Train Education Plan CF188 Fighter Pilot* (Cold Lake: 410 Tactical Fighter Operational Training Squadron).

32. Canada, DND, *Training Education Plan CC130J Combat Ready First Officer* (Trenton: 426 Transport Training Squadron, 2011). The specific classroom lecture was not available to be reviewed.

33. Raymond Townsend, *CP 140M LRP Tactical Coordinator (TACCO) Basic Training Plan (TP)* [Greenwood: 404 Long Range Patrol and Training Squadron, 2018].

34. The specific classroom lectures were not available for review.

35. The "10,000 hours rule" is an often-quoted theory by Malcolm Gladwell indicating that, to reach true mastery of a skill, one must invest 10,000 hours into practising that skill. The limited mention of degraded navigation and a mere one or two hours of syllabus focus do not place the required emphasis on this skill's development.

36. Stickings, "The Normalisation of Anti-Satellite Capabilities," 38; Luccio, "Access Denied"; and Canada, DND, *Strong, Secure, Engaged*, 57.

37. Bennett, "Early Navigational Cultures."

38. F. Pappalardi et al., "Alternatives to GPS," in *MTS/IEEE Oceans 2001: An Ocean Odyssey Conference Proceedings* (Honolulu: Institute of Electrical and Electronics Engineers, 2001): 1,452, https://doi.org/10.1109/OCEANS.2001.968047; and Xiaolin Ning, "A Celestial Assisted INS Initialization Method for Lunar Explorers," *Sensors* 11, no. 7 (2011): 6,992.

39. Pappalardi et al., "Alternatives to GPS," 1,452.

40. Bennett, "Early Navigational Cultures."

41. David S. Radin, "Back to eLORAN Reduces GPS Vulnerability," *United States Naval Institute* 142, no. 9 (September 2016): 82–85.

42. Kim Heyone et al., "Performance Evaluation of Multi Radio Integrated Navigation System under Navigation Warfare in M&S Software," *E3S Web of Conferences* 94, no. 01008 (2019): 1–6.

43. Mohamed Moussa et al., "Direction of Arrival Estimation of GPS Narrowband Jammers Using High-Resolution Techniques," *Sensors* 19, no. 24 (December 15, 2019): 5,532, https://doi.org/10.3390/s19245532.

44. Moussa et al., "Direction of Arrival Estimation," 5,532; "Raytheon Delivers 2000th Anti-Jam Antenna System," in *NATO's Nations and Partners for Peace*, 248–49.

BOOK REVIEWS

I WILL RUN WILD: THE PACIFIC WAR FROM PEARL HARBOR TO MIDWAY

By Thomas McKelvey Cleaver

Osprey Publishing, 2020
320 pages
ISBN 9781472841339

Review by **Chris Buckham**

The title of this book is drawn from the comment made by the Commander of the Japanese Navy, Admiral Yamamoto, when advised that war with the United States was inevitable: "For the first six months I will run wild. After that I can promise nothing."[1] Indeed, the Japanese did, repeatedly defeating the forces of the United Kingdom, Holland, the Commonwealth and the United States (US) operating in the Far East. Thomas McKelvey Cleaver's is a fastidiously researched account of those months, with a particular emphasis upon the US experience.

Conventional wisdom suggests that this period was one of predominant success for the forces of Imperial Japan; however, as the author demonstrates, the angel of fortune flies on wings that are a combination of opportunity, competency and luck. As Cleaver's narrative unfolds, repeated examples are presented where this assertion is proven:

1. The Japanese attack on Pearl Harbor crippling the US Pacific Fleet while missing both its carriers as well as the maintenance and fuel-storage reserves of the harbour;

2. The Japanese codes (which were broken by the US in early 1942) being changed on May 27, 1942, seven days before the attack on Midway but too late to prevent the US from knowing the order of battle and the anticipated attack date;

3. The US relief fleet for the garrison at Wake Island (under attack by Japanese land and sea forces) being turned back 24 hours before its anticipated engagement with the Japanese (who were not aware of their presence and were not at all prepared for a sea engagement); and

4. A damaged Japanese Zero ditched during an attack on the Aleutian Islands. It was a chance finding by a lost Catalina. The crashed Zero was intact because two other Zero

> pilots who had been escorting the crippled aircraft did not want to destroy it from the air (despite standing orders to do so) for fear of possibly injuring their friend and fellow pilot, who was later discovered deceased—likely immediately—from the impact. Up to this point, the US had not been able to capture a Zero; the Japanese considered it a loss no less serious than the Battle of Midway itself.

As with his other books, Cleaver draws heavily upon first-hand accounts from a myriad of sources and ranks, adding a poignancy to his narrative and a very human face to the fighting. His style skilfully captures the breadth of the geographic canvas that was the Pacific theatre of operations, concurrently presenting it in a style accessible to both the avid historian and the casual reader.

An eminently comprehensible and informative work that presents the reader with all of the hubris, drama and humanity from a myriad of perspectives, it is a recommended addition to those seeking a deeper appreciation for the challenges of the Pacific War.

Chris Buckham served in the Royal Canadian Air Force (RCAF) as a logistics transport officer for 33 years. Highlights of his career include serving almost 11 years abroad and 5 years with Canadian Special Operations Forces Command as well as assuming the roles of equerry to the Queen and exchange officer with United States European Command. He now works as a project-manager contractor with the RCAF.

NOTES

1. Thomas McKelvey Cleaver, *I Will Run Wild: The Pacific War from Pearl Harbor to Midway*, (n.p.: Osprey Publishing, 2020).

SUBMISSIONS BEING SOUGHT FOR THE J. A. WILSON AIR POWER AND HISTORY ESSAY CONTEST

The Royal Canadian Air Force Journal is pleased to assist the RCAF Heritage Fund (RCAF HF) in announcing the first annual J. A. Wilson Air Power and History Essay Contest. The top prize in the contest is $1,750, with the runner-up garnering $750.

ESSAY TOPICS

The essay contest is open to individuals who produce a well-researched, scholarly paper relating to one of the following subject areas:

a. Canadian military aviation—history / historical operations;
b. the RCAF and national security;
c. RCAF policy and doctrine;
d. RCAF organizational and development issues;
e. RCAF operations;
f. the RCAF and equipment acquisition;
g. Canadian space policy and issues;
h. Canadian air defence, sovereignty-policy and issues; and
i. Global air and space power issues (e.g., coalition operations, air policing, future aviation technology, space).

Questions concerning the suitability of a topic should be referred to the RCAF Chief Historian, Dr. Richard Mayne, at Richard.Mayne@forces.gc.ca.

SUBMISSIONS GUIDELINES

The following guidelines shall be followed for all submissions to the J. A. Wilson Air Power and History Essay Contest:

a. Submissions may be made in either of Canada's two official languages.
b. Submissions are to be between 3,000 and 5,000 words in length, not including endnotes/footnotes.

c. Submissions are to be written in accordance with the conventions of *The Chicago Manual of Style*.

d. Authors should follow *Concise Oxford English Dictionary* or *Le Petit Robert* spelling conventions.

e. Essays should be submitted digitally in Microsoft Word or rich-text format.

f. All supporting tables, images and figures that accompany the text should be sent in separate files (i.e., not embedded in the text). Original vector files are preferred; high-resolution (not less than 300 dpi) .psd or .jpg files may be submitted.

g. Copyright permissions are required for all material that is not Department of National Defence (DND) or author originated.

h. The author must include a brief biographical sketch (not more than 250 words) that includes their current position/occupation and contact information (telephone number, email address).

SUBMISSION DEADLINE AND DETAILS

Submissions to the J. A. Wilson Air Power and History Essay Contest are to be sent to the RCAF Chief Historian at Richard.Mayne@forces.gc.ca and should include the contest name in the subject line. Entries must be received no later than Friday, November 26, 2021. Late submissions will not be considered. Essays must be original. Those that have been published elsewhere will be rejected.

Submissions will be vetted by the RCAF HF. Selection criteria for essay prizes are subjective in nature and are solely based upon the RCAF HF committee's opinion as to the applicability and utility of the submissions in furthering Canadian air power and historical studies. Individuals whose submissions are not chosen will be notified via email.

Winning authors agree that the right of first refusal for the publication of their essay will rest with the editor of the *Royal Canadian Air Force Journal*.

BACKGROUND

John Armistead Wilson was born in Scotland in 1879, trained as an engineer and moved to Canada in 1905. Although he was not an aviator himself, he was heavily involved in the formation of the Royal Canadian Naval Air Service. He was a key figure in the formulation of the Air Board Act of 1919 and most post-war aviation policy for Canada. While he was dubbed "the Father of Canadian Civil Aviation," the policies he spearheaded ensured the mechanisms and political support essential for the successful creation and eventual growth of the RCAF. He was inducted as a member of Canada's Aviation Hall of Fame in 1974, twenty years after his death. He is generally regarded as one of Canada's first "airminded" thinkers.

The RCAF HF is an independent organization designed to promote and preserve Canadian military aviation history and heritage projects that have difficulty finding support from other sources.