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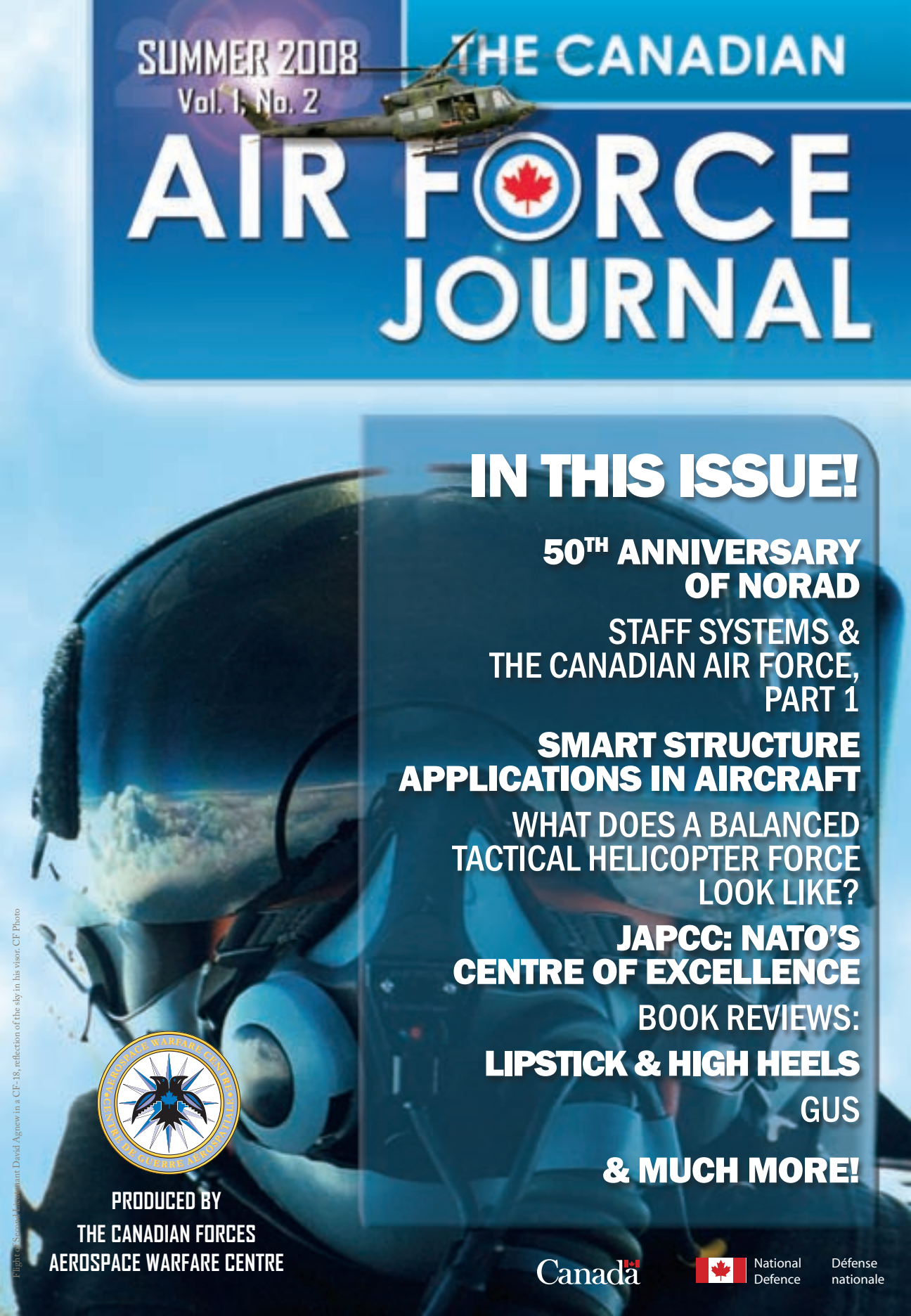

IN THIS ISSUE!

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THE CANADIAN FORCES
AEROSPACE WARFARE CENTRE

Flight Sergeant Lieutenant David Agnew in a CF-18, reflection of the sky in his visor. CF Photo

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THE CANADIAN AIR FORCE JOURNAL is an official publication of the Chief of the Air Staff and is published quarterly. It is a forum for discussing concepts, issues and ideas that are both crucial and central to aerospace power. The journal is dedicated to disseminating the ideas and opinions of not only Air Force personnel, but also those civilians who have an interest in issues of aerospace 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 Air Force. It serves as a vehicle for the continuing education and professional development of all ranks and personnel in the Air Force, as well as members from other environments, employees of government agencies, and academia concerned with Air Force affairs. ■

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NOTE TO READERS

As a bilingual journal, readers should take note that where citations in endnotes are translated from their original language, we will use the abbreviation 'TOQ' at the end of the note to indicate that readers can find the original citations in the other language version of the Journal.

THE CANADIAN AIR FORCE JOURNAL

CANADIAN AIR FORCE JOURNAL

EDITOR'S MESSAGE

Welcome to the second edition of our new Canadian Air Force Journal! We have received many positive replies on our inaugural edition, so I can only hope that the second one will again provide some material that will stimulate debate and discussion. I again invite both supportive and counter opinions on any submissions as Letters to the Editor.

As we actively plan and prepare for our future, we must never forget our past and our heritage. Therefore, in this and subsequent editions, we will periodically republish articles from former publications such as the Roundel or the RCAF Staff College Journal. In this edition, you will read about the oldest command in "The Evolution of Air Material Command." Also included is an article on Admiral Yamamoto as a case study on the utility of continual professional reading – a personal fundamental tenet. A piece drawing on past experiences is the first of two articles on "Staff Systems and The Canadian Air Force." Touching on a current issue is the "Joint Air Power Competence Centre." Finally, there are two articles casting to our future – the first on a balanced helicopter force and the second on smart structures. This edition concludes with one Point of Interest on the 50th anniversary of NORAD as well as four book reviews.

We have been blessed with quality submissions for both the first and second editions of the Canadian Air Force Journal and sincerely hope that the trend will continue. I would especially invite recent attendees at the various courses at our Canadian Forces College to submit articles. I again want to thank the Production Staff at the Canadian Forces Aerospace Warfare Centre – it is a distinct privilege to work with such talented and professional individuals. Due to a posting this summer, this will be my last edition as your Senior Editor, but I will remain an active member of the Editorial Board.

Enjoy our second edition.

Col W.J. Lewis, OMM, CD, PhD
Senior Editor

SUBMISSION REQUIREMENTS

THE AIR FORCE JOURNAL welcomes the submission of manuscripts, research notes, book reviews, points of interest and letters to the editor 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.

AUTHORS ARE ASKED TO NOTE THE FOLLOWING GUIDELINES

- Submissions may be made in either official language.
- Articles should be 3000-5000 words exclusive of endnotes, research notes 1000-1500 words, book reviews 500-1000 words, and points of interest 1000 words or less.
- Authors must include a brief (one paragraph) biographical sketch which includes current appointment, telephone number, email and mailing address.
- All submissions will be peer reviewed, and the Editor will notify contributors on the status of their submission.
- 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, ie. not imbedded in the text. Original vector files are preferred, or high resolution (not less than 300 dpi) .psd or .jpg files.
- All diagrams, photos and text must be of Department of National Defence origin, or copyright held by author. If any material used requires copyright permissions, it is the responsibility of the author to obtain permission, and to attach all permissions received including name of author, locations and name of publisher. Any submissions not meeting these requirements may be omitted from the article. If required, the publisher of The Canadian Air Force Journal may provide diagrams or images to accompany articles.
- Manuscripts should conform to academic style, using Oxford English or Petit Robert spelling with endnotes rather than footnotes. Citations must conform to the Chicago style. For assistance refer to *The Little, Brown Handbook*, *Le guide du rédacteur* or CFAWC Production Section at romard.f@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 followed by the abbreviated form in brackets. Abbreviations are to be avoided as much as possible in tables and figures; if used, each table and figure will contain a list of abbreviations. When abbreviations are used a table of all abbreviations and their terms will be included at the end of manuscript.
- In addition to the above, book reviews must include the following:
  - the book's complete title (including sub-title);
  - complete names of all authors as presented on the title page;
  - the book's publisher;
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  - the book's ISBN; and
  - the number of pages.
- Furthermore, all published book review will include a picture of the book's cover. Please provide a high resolution (at least 300 dpi) .jpg file of the book's cover that is at least 5 by 7 inches.

The Editor reserves the right to edit manuscripts for style, grammar and length, but will not make editorial changes that will affect the integrity of the argument without consulting the author.

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14th Annual
Air Force Historical Workshop *

24-25 September 2008
Holiday Inn Select & Suites
101 Kanata Avenue
Ottawa, Ontario, Canada

"MAPLE LEAF ALOFT:
THE HISTORICAL DIMENSION OF CANADIAN AIR POWER LEADERSHIP."

CANADIAN FORCES
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The current security environment brings with it a broad range of challenges for leaders at all rank levels within the Canadian Air Force. Yet, many of these challenges are not new. Throughout our history, both at home and abroad, during peace and in combat, Canadian airmen and airwomen consistently demonstrated their ability to overcome adversity and accomplish their assigned missions both in the air and on the ground. Key to our successes has been air force leadership.

The purpose of this workshop is to explore the historical dimension of Canadian air power leadership in all its facets.

For registration information, administrative details and a list of speakers/topics please visit the following site:

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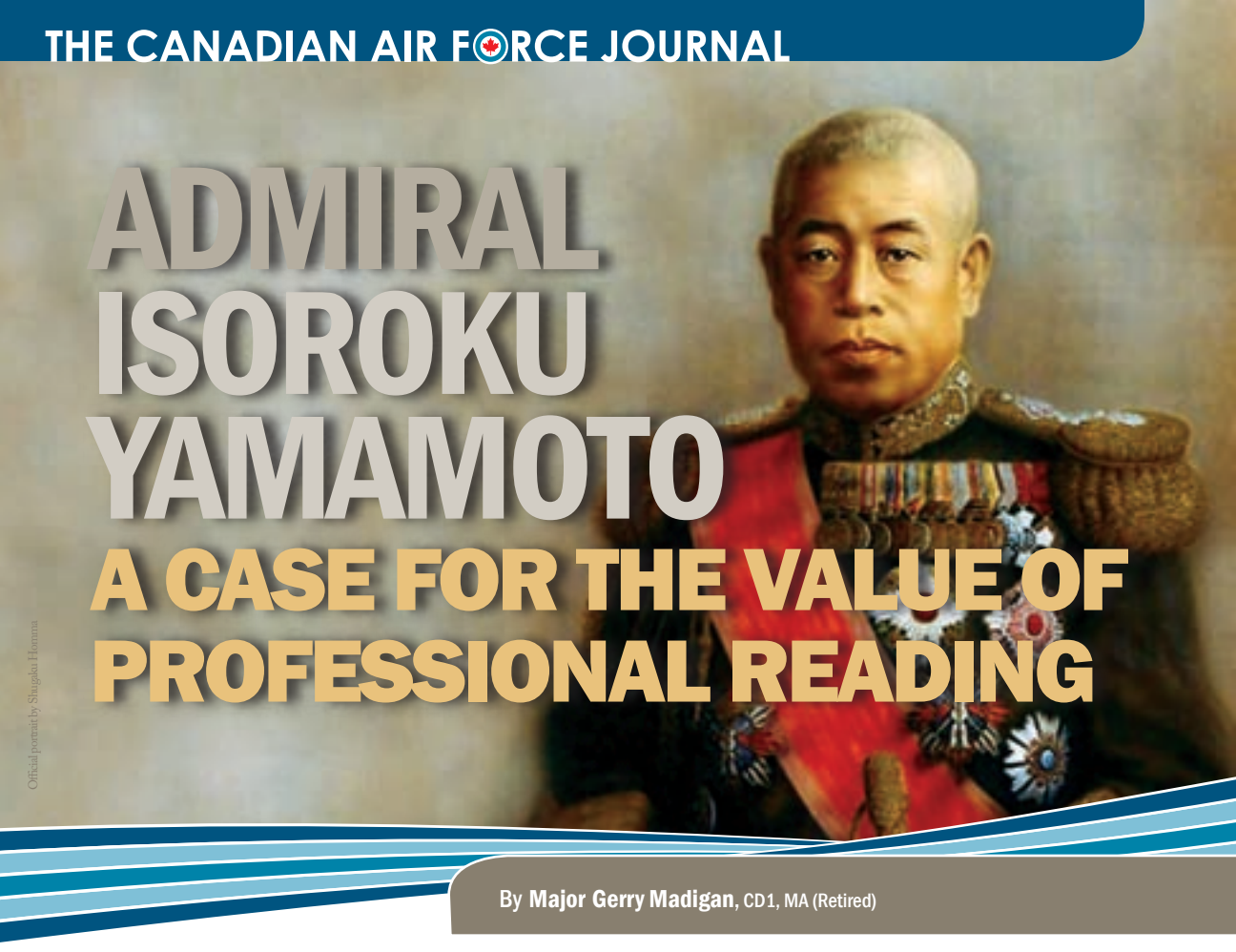


ADMIRAL ISOROKU YAMAMOTO

A CASE FOR THE VALUE OF PROFESSIONAL READING

Official portrait by Shugaku Homma

By **Major Gerry Madigan**, CD1, MA (Retired)

Introduction

Reading is a wonderful past-time which opens the mind to exploration and relaxation. Disciplined reading, which is reading with a purpose, is a chore. Finding the time to fit it into the complex mosaic of our lives is often difficult. However, disciplined reading is the lifeblood of professional development and military competence.

What role does professional reading play in a military officer's development? Some have argued that history has little to offer because technology is maturing too quickly and events are superseding lessons learned for them to be of any immediate value. This begs the value of a systemic approach to the application of "historical" knowledge to the military professional.[1] One may argue that "reading" is a redundant skill, yet reading with a purpose is a necessary tool that develops "the forward thinkers" of the future.

Many professionals today rely heavily on fast paced and technically based media for much of their information needs. Many of us have little time for the printed word. The multi-media have come to be the sole source of information to quickly justify our precepts and conclusions. However progress in any field of human endeavour must come with some deep thought, reflection, analysis and conceptualization to avoid superficiality. Analysis and conceptualization cannot be a process of simply ticking the box, to say "been there, done that, got the T-shirt!" The lack of time cannot always be the excuse as the limiting factor in decision making. Experience may offer the counter balance but many leaders do not necessarily have experience of a given situation. When time is of the essence then, where lives may be at stake, or where a nation's resolve matters, reading history may offer some insight. In order to use history and professional reading to its fullest potential, the professional must be able to juxtapose the present to the past, analyse the consequences and then conceptualize the way ahead.


Shokaku

Courtesy of U.S. Naval Historical Center

The Case of Isoroku Yamamoto

Military officers in particular need to reflect upon the value of disciplined reading. We cannot view it a lost cause. We need examples where disciplined reading and experience made a great contribution to strategic action. One such example may have been Isoruku Yamamoto; the Admiral of the Japanese Imperial Navy who orchestrated the 1941 attack on Pearl Harbor. Though there is little clear direct evidence suggesting that Yamamoto was widely read, his career does offer insight that suggests he had a unique opportunity for development, synthesis, and evolution of a novel strategic concept for his time—the employment of aircraft carriers in a theatre of war. Yamamoto may have been simply an objective observer of his day who was open to the potential of synergies offered by new technologies because of time, place, and most importantly, professional reading.

The period following the Great War may provide some insight to Yamamoto's opportunity. The inter-war period was an era of prolific strategic thinking and writing. Many writers wrested lessons learned from the First World War in the hopes of defining breakthrough ideas that would lead to creating force structures of the future. Many also argued a dominant service view as the fighting services were bidding against one another for a limited share of dwindling budgetary resources in the inter-war years. This produced a running debate that was often fought in the popular and technical press. Yamamoto was exposed to this debate.

An ambitious naval officer; Yamamoto was brought up in the great tradition of the supremacy of the battleship. He was a world traveler and spoke fluent English.[2] As an up-and-coming naval officer, he was sent to the United States to study economics at Harvard University between 1919-1921.[3] While there he took a keen interest in aviation and, in particular, military aviation. Yamamoto was noted for being well-versed in matters of naval aviation.[4] Upon his return to Japan in 1923 and until 1925, he was director of a new naval air training unit. He was subsequently appointed Naval Attaché in Washington (1925-27). One of his duties in this position was to report on military advancements.

Most information of the day was gleaned from technical journals, magazines, and newspapers. Some have argued that this information was of little intrinsic value as it was played in the court of public opinion. Debating in the court of public opinion is a different character to that of debate within professional service. The court of public opinion appeals to the heart strings of a popular cause to swing the public's mood toward that cause. A professional service debate, however, must ensure that its arguments are based on fact—not fancy—as lives and national treasure are at stake, scarce commodities that are highly valued. Most military officers were likely biased and championed concepts and specific causes that supported their own particular service or strategic interests.[5] Yamamoto was different. He appeared to be more open and objective; and came to believe in the value of the aircraft carrier.[6]

In 1931, Yamamoto was promoted to rear admiral, became responsible for his navy's technical service, and learned to fly. As vice minister of the Japanese Navy he oversaw the building of two modern aircraft carriers, *Shokaku* and *Zuikaku*.[7] He became increasingly convinced that future wars would be decided by air power. Yamamoto envisaged the necessity for immediate surprise for the neutralization of the enemy in future conflict and saw the aircraft carrier as the means to do so. Exceptionally well-versed in matters of naval aviation,[8] he argued for the cause of the aircraft carrier, which must have been exceedingly difficult given the cult of the supremacy of the battleship as the capital ship of the line. Yamamoto's argument was accepted by the Japanese Naval staff at the time.[9]


Zuikaku

Courtesy of U.S. Naval Historical Center

The Stage

Yamamoto had many sources for his development. The inter-war period following the Great War was a point of departure for strategic thinking about future war. There were many prolific and passionate writers who advanced significant study of military strategy on land, sea and air that was often conducted in the popular press. Some examples include Liddell Hart, J.C. Fuller, Guilio Douhet,

Guilio Douhet

William Mitchell, Heinz Guderian, Charles deGaulle and Hector Bywater. Their works often provoked heated discussion, debate and controversy for the study of military affairs during the inter-war period. Their works stimulated progressive thinking but despite new concepts, technologies or capabilities, many felt that the fundamental nature and reality of war had not changed. There would always be the factors of friction, fog, ambiguity, chance, and uncertainty. It was assumed that these factors would continue to dominate the future.[10] This was the crux of the issue for many correspondents. Many argued a "favoured" service view that offered what they felt was the best solution that mitigated these future factors, and uncertainty, at a lower cost.

This debate posed great problems for the readers of the day, including Yamamoto, who were left to sift through the details to sort the wheat from the chaff. The resolution is essentially a matter of the reader's objectivity and openness. A military professional must be a competent observer, but not necessarily an expert one. Although Yamamoto was well-versed in matters of naval aviation, he still mistrusted his grasp of naval air – sea operations.[11] Yamamoto knew, however, that the aircraft carrier was an untried and immature asset.[12]

Yamamoto was a gambler at heart, but he was not reckless. His affirmation of naval air power must have been premised on considerable reflection and analysis that was surely based on professional reading. The key to understanding Yamamoto is the consideration that his reading was not simply a matter of a service-centric interest, but that it was also broadly based in

Billy Mitchell

Ostfriesland

other areas beyond his specific technical and professional interests. Yamamoto would not have been entrusted great power if he did not have the professional trust of his peers and government. Significantly, he not only challenged conventional wisdom but had the daring and audacity to propose significant change.

Why was Yamamoto so sure of himself? It may be that he based his concept on his synthesis of readings from many intellectual influences including Generals Guilio Douhet, Hugh Trenchard, and Billy Mitchell. This idea is not without merit. All were widely written about and quoted in the popular press. Yamamoto had the opportunity as a keen observer both as a student and as a professional officer to garner this knowledge. Guilio Douhet was one of the first to express a number of ideas in his work, *The Command of the Air*. Mitchell, a contemporary of Douhet, was as passionate in his advocacy for the championing of air power. Both Douhet and Mitchell debated in the court of popular opinion. Like Douhet, Mitchell's passion tended to grate on his peers and others within their defence community.[13] However, their view of the air force's role differed considerably. Douhet preferred a balanced development of capabilities in air power with offensive and defensive capabilities in a balanced approach to ensure mastery of the air that exploited air power in a quest for victory. On the other hand, Mitchell believed in the value of strategic bombing and supremacy of the air and sought opportunities to demonstrate that power.

Mitchell's first opportunity came on July 21, 1921 when he demonstrated the value of air power by the sinking of the ex-German battleship, Ostfriesland with six 2000 pound bombs. Mitchell had hoped that this demonstration would clearly illustrate the value of air power as he was seeking a mission for his fledging air force. He was attempting to carve out a niche in the costal defence mission; which was the navy's domain. He hoped that the efficacy of his demonstration (arguably the first demonstration of an initial application of a precision engagement) would stir the nation and its leaders to his cause.[14]

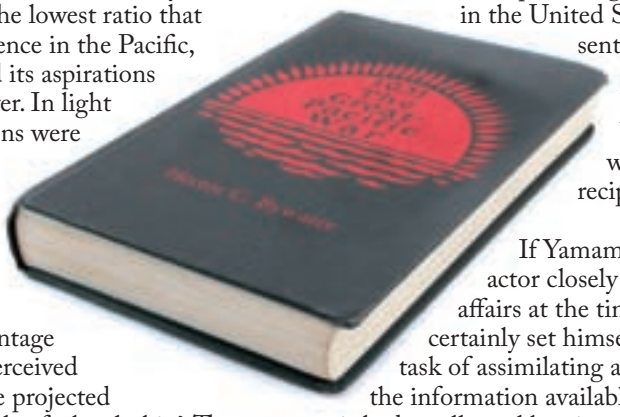
Why would a professional naval officer such as Yamamoto lend any credence or interest to this incident? The strategic debate was not just a purely academic exercise. It was being fought for public opinion. Air power caught the public's imagination as it offered the promise of an expedient and ready solution to the way for quick strategic victory in future wars. This must have played heavily to the sentiments of service personnel of all stripes, reformers and politicians of the day and to anyone whose primary duty was to comment on the service implications and national interest. Air power seemingly offered the promise of the "right solution," at an appropriate moment in time, with promises of resolving problems of manoeuvre, movement, and stalemate of trench warfare. More importantly, air power's solution seemed to be at a lower cost than other arms. A glowing economic argument was being made for defence at a lower price. The surgical precision of the air strike also appealed to the public who were enamoured by a scientific approach that promised minimized impacts and expeditious wars. More importantly, it was Yamamoto's duty as Naval Attaché to report, analyse and comment on the events of the day.

The public sentiment at the time was open to an advancement of revolutionary concepts. It was an era of a rapid change, new technology, and more importantly the public was looking for a panacea to stem prolonged warfare with a demand for reduced defence spending. Historically, however, there was little experience or precedent for the employment of air power as it was a new and open field. The airplane was being cast as the latest challenge to the supremacy of the great surface ships. Mitchell's demonstration was certainly setting the stage for controversy. Air power enthusiasts argued that the battleship was a thing of the past. But the "big ship" proponents countered by claiming that Mitchell's demonstrations were unrealistic because he staged his demonstrations on stationary targets that were undefended. This prompted a furious debate and the resulting furor accomplished two things; it helped promote the aircraft industry and may have initiated the development of the aircraft carrier.[15]

As mentioned previously, at this time Admiral I. Yamamoto, then a Captain, was the Japanese Naval Attaché in Washington. The controversy around this issue must have been noticed, at least as a matter of a national interest, by this ambitious naval attaché. Coincidentally it may have situated his thoughts to the need for

mitigating the naval arms reduction treaties of his day. Japan had agreed to a naval arm's limitation of 5:5:3 ratios with the United States and Great Britain in the Washington Naval Treaty (Five Power Naval Treaty) of 1922. Japan enjoyed the lowest ratio that limited its naval influence in the Pacific, which greatly reduced its aspirations for dominant sea power. In light of this treaty, conditions were ripe for Yamamoto's considerations for alternative solutions to Japan's naval deficiency. What would possibly give Japan a strategic advantage in a world that still perceived true naval power to be projected through the gun barrels of a battleship? The answer may have been the aircraft carrier, which promised potential for naval aviation in particular.

There are few sources suggesting this synthesis but William H. Honan *Visions of Infamy* offers some insight. He reported that Yamamoto read Hector C. Bywater's work, *The Great Pacific War*, while in Washington. Bywater was a naval correspondent and author who was considered by many to be the pre-eminent naval correspondent of his time. Some have argued that Bywater's *The Great Pacific War* became the template for Yamamoto's future battle in the Pacific.[16] Upon his return to Japan two years later, Yamamoto presented a lecture that virtually adopted Bywater's ideas/concepts from *The Great Pacific War* as his own; thus he must have taken Bywater's work very seriously. Honan cites that Japanese agents stationed in the United States discreetly sent reports about Bywater's latest book to Tokyo. Yamamoto was one of the recipients.[17]



If Yamamoto was a key actor closely following military affairs at the time, he must have certainly set himself down to the task of assimilating and synthesizing the information available especially if it had a collateral bearing on naval affairs. A considerable amount of research, reading and synthesis of information must have been required on subjects beyond his professional expertise and interests.

To Yamamoto, a scholar, actor and observer of these events, the solution may have been self-evident. Mitchell's demonstration in the public press may have been the key to Yamamoto's thinking. Bomber aircraft sank something that was considered by many as invulnerable. But air power was land-based and, based on the technology of the day, had a limited range. This limitation had to be resolved. It is possible that Yamamoto saw the aircraft carrier as the resolution of that limitation.

Nations experimented with marrying these two technologies. The results in the beginning were very desultory. The aircraft carrier was limited in power projection by the state of emerging aircraft technologies, the weight or arms that could be borne, limited doctrine, and the platform itself. Moreover there was the problem that current service doctrine that was based on the primacy of the battleship, which was considered to be the principle unit of naval power projection. But Yamamoto had a reason to see that these weapons systems, along with tactics and doctrine, evolved. It is also possible that the Naval Treaty of 1925 forced Japan to consider the aircraft carrier.

Yamamoto may have perceived an opportunity but there is no direct evidence to suggest that he considered the issue of air power in a naval

context. There is, however, anecdotal evidence that was found post World War II that suggests that Yamamoto's thinking was influenced by events that he observed while Naval Attaché. When his closest friends and members of his naval staff were interviewed many cited the Japanese translation of Bywater's work as a prominent document that was circulated amongst Japanese naval staff. All but one recognized Bywater's name and the work entitled the *Great Pacific War*.[18] Further Takagi, a confidante, said Yamamoto took a number of hints from American strategic thinking from his time in the United States. In Takagi's opinion, the work that had the most profound inspiration on Yamamoto was not Bywater's *The Great Pacific War* but rather William "Billy" Mitchell's book *Winged Defense* which was published in 1924 while Yamamoto was Naval Attaché in Washington.

It becomes clear then that Yamamoto was greatly influenced by the works of at least two strategic writers. Consequently, we may deduce that Yamamoto read very broadly both in areas of professional arms and ancillary interests. The ultimate proof surely lies in the initial success of his planning and consequent results of the Pearl Harbor attack. Significantly, he employed the aircraft carrier in the opening phase of battle whose, ultimate prize was the American carrier fleet. His plan thus was premised not only on command of the sea but also command of the air. This was a novel approach and could not have developed if he was not broadly read man who synthesized his plan in a systemic way.

Finis

Clearly there are definitive linkages to air power by career, education and events that suggest Yamamoto may have considered the problem in the context of both naval and air power. By inference Yamamoto may have been able to synthesize a variety of ideas into a unique amalgam that led to a new revolutionary stratagem for Japan using ideas from stock military concepts, history, reading and prevailing technology. These were blended to achieve air and naval strategic thinking which provided a novel solution for the Japanese Pacific naval strategy in 1941. He merged both air power and naval power in an attempt to develop a strategy that would achieve decisive victory at the outset with the intent of convincing the United States and others of the futility of further hostilities. Once the American fleet was annihilated, it would be pointless. He would not only have command of the sea but also command of the air. These events were crucial for the eventual conquest of land and march across the Pacific.

Yamamoto's plan was a calculated risk premised on the hope that the entire American fleet would be tied up in Pearl Harbor on one particular day. His tactics were the product of a synergy that merged the elements of three services in his planning. It was certainly novel for its time as the resultant power projection was certainly greater than the sum of the individual parts. Unfortunately for Yamamoto, a significant portion of the American fleet, the aircraft carriers, were at sea that day (December 7, 1941). This fleet posed a counter-threat to his whole operation and served to upset his strategy.

Yamamoto's initial victory at Pearl Harbor was neither total nor decisive. However, it could have just as easily gone the other way had the entire American fleet been tied up in Pearl Harbor on that fateful day. Such is luck or the fog of war.

Still, Yamamoto was a man of great vision. His fundamental understanding of the issues surrounding the very real problems of managing the three dimensions of modern warfare made him unique. Yamamoto's career suggests that knowledge was a key factor for the development of his strategic plan. This implies the power of the thinking man and the power of professional reading.

Yamamoto was quite likely a man before his time. He was pointing toward the future of jointness and combined arms. It is certainly an interesting speculation that a man with an open mind, not bound by rules of the conventions of his service, yielded results beyond measure. This certainly places Yamamoto in a class of his own and may be a lesson for military professionals who follow. ■

Gerry Madigan, CD1, MA is a retired logistician, Canadian Armed Forces. Major (Retired) Madigan's career spans 28 years as a finance officer. His notable postings include time served at National Defence Headquarters, Canadian Forces Base Europe, Maritime Canada and the First Gulf War as comptroller in Qatar. He has a Master of Arts in War Studies from the Royal Military College of Canada.

Notes

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2. Arthur Zich, *The Rising Sun,* (Time Life, 1977), 186.
3. "Biography of Isoroku Yamamoto," http://www.euronet.nl/users/wilfried/ww2/yamamoto.htm (accessed May 1, 2008).
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7. Spartacus Educational, "Biography Isoroku Yamamoto," http://www.spartacus.schoolnet.co.uk/2WWyamamoto.htm (accessed May 1, 2008).
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13. Major Randy Kee, USAF, "Brig Gen Billy Mitchell's Continuing Legacy to USAF Doctrine," *Air & Space Power Journal – Chronicles Online Journal,* (July 8, 1999), http://www.airpower.maxwell.af.mil/airchronicles/cc/kee1.html (accessed May 1, 2008)
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15. William H. Honan, *Visions of Infamy – The Untold Story of How Journalist Hector C. Bywater Devised The Plans That Led To Pearl Harbor* (New York: St. Martin's Press, 1991), 201.
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WHAT DOES A BALANCED TACTICAL HELICOPTER FORCE LOOK LIKE

AN INTERNATIONAL COMPARISON

By Thierry Gongora and Slawomir Wesolkowski

The Canadian Forces (CF) has operated a single fleet of CH146 *Griffon* helicopters as its dedicated tactical aviation assets to support land operations for over a decade. This situation will change with the Canadian Government's decision to procure 16 *Chinook* transport helicopters to augment the air mobility assets available to the CF[1].With the introduction of the *Chinooks*, it is inevitable that analysts both inside and outside the CF and the Department of National Defence will start asking questions about the structure of the tactical aviation force in Canada. Can the CF operate heavy transport helicopters without the protection typically provided by armed or attack helicopters? Does a tactical aviation force made up only of utility and transport aircraft make sense? Shouldn't Canada complement its fleet of transport and utility helicopters with other assets that could provide reconnaissance and fire support to transport helicopters, light infantry forces, or to special operations forces? In summary, what are the elements of a balanced force of helicopters dedicated to the support of land operations?

This article provides a partial answer to the last question by resorting to an international comparison between Canada and a number of nations and their armed services. This comparison is conducted for the present and complemented by a similar comparison that looks at the near to mid-future (up to 2015). The focus of the comparison is on helicopters dedicated to the support of land operations and in particular expeditionary operations. No attempt has been made to take into account the domestic requirements that could also affect the balance between the different elements of the helicopter force. Domestic requirements can be highly variable because legislative and institutional differences across nations affect the domestic mandates of armed forces, of police forces (including paramilitary gendarmeries), and of other organizations that rely on helicopters to provide emergency services (e.g., search and rescue, air ambulance services). To include domestic requirements in the international comparison would, therefore, require a careful consideration of all helicopter fleets available to public authorities and how they are distributed between the armed forces and other organizations. This task was beyond the scope of this article.

In the context of this article, the meaning of balance in a force structure can be understood as the combination of force elements that is likely to ensure the successful completion of a range of military tasks across a range of operational environments or scenarios. For a given force size, a force structure made up of a single aircraft type is likely to provide more capacity but over a narrower range of tasks or operational environments and scenarios than a more diverse force. The more diverse force, on the other hand, might be capable of handling a greater range of tasks or operational environments and scenarios but with less capacity to sustain them. Balance (i.e., the degree of diversity of a force structure) can be difficult to determine a priori; this is why our analysis relies on a sample of foreign cases to determine the point toward which various armed forces faced with similar challenges tend to congregate in terms of degree of diversity in their force structure. In doing so we are able to tap into decades of force development experience embedded in the force structure of these nations and services.

Our comparative analysis allows us to make the following observations. First, all the foreign helicopter forces studied have a mix of helicopter categories that included at least four different categories and sometimes up to seven categories for the larger fleets. Second, these balanced fleets are maintained by nations and services despite significant differences in fleet, service, defence budget or nation sizes. Third, the international standard, based on our sample, for what appears to be a balanced helicopter force includes a mix of transport helicopters and attack helicopters, supported in most cases by utility helicopters. Fourth, the CF tactical helicopter force is, and will remain (up to at least 2015) unbalanced in light of the foreign helicopter forces considered in this study. The CF currently has a force based solely on utility helicopters. The future will transform it with a heavy transport helicopter component and perhaps a fleet of utility helicopters with limited sensor and armament capabilities. However, even with the addition of heavy transport helicopters, the CF tactical helicopter force will continue to lack diversity and therefore balance. The main missing component will remain a dedicated reconnaissance and fire support capability provided by a purpose-designed attack helicopter.

An International Comparison

In order to conduct this international comparison, we had to make a number of decisions on the countries and armed services to be compared, and the types of aircraft to be included in the comparison. For the selection of nations and armed services, our selection was informed by the need to shed light on the Canadian case. Therefore, we selected cases sharing with Canada a common military doctrine (i.e., North Atlantic Treaty Organization [NATO]), a common tradition of force development, and similar commitments to alliances and out-of-country operations. To these criteria we added some variation on the size of the country, of its armed forces, and of its defence budgets in order to determine if these intervening variables affected the force structure. This is why our study does not include, among others, small NATO or allied powers like Belgium, Norway, or New Zealand; or any nation that until recently had followed a neutral defence policy such as Sweden or Finland. The selection of NATO countries did not include Eastern European nations that joined the Alliance after the Cold War because their force structure and equipment remain in transition between old Warsaw Pact and emerging NATO patterns. Finally, we have not included in our

study cases from the developing world because we determined that these cases did not share enough common features with Canada on the issues studied to deserve their inclusion in the sample. As a result of these decisions, in addition to Canada, the selected national cases were Australia, France, Greece, Italy, the Netherlands, Spain, the United Kingdom, and the United States of America (with two sub-cases: the US Army and the United States Marine Corps [USMC]).[2] Table 1 provides some comparative data on these nations and their armed services.

The selection of aircraft to be included in the comparison was informed by our focus on expeditionary land operations. Therefore, our comparison includes helicopters operated by land, air, or naval services that are designed to support land operations. The comparison excludes fixed-wing aircraft (with the exception of the MV-22 Osprey vertical take-off and landing [VTOL] aircraft) and helicopters designed for naval (i.e., over water) operations, as well as helicopters used for (non-combat) search and rescue, training, and the transport of dignitaries. The aircraft selected were further broken down into categories generally based on NATO definitions.[4] These categories are: attack helicopters, reconnaissance (also known as observation) helicopters, utility helicopters, and transport helicopters. This last category includes light, medium, and heavy transport helicopters. Finally, we created a residual "other" aircraft category that includes specialized helicopters dedicated to certain missions such as combat search and rescue, combat/medical evacuation, or wide-area battlefield surveillance, as well as the new MV-22 Osprey transport aircraft. Table 2 provides the definitions for each aircraft category.

Table 1: National Armed Forces and US Services Compared[3]

Case	Population (millions)	Defence Budget 2005 (US$ billion)	Size of armed forces or service (active and reserve)
Canada	32.5	10.9	98,900
Australia	20.1	13.2	73,672
France	60.7	41.6	276,545
Greece	10.7	4.5	488,850
Italy	58.1	17.2	248,375
Netherlands	16.4	9.7	107,530
Spain	40.3	8.8	466,255
United Kingdom	60.4	51.1	478,440
US Army	293.0 (US population)	423.0 (all services)	633,630
USMC	293.0 (US population)	423.0 (all services)	186,661

The tactical aviation fleets of the nations considered are in a state of change. The establishments and equipment that were in place during the Cold War are giving way to new equipment and force structures. As a result any snapshot in time may give an incomplete picture of the force in development. To correct this situation we are providing two points of comparison in time: one based on 2005/06 data and a second snapshot of the future situation that includes the currently planned additions and re-adjustments to the 2005/06 fleets. This future snapshot goes as far as 2015 in some cases and represents planned or undergoing procurements. As a result, the future snapshot refers to a highly plausible future and is not based on wishes or notional plans that have not yet matured into procurement decisions. The sources used to establish the 2005/06 and future forces were the *Military Balance 2005-2006* of the International Institute for Strategic Studies and the various publications of the Jane's Publication Group available through subscription services on the Internet.[5] Our data collection stopped in November 2006 and was updated in the case of Canada in November 2007. In order to meet the length of an article we present here only the results of this comparison without the detailed database that supports the graphics.


USAF Photo

MV-22 Osprey

Balanced Tactical Helicopter Forces

All foreign aviation forces studied include a mix of aircraft categories. This mix includes at least four different categories and as many as seven. These fleets are maintained by nations and services despite significant differences in fleet size, country size, and defence budgets. It would be an error to assume that a balanced and diversified aviation

Table 2: Aircraft Category Definitions

Aircraft Category		Definition
Attack helicopter	AH	A helicopter specifically designed to employ various weapons to attack and destroy enemy targets.
Reconnaissance helicopter	RECCE	Helicopter designed primarily for reconnaissance operations.
Light transport helicopter	LTH	Helicopter used primarily for carrying troops and/or equipment with a maximum all up mass of 6-7.99 tonnes.
Medium transport helicopter	MTH	Helicopter used primarily for carrying troops and/or equipment with a maximum all up mass of 8-10.99 tonnes.
Heavy transport helicopter	HTH	Helicopter used primarily for carrying troops and/or equipment with a maximum all up mass of 11 tonnes and over.
Utility helicopter	UTL	Helicopter with a maximum take-off weight of less than 6 tonnes that can be used for lifting troops, command and control, logistics, casualty evacuation, or armed helicopter roles.
Other aircraft	Other	Specialized helicopters kitted for and dedicated to a particular mission and VTOL fixed-wing transport aircraft. Four subcategories were found: a) combat search and rescue, b) combat/medical evacuation, c) wide-area battlefield surveillance, and d) VTOL transport aircraft.

force can only be sustained with very large fleets and budgets as those associated with the US Army or Marine Corps. What are the common elements of a balanced helicopter force? Figures 1 and 2 show the percentages of aircraft categories in the current and future fleets for all the countries and services considered in this study. In addition, Tables 3 and 4 show the numerical breakdown by categories for the same countries and services.

With the exception of Canada, our sample of nations and armed services all have attack helicopters and a mix of transport helicopters (nine cases out of nine), to which most (eight cases out of nine) add light utility helicopters. The fact that the mix of attack, transport, and utility helicopters holds across a relatively diverse set of nations and armed services leads us to characterize it as the core elements of a balanced helicopter force designed to support land operations. This appears to be the standard

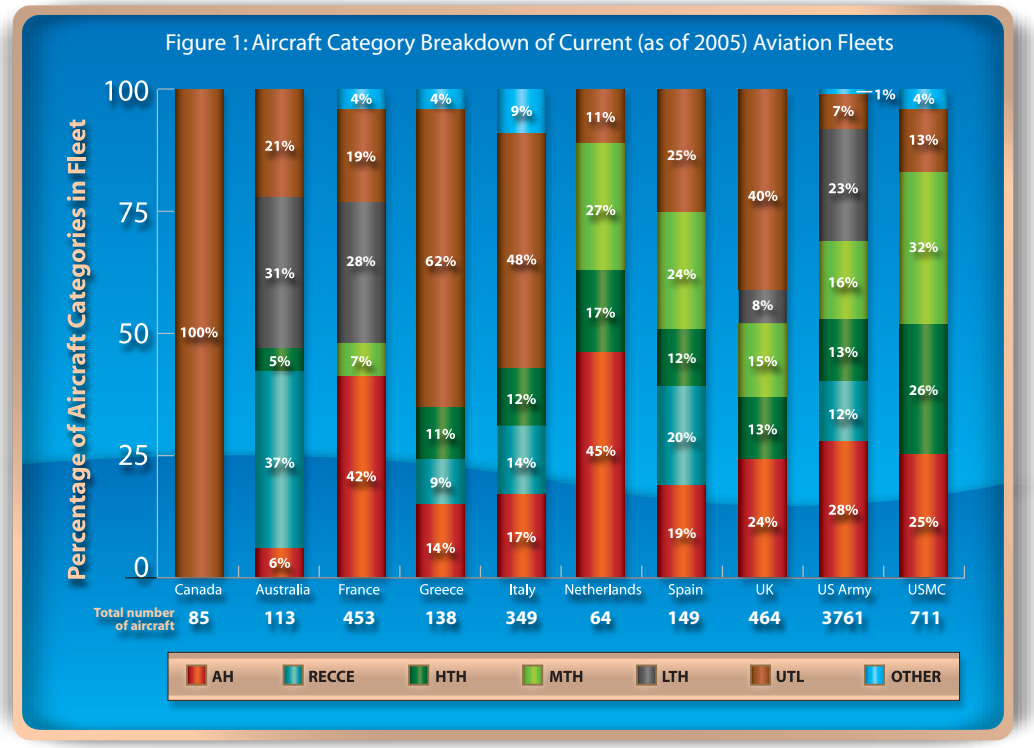
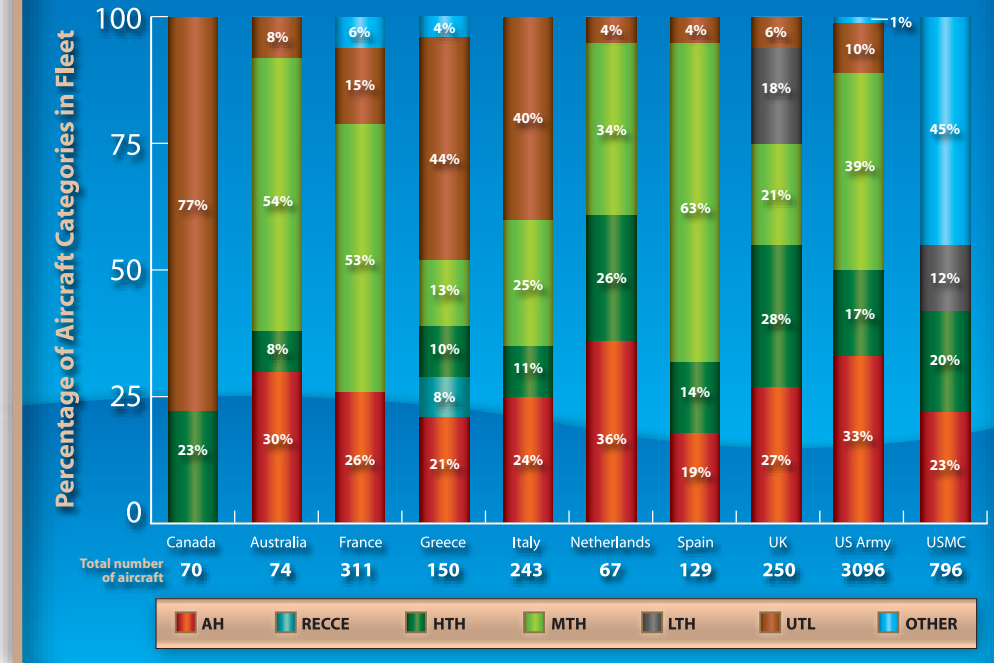


Figure 2: Aircraft Category Breakdown of Future (up to 2015) Aviation Fleets



among middle and great powers within the Western alliance.

Our cases also show that a balanced aviation force is not limited to the larger fleets or larger nations or armed services. Even a relatively small nation like the Netherlands maintains a balanced fleet of attack, (medium and heavy) transport, and utility helicopters out of current and future forces of 64 and 67 aircraft respectively (see Tables 3 and 4). Australia, a country often compared to Canada, maintains a similarly balanced fleet with a current total of 113 aircraft and will maintain it in the future with only 74 aircraft. Greece and Spain will maintain similarly balanced forces in the future with 150 and 129 aircraft respectively. Where a significant difference in the composition of aviation forces appears is in the category of specialized aviation assets such as helicopters dedicated to combat search and

Table 3: Current (as of 2005) Tactical Aviation Fleets

	Total	AH	RECCE	HTH	MTH	LTH	UTL	OTHER
Canada	85						85	
Australia	113	7	41	6		35	24	
France	453	188			31	129	86	19
Greece	138	20	12	15			85	6
Italy	349	60	50	40			166	33
Netherlands	64	29		11	17		7	
Spain	149	28	30	18	36		37	
United Kingdom	464	112		62	71	35	184	
US Army	3761	1055	458	492	615	875	250	16
USMC	711	180		184	223		94	30

Table 4: Future (up to 2015) Tactical Aviation Fleets

	Total	AH	RECCE	HTH	MTH	LTH	UTL	OTHER
Canada	70			16			*54	
Australia	74	22		6	40		6	
France	311	80			164		48	19
Greece	150	32	12	15	20		65	6
Italy	243	60		26	60		97	
Netherlands	67	24		17	23		3	
Spain	129	24		18	81		6	
United Kingdom	250	67		70	52	44	17	
US Army	3096	1021		514	1217		322	22
USMC	796	180		156		100		360

Note: * The total for the future CF utility helicopter fleet remains the object of analysis. The number reported here reflects a scenario looked at in the fall of 2007 and, as indicated in the scope of this study, it does not include additional aircraft dedicated to domestic tasks such as search and rescue.

rescue, medical evacuation, or battlefield area surveillance, as well as in the emerging area of vertical take-off and landing transport aircraft. Not all nations or services studied maintain such assets. In fact, this is where fleet and service sizes seem to matter. Generally, these assets are limited to major powers or very large armed services. Smaller powers or armed services often resort to non-specialized aviation assets to carry out specialized missions, such as combat search and rescue and medical evacuation, on a temporary basis.

Implications for the CF Tactical Helicopter Force

In light of the cases analysed in this study, the current and future CF helicopter forces dedicated to land operations remain unbalanced. The current force of 85 CH146 utility helicopters appears to be a singular solution to land aviation requirements. None of the countries or services here reviewed supports land operations with a single aircraft category or aircraft model. Furthermore, other services or nations with an equivalent or slightly larger utility helicopter fleet are services or nations that maintain a significantly larger tactical helicopter force (e.g., US Marine Corps, Italy, and the United Kingdom). Clearly, the current CF tactical helicopter fleet does not meet the standard of a balanced fleet as established in this study.

The future (up to 2015) CF tactical helicopter fleet being envisaged starts to address the force imbalance by adding heavy transport helicopters (16 *Chinook* helicopters) and a fleet of CH146 utility helicopters equipped with a limited sensor and fire support capability.[6] Even with this addition, however, the CF tactical helicopter force will continue to fail to meet the standard for a balanced force established in the present study. Most outstanding will be the absence of a dedicated attack helicopter that could provide reconnaissance, fire support, and escort to transport helicopters and to ground troops. The possibility of equipping the CH146 helicopters with sensor and armament appears to be the way forward favoured by the Air Force based on open sources.[7] This is an approach that has value in terms of increasing the self-defence capacity of these helicopters, as well as for specialized missions such as combat search and rescue or support to special operations forces—assuming that these aircraft meet the other requirements for these missions in terms of range, payload, navigation, and survivability. None of the nations or services here reviewed, however, attempts to build the attack and reconnaissance components of their balanced force through modifications to utility or transport helicopters. In fact, all those that have utility or transport helicopters with sensors and armaments, also have dedicated attack helicopters, a possible indication that the former cannot be a substitute for a dedicated capability.

Conclusions

This article presented the results of an international comparison to determine the elements of a balanced tactical helicopter force. The international comparison was based on a set of ten cases that included Canada as well as Australia, France, Greece, Italy, the Netherlands, Spain, the United Kingdom, the US Army, and the USMC. The comparison looked at both current fleets (as of 2005) and future fleets (up to 2015) and was focused exclusively on support to expeditionary operations. No attempt was made to take into account unique national domestic requirements that could affect how each nation defines its balanced fleet requirements.


CF Photo by MCpl. Brian Walsh


CF Photo

All the foreign helicopter forces studied had a balanced mix of helicopter categories that

included at least four different categories. Balanced fleets are maintained by nations and services despite significant differences in fleet, service, defence budget or nation sizes. The international standard for a balanced helicopter force includes a mix of transport helicopter categories and attack helicopters, supported most of the time by utility helicopters. The CF tactical helicopter force is, and will, remain unbalanced in light of the foreign helicopter forces considered in this study. The CF currently has a force based solely on utility helicopters. The future will transform it with a heavy transport helicopter component and a fleet of utility helicopters with perhaps limited sensor and fire support capabilities. However, even with this addition, the CF tactical helicopter force will continue to lack balance and diversity. The main missing component will remain a dedicated reconnaissance and fire support capability provided by a purpose-designed attack helicopter. Based on the results of this limited study we think the CF, and the Air Force in particular, should consider the option of purpose-designed attack or armed reconnaissance helicopters as part of their efforts to develop a more balanced tactical helicopter force for the future. ■

Notes

1. Assistant Deputy Minister (Public Affairs), "Backgrounder: "Canada First" Defence Procurement—Medium-to Heavy-Lift Helicopters," Department of National Defence, http://www.forces.gc.ca/site/newsroom/view_news_e.asp?id=1968 (accessed July 17, 2006).

2. The case of the United States was broken into two sub-cases given the very significant military resources this nation possesses and the fact that the US Army and Marine Corps each have tactical helicopter fleets that dwarf the fleets of other nations and are often perceived as setting the world standards.

3. International Institute for Strategic Studies, *The Military Balance 2005-2006* (London: The International Institute for Strategic Studies / Taylor & Francis, 2006).

4. The definitions for attack, reconnaissance, transport, and utility helicopters were taken or adapted from the definitions for these aircraft categories found in the following NATO publications: North Atlantic Treaty Organization, *Use of Helicopters in Land Operations: Tactics, Techniques and Procedures* (NATO publication ATP-49(D) Volume II); and NATO Standardization Agency, *NATO Glossary of Terms and Definitions* (NATO publication AAP-6, 2007), http://www.nato.int/docu/stanag/aap006/aap6.htm (accessed August 22, 2007).

5. International Institute for Strategic Studies, *The Military Balance 2005-2006* (London: The International Institute for Strategic Studies/Taylor & Francis, 2006). The references from the Jane's Publication Group are too numerous to be listed here but include articles and entries in the following publications: *Jane's Aircraft Upgrades*, *Jane's All the World's Aircraft*, *Jane's Defence Weekly*, *Jane's Fighting Ships*, *Jane's International Defence Review*, *Jane's Navy International*, *Jane's Sentinel Security Assessment*, *Jane's World Air Forces*, and *Jane's World Armies* accessed through the Internet as of November 2006.

6. On the possibility of adding a sensor and limited armament capability to the CH146 see for instance, David Pugliese, "Canada Considers Armed Escort Choppers," *Defense News* 22, no. 32 (13 August 2006): 16; and Sharon Hobson, "Canada wants armed escort helos to protect *Chinooks*," *Jane's Defence Weekly*, 43, no. 35 (30 August 2006): 7.

7. Pugliese, 16; and Hobson, 7.

Thierry Gongora and Slawomir Wesolkowski are defence scientists working for Defence Research and Development Canada (DRDC). They researched the material for this article while working with the Canadian Forces Aerospace Warfare Centre and published a more extensive version of their research in a DRDC publication. **The authors would like to thank Dr Denis Bergeron (DRDC Centre for Operational Research and Analysis) for his comments on a draft of this article.** **The reported results, their interpretations, and any opinions expressed in this article remain those of the authors and do not represent, or otherwise reflect, any official position of DRDC, the Department of National defence or the Canadian Forces. Dr Gongora is the point of contact for both authors and he can be reached via email at Thierry.Gongora@drdc-rddc.gc.ca or by phone at 613-947-7810.**

List of Abbreviations

AH	attack helicopter	NATO	North Atlantic Treaty Organization
CF	Canadian Forces	RECCE	reconnaissance helicopter
HTH	heavy transport helicopter	USMC	United States Marine Corps
LTH	light transport helicopter	UTL	utility helicopter
MTH	medium transport helicopter	VTOL	vertical take-off and landing

STAFF SYSTEMS AND THE CANADIAN AIR FORCE:

Wellington at Waterloo by Robert Alexander Hillingford.

By **Major Paul Johnston,** Canadian Forces Aerospace Warfare Centre

Pity the poor staff officers; like Rodney Dangerfield, they just don't get any respect. Furthermore, air forces have always been more fascinated by the daring-do of flying operations than the mundane details of command and staff work on the ground.[1] Nevertheless, one of air power's signal characteristics has always been the critical importance of command and control, in particular that it be centralized. These two facts lead to an irony. On the one hand, the traditional Air Force devotion to flexibility and aversion to formalized doctrine has tended to undermine standardization of command and staff arrangements. On the other hand, centralized control (albeit with decentralized execution) requires highly developed command and control organizations that should favour a standardization of command and staff arrangements in air forces.

Whatever the merits of such standardization, currently the Air Force is not standardized. No two wings seem to be organized the same way. The Air Division Headquarters and Air Staff in Ottawa are not organized the same way, and keep reorganizing. Recently, it has become a principle that emphasis should be placed on moving from a "staff centric" culture to a "command centric" one.[2] In a similar vein, it was a motivating concern behind the recent Canadian Forces transformation that command, or at least command-like responsibilities, were being exercised by staff officers.[3] Apparently there are problems with the way headquarters have tended to work in the Canadian Forces.

Often times, these sorts of complaints have tended to focus on either the bloated size or the bureaucracy of our headquarters[4]. What this paper will argue is that while those issues are certainly often symptoms of our problems, there are deeper issues. This paper will argue that, ironically, the Canadian Forces in general, and the Air Force in particular, have chronic problems with over-bureaucratic "staff centric" headquarters in part because we have not paid enough attention to staff work as a form of the military art. Rather, a propensity to "muddle through" staff work has been a characteristic of the Canadian military for most of our history. Staff work, or perhaps more specifically a *system* for operational staff work, is an important, indeed central aspect of military professionalism. Paradoxically, as we shall see, the lack of emphasis on a staff system in this sense that has led to "staff centric" headquarters because, without a deeper grounding in the fundamentals of staff systems, staffs have tended to react reflexively to each new pressure of the day, leading to the uncontrolled growth of bureaucracy. Furthermore, the more muddled the staff work becomes, the harder it is to deal with, necessitating even more staff. This can all too easily become a vicious circle.

This is a series of two articles. The first examines the history of command and staff systems generally. With that as background the second will trace the evolution of command and control organization and staff systems in the Canadian Air environment specifically, and then consider the subject and draw some conclusions.

Staff Systems' History

In the history of military staff systems, two broad approaches to the matter are discernable: the Prusso-British approach which divides staffing responsibilities into two or three simple parts and gives primacy to operational considerations, and the French-American "bureau" approach, in which the staff is sub-divided into many functional directorates. The origins of the operational primacy approach are complex, but it was pioneered by the Prussians, adopted by the British, and also picked up by the Russians. The history of the bureau approach is clearer – it was begun by those consummate bureaucrats the French and then developed further by the engineering and process minded Americans. Such is the influence nowadays of the US, however, that their "continental staff system" has almost completely displaced all other approaches to the matter amongst Western militaries. The Canadian Forces, for instance, has now adopted it almost across the board. What is interesting, however, is that the older British philosophy – which is "bred in our bones" – tends to show through in our actual practice.

The Traditional British System: A Diarchy

The British staff system and principles represented a somewhat idiosyncratic but quite highly articulated approach to the matter. Going back to the days of the New Model Army under Cromwell, the British Army based its staff organization upon a division into three parts: a generalist staff to handle operational issues, an "adjutant's" staff to handle personnel and related administrative issues, and a "quarter-master's" staff to handle what today we would call logistics.[5] This three fold division was sometimes succinctly summarized as "mission, men, material."

In practice however, in almost all cases below that of the highest command level, the adjutant and quarter-master's staffs were combined under one officer, which meant that commanders had two principal staff officers working for them – one to oversee all operational issues and one to oversee all support issues.[6] This is the "staff diarchy" referred to above – a philosophy that within their headquarters staffs, commanders would have two principal staff officers as their immediate subordinates: one dedicated to

operational issues concerning the prosecution of the mission, and one dedicated to ensuring adequate support in all its forms. Furthermore, this relationship between the commander and his two principal staff officers was direct; traditionally there were no deputy commanders or chiefs of staff in British practice to mediate between commanders and their staffs.[7] This staff diarchy as an organizing principle for military staffs was already discernible in Wellington's headquarters, which is shown in Figure 1, during the peninsular wars.[8]

Staff systems in Britain remained not much changed up to the late nineteenth century, when the successes of the Prusso-German system in Bismarck's wars seemed so impressive, especially compared to the British performance in the Crimea. Various reforms in Britain were initiated. Indeed the Army staff college at Camberley dates from this era, but it was not really until the further shock of the Boer war that the British finally got serious, and in imitation of the Germans formed a general staff and regularized their staff procedure. In 1912 a *Staff Manual* was published, laying out the basics of British Army staff doctrine, which remained unchanged in its essentials right up to the 1980s.

By the time of the Great War, the British had evolved a staff system that combined some features of the Prusso-German system with their own traditional approaches. In fact, the two were a good fit, as both adhered to the "staff diarchy" philosophy. The 1912 *Staff Manual* defined three staff branches which were signified by letter code:[10]

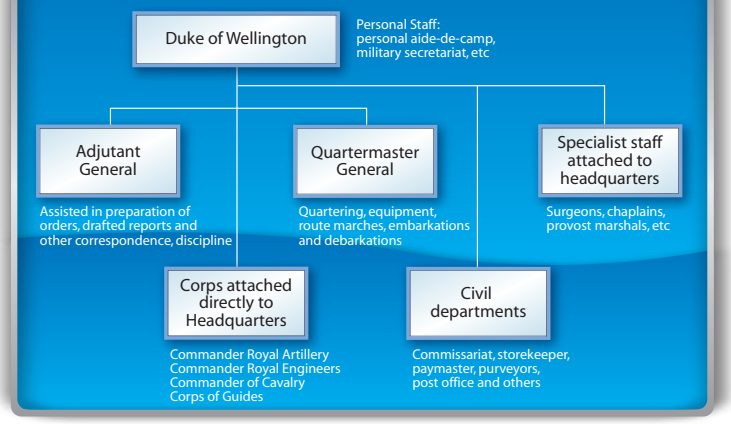
G – for the General staff who handled operational issues, and were in principle at least meant to be staff college graduates;
A – for the Adjutant General Branch, which handled personnel issues; and
Q – for the Quartermaster General Branch, which dealt with what we would now call logistics.

This reflects the three-fold division into "mission, men, material" but in practice the A and Q staffs were combined into a single "AQ" Branch. As mentioned, another feature that distinguished British staff practice was the lack of either a chiefs of staff or deputy commanders, neither of which appear in the 1912 *Staff Manual* or, any actual headquarters organizations until the Second World War.[11]

The use of a chief of staff in British Commonwealth practice was introduced by Field Marshal Montgomery, who was convinced of its value, and when he took over the command of Eighth Army in North Africa he announced:

I want to tell you that I always work on the Chief-of-Staff system. I have nominated Brigadier de Guigand as Chief-of-Staff Eighth Army. I will issue orders through him. Whatever he says will be taken as coming from me and will be acted on at once.[12]

Figure 1: General Structure of Wellington's Headquarters[9]




MONTGOMERY

Figure 2: British Corps Headquarters, late WWII[15]

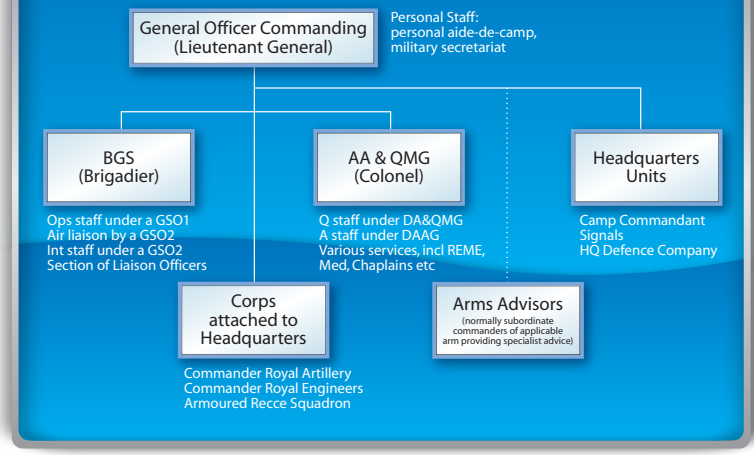


Figure 3: British Divisional Headquarters, late WWII[16]

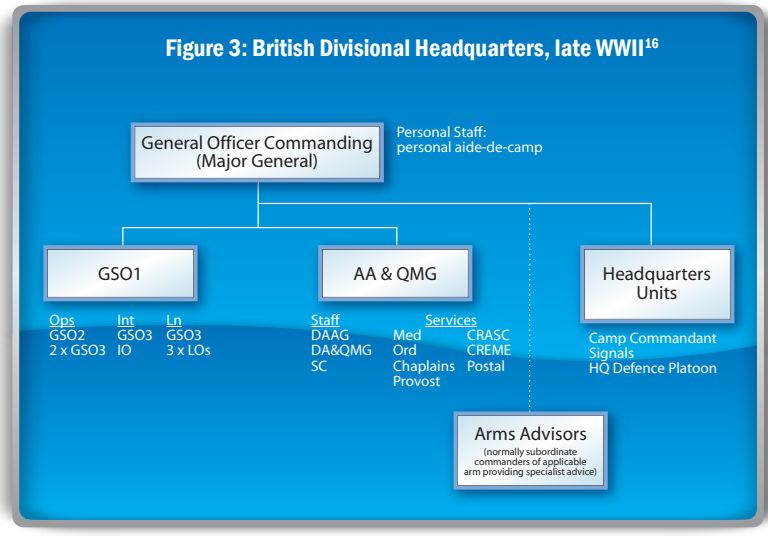
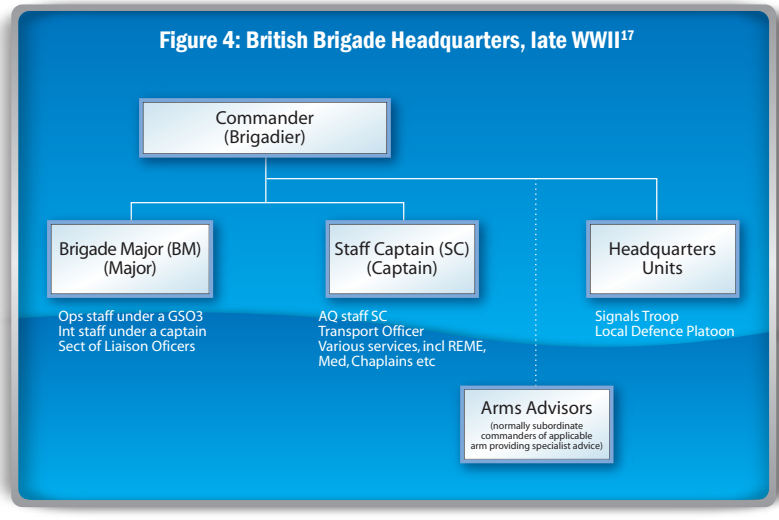


Figure 4: British Brigade Headquarters, late WWII[17]



Technically, De Guigand was the "Brigadier, General Staff" or "BGS", i.e. the head of the G branch of the headquarters.[13] Although the practice of utilizing a chief of staff spread, British doctrine maintained, until the 1980s, that chiefs of staff were only provided for headquarters at corps level or higher.[14]

As shown in Figures 2, 3 and 4, this diarchic staff system can be seen in the organization of British and Commonwealth, which followed British staff tables, headquarters organizations during World War II.

The Royal Navy

Traditionally, in the Royal Navy (RN) admirals went to sea on a flag ship; thus, given the limited space available on board ship staffs were, of necessity, small. Above the level of admirals at sea, there was simply the Admiralty in London. In such circumstances, until the very end of the nineteenth century, naval staffs were small, and systemization of Royal Navy staffs came even later than in the British Army.[18] As late as 1911, the Sea Lords (i.e. the naval officers appointed to the Admiralty) were actively opposing the creation of a naval war staff. That year a young Winston S. Churchill was appointed First Lord of the Admiralty with a specific mandate from the Prime Minister to force such an innovation through. The Sea Lords, viewing such a thing as the inappropriate imposition of an Army institution upon the Royal Navy, continued to resist and it was only after asking for and receiving the resignations of the entire Board that Churchill got his plan through.[19]

List of Abbreviations for figures 2, 3, and 4

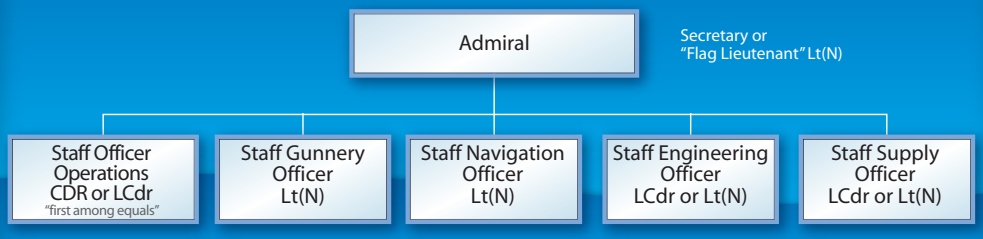
AA & QMG	Assistant Adjutant and Quarter Master General	Int	Intelligence
BGS	Brigadier General Staff	IO	Intelligence Officer
CRASC	Commander, Royal Army Service Corps	Ln	Liaison
CREME	Commander, Royal Electrical Mechanical Engineers	LO	Liaison Officer
DA & QMG	Deputy Adjutant & Quarter Master General	Med	Medical
DAAG	Deputy Assistant Adjutant General	Ops	Operations
GSO 1	General Staff Officer 1st Grade	Ord	Ordnance
GSO 2	General Staff Officer 2nd Grade	REME	Royal Electrical Mechanical Engineers
GSO 3	General Staff Officer 3rd Grade	SC	Staff Captain
HQ	headquarters		

It was not until almost the end of the First World War that further progress was made. During that conflict, RN headquarters of various sorts had inevitably grown, but this growth had been rather ad hoc as the RN still lacked a staff doctrine comparable to that enunciated by the Army in the 1912 *Staff Manual*. By 1918 it was felt necessary to bring some order to things, and on 11 September 1918 an order was released stating that distinction was to be made "between officers appointed to the staff for operations and those attached to the staff for technical and administrative duties."[20] Thus, the diarchic staff principle was brought into Royal Naval use. In 1924 the system was further elaborated in the *King's Regulations and Admiralty Instructions* and in 1938 when the *Naval War Manual* and the *Naval Staff Handbook* were released the RN's staff system was more-or-less in its final traditional form.[21]

This form established that higher naval staffs would have a primary staff officer for operations, usually titled the "chief of staff (operations)" and a primary staff officer for support, usually titled the "chief staff officer." A unique naval innovation was a third group known as the "secretariat" which provided administrative staff support to both the operational and support staff arms, and served as a clearing house for all correspondence in and out of the headquarters.[22]

However, the RN's approach was far less systematized than the army's. They did not follow a standard approach at all levels. Essentially, staffs were simply the admiral and whatever "staff officers" he chose to appoint. Generally, staff titles consisted of the word "Staff" (at squadron level), "Fleet" (at fleet level), or "Command" (at higher level), followed by a word or phrase to denote that officer's specific duties.[23] Thus for example, there were no standardized positions in a fleet headquarters such as the 1912 *Staff Manual* would specify for an army brigade, but there

Figure 5: A Typical Staff at Squadron Level[26]



Note: Other staff and administrative support could be drawn as secondary duties from the personnel of the ship upon which the admiral had his flag.

would be positions such as "Fleet Gunnery Officer," as the admiral saw fit.[24] Another significant factor at lower level headquarters which went to sea, was that the size of staffs at this level was sharply circumscribed by the availability of bunk-space on board ship.[25]

The RAF Follows the Army

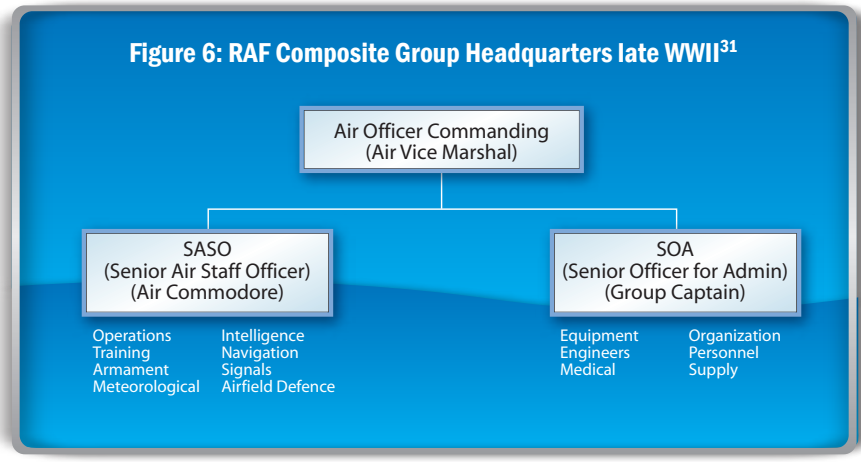
Unsurprisingly, the 1912 British Army staff system formed the RAF's starting point towards command and staff issues. Most of the RAF's founding officers were drawn from the Army, not least the first Chief of the Air Staff, Sir Hugh Trenchard. Furthermore, as we have just seen, at the time of the RAF's founding at the end of the First World War, the RN's staff system was still somewhat nascent. In consequence, the primary influence upon the development of staffs in the RAF was the British Army system of 1912. Indeed, that the RAF's staff system was closely modeled on the Army's was expressly noted in official publications of the inter-war years.[27]

As in the British Army, at higher levels the RAF divided staffs into three branches, which in RAF practice were termed: air, administration and technical.[28] These were essentially analogous to the British Army's G, A and Q branches respectively. And just as the British Army tended to combine the A and Q branches under one officer to create in practice a diarchic staff system, so did the RAF at formation level tend to combine the administrative and technical functions under one officer who dealt with "administration" in the broadest sense of that word, i.e. all services and support.[29] The primary air staff officer was known as the Senior Air Staff Officer or "SASO," a position roughly analogous to the senior G staff officer in an army headquarters.[30]

The primary administrative officer was known as the Senior Officer for Administration or "SOA" (or Air Officer for Administration, "AOA," if the incumbent was of Air, i.e. general officer rank), which roughly corresponded to the senior "AQ" officer in an army hadquarters.

At the tactical levels, traditional RAF/RCAF practice was somewhat different. Wings and stations were treated as a single entity with a full three-pronged split rather than a diarchy, the three prongs being air operations, administration and technical.[32] This reflected the traditional British categories of "mission, men, material."

Figure 6: RAF Composite Group Headquarters late WWII[31]

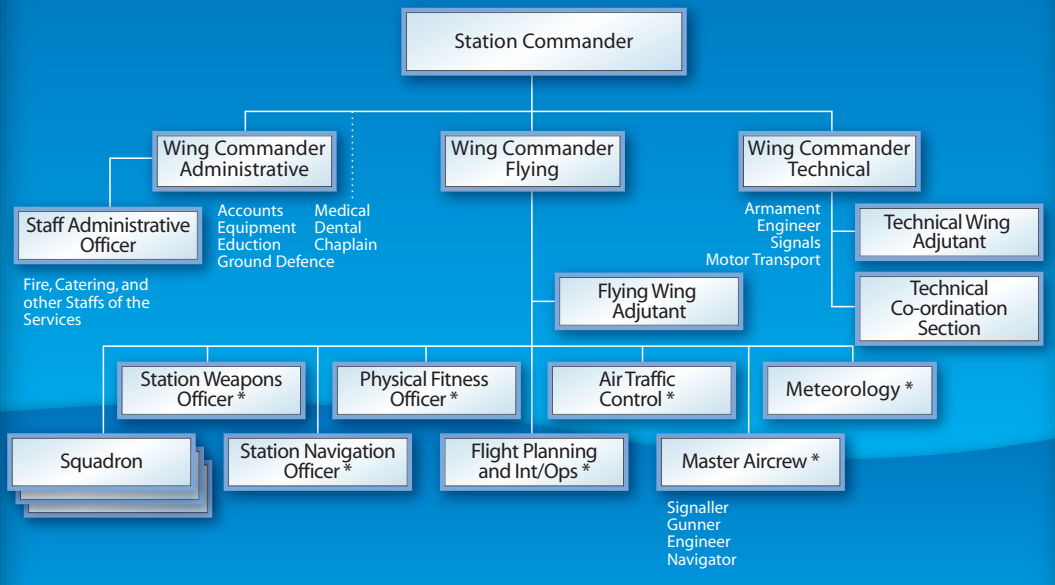


Air force commanders at the tactical level thus had three principal immediate subordinates in their staffs, rather than two. Interestingly, the line units of the station or wing (including the flying squadrons themselves) all reported to the commander through one of those three positions. Those positions thus combined both line and staff responsibilities and the wing or station was something of an indivisible whole. Another point to note is that unlike practice in the Army and at higher formation level in the RAF/RCAF where the operational staff officer out-ranked the support staff officer(s), in this wing organization all three staff principals were the same rank.

The Germans: *im Generalstab*

Much has been written about the famous (or infamous) German Greater General Staff

Figure 7: Traditional RAF Station or Wing level Organization[33]



Note:
1. The wing commander administrative is responsible for the discipline and administration of the station as a whole.
2. The signals officer is responsible to the wing commander technical for the technical aspect of signals, but must work closely with the wing commander flying on operational signals matters, and with the wing commander administrative on administrative signals matters.
3. In Fighter Command the duties of technical wing adjutant and officer i/c technical co-ordination section are combined.
4. Sections marked * may be combined into one flying support squadron.

(*Grosser Generalstab*), in particular its possibly pernicious political effects in the fostering of militarism and thence two world wars.[34] What concerns us here are not those wider political effects, but rather the application of the German staff system at the purely military level, and its strong influence upon the British staff system.[35]

One of the Germans' most unique and remarked upon staffing characteristics was their formation of a specific corps of general staff officers. In most militaries, staff positions are filled by postings from the general pool of qualified officers, although often there is a prerequisite for a staff course of some sort.[36] The Germans, on the other hand, selected their brightest young officers in competitive examinations from the rank of captain, and sent them to the *Kriegsakademie* (war college). Thereafter, their careers proceeded in a special stream, filling general staff billets in formation headquarters or with the main body of the general staff at the high command in Berlin. They were also regularly given command appointments, and promoted faster than regular officers; they constituted a specifically appointed elite within the German Army, and to signify this they wore "wine-red" stripes down the sides of their uniform pants and the letters "i.G." (*im Generalstab*, i.e. "in the general staff") after their rank.[37] There was some debate in Britain in the early 1900s regarding the advisability of adopting a similar system, but in the end it was decided not to, although those who were staff qualified (i.e. had passed the staff college course at Camberley) and were serving in a staff billet at a headquarters, were designated by wearing a red band on their forage cap and scarlet gorgets on their uniform.[38]

German staffs were formally divided into five sections as shown below, but for work they were arranged into three "groups": the operations group, the adjutant's group and the supply group.[39] This grouping thus reflected the full three categories of "mission, men, material" recognized in British practice. Unlike the British, however, the Germans preserved three

prongs right down to their lowest formation levels—they did not combine the adjutant and supply groups under a single officer as the British did.[40]

Formal German Staff "Sections" consisted of:[41]

I: General Staff – all members of this section were general staff corps officers. They were lettered as follows:
- **Ia – senior operations officer**
- **Ib – senior supply and administrative officer**
- **Ic – intelligence officer**
- **Id – training officer**

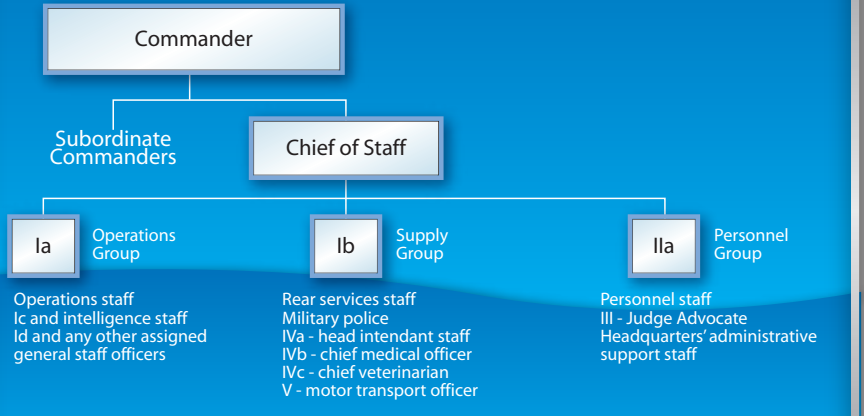
II: Adjutant – the officers of this section handled the administrative affairs of the headquarters and personnel issues.

III: Legal – legal

IV: Intendant – the officers of this section constituted the specialists responsible for services such as medical, supply, and veterinary.

V: Transport – the officers of this section constituted the specialists responsible for all transport and equipment

Figure 8: German Corps Headquarters, World War II, Reflecting the organization of the staff into three groups.[42]



NB: the chief of staff and positions numbered with a roman numeral "I" are filled by general staff branch officers, the others by specialists appointed as appropriate.

The French "Bureaux" Approach

The French, in contrast to the Prusso-British di-or-triarchical approach, followed a rather different philosophy. Napoleon himself had a quite large and complex headquarters, but one of the features of the Napoleonic era was the development of a standardized staff system at not just the high command, but for all French field headquarters. This grew in large part from the work of Pierre Alexandre Berthier, who was Napoleon's chief of staff from his days with the Army of Italy. In 1796 Berthier published his *Document sur le Service de L'État-Major General a l'Armée des Alpes*, in which he outlined the organization and principles under which the staff there would work.[43] This proved to be an influential document, especially since Berthier subsequently became chief of staff at Napoleon's Imperial Headquarters.

Berthier divided the staff into four sections. The first handled a miscellany of details, including records, inspections, troop movements, courts martial and prisoners of war. The second handled technical issues such as armaments, engineers, and hospitals. The third dealt largely with operational issues such as reconnaissance and operational plans, and also the lines of communication. The fourth section handled the headquarters itself, including its local security. Each of these sections was under an "adjutant general," and the whole was coordinated for the commander by a chief of staff. Whilst the precise distribution of duties between the various staff branches was different from that of later staff systems (and to modern eyes appears somewhat idiosyncratic), this system already reflected the philosophy of the modern "continental staff system," in that it represented a staff divided into a multitude of separate branches, all of which were coordinated for the commander by a chief of staff.

By the time of the First World War, the French system had evolved to one in which staffs

were divided into three "bureaux," as they were called. The first dealt with all administrative issues, including both personnel and supply. The second handled intelligence, and the third dealt with operations and plans. (Note that this represented a different three categorization than the traditional British "mission, men, material." The French divided the "mission" part between operations and intelligence and combined the "men and material" into a single category.) Under the stress of the First World War, with its heavy material demands, it was decided to split the administrative responsibilities. Personnel issues were retained in the first bureau, and all logistic responsibilities were moved to a new, fourth bureau. As before, all remained under a chief of staff who coordinated the whole staff on behalf of the commander. The French system developed during the First World War is the essence of the modern form of the continental staff system.[44]

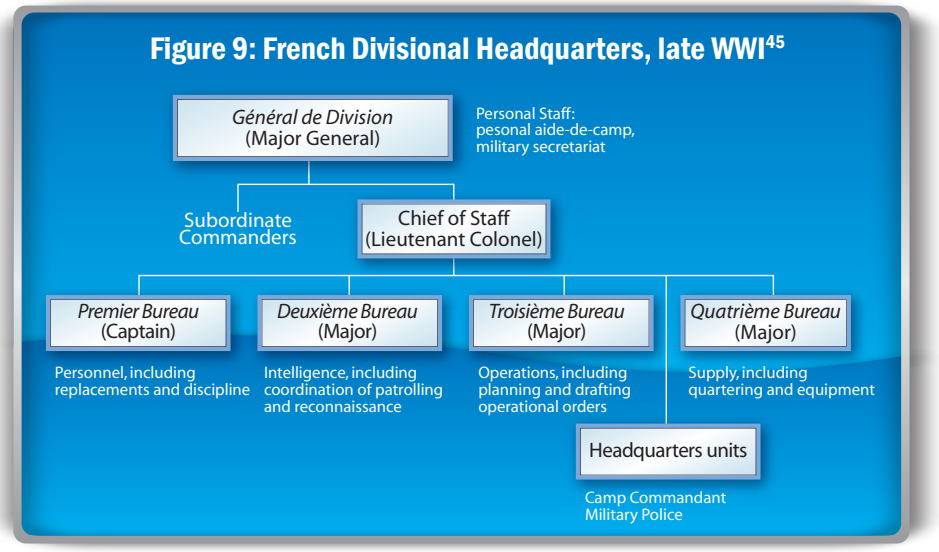


Figure 9: French Divisional Headquarters, late WWI[45]

The US Model Themselves on the French

The Americans developed their staff system from the French. In 1917, when the US entered the Great War and decided to raise a mass army and send it to France, they had no recent experience with warfare on such a scale. Quite prudently the decision was therefore made to send a team of officers to France to examine the staff systems employed by the Allies, and make recommendations as to how the American Expeditionary Force should organize itself for the war into which they were getting themselves. After some consideration, the Americans decided to model their staff system primarily on the French, and since this system was intended for their operations on the continent of Europe, it became known as the "continental staff system."[46] In 1921 the Harbord Board, convened by U.S. Army Chief of Staff General Pershing under Major General James Harbord, formalized this wartime practice as the official staff system for the entire US Army, and by the Second World War it had already evolved into more-or-less its modern form.[47] The Americans in World War II even employed the practice of varying the first letter of the staff designator to differentiate ground from air staffs – "G" for land force headquarters and "A" for air force headquarters.

Conclusion: Two Philosophies of Staff System

There have thus been two broad philosophies of staff system in Western military practice – the Prusso-British operational supremacy approach and the Franco-American continental system. The difference between these two is more than just a question of the way their organizational charts are drawn – there is a real difference in philosophy between them. Reduced to its fundamentals, the essence of the traditional British system is that all staff issues will be fit within one of only two fundamental realms: either the operations or the support arena, and that the entire staff will be expected to work together amongst themselves, with coordination achieved not by a chief of staff but by the principle of the primacy of operations. On the other hand, the fundamental philosophy behind the continental system is that staff issues will be subdivided into a larger number of specialties, each of which is meant to be at least nominally co-equal, and that coordination between those many sub-areas will be achieved

not by the principal of operations primacy, but by a bureaucratic machinery overseen by a chief of staff.

In the continental system, the question of what functions, exactly, are awarded branch status thus becomes significant. Originally, there were only the classic four: personnel, intelligence, operations and logistics. Of particular note, the intelligence function was given its own standing, whereas in the British (and German and Russian) system intelligence was subsumed within operations. J.D. Hittle, the author of the classic study of staff systems,[48] considered this sub-dividing of functions a positive virtue—he argued that it constituted a system of checks and balances that would allow each branch to evaluate its area of expertise independently and prepare its advice objectively, without undue distorting influence, in particular in the form of the operational directorate's views crowding out intelligence and logistic concerns.[49]

An additional point is that the traditional British system placed the commander far more at the centre of the process—the British system (as originally developed) did not provide either deputy commanders or chiefs of staff. In army higher headquarters (before Montgomery's introduction of the chief of staff concept) the commander himself was the only point at which the "G" and "AQ" staffs came together, and likewise in RAF headquarters the commander was the only point at which the SASO and SOA came together. At wing or station level, there was a three-fold split between mission, men and material that only came together in the person of the commander himself. The continental system, on the other hand, was a more complexly articulated organization with its own chief of staff, and thus more prone to run as an autonomous bureaucracy. Inherently, any system that is subdivided into many parts will be more bureaucratic. A military that professes to be trying to move from a "staff centric" to a "command centric" philosophy might want to consider that carefully. ■

Notes

1. See for instance Carl Builder, *The Icarus Syndrome* (New Brunswick, NJ: Transaction Publishers, 1994) and James Mowbray, "Air Force Doctrine Problems: 1926-Present" *Airpower Journal* (Winter, 1995) or, from closer to home, Colonel P.J. Taggart "A Working Paper on Proposals for the Development and Dissemination of Air Force Doctrine" *Air Doctrine Symposium, Summary Proceedings* (Canadian Forces College, 1994).

2. See Canadian Forces Transformation Website on the DWAN at http://cds.mil.ca/cft-tfc/pubs/documents_e.asp (accessed 15 Jan 08), and more specifically the report "CDS Action Team 1 Report," 2005. Available on DWAN at http://cds.mil.ca/cft-tfc/pubs/cat_e.asp (accessed 15 Jan 08), in particular paragraph 18 "Separation of Line and Staff" page 7 and paragraph 3 of annex A "Separation of Staff and Command Functions" page A-1/5.

3. Ibid.

4. See for instance Douglas Bland's *Chiefs Of Defence: Government And The Unified Command Of The Canadian Armed Forces* (Toronto: Canadian Institute of Strategic Studies, 1995); *Institutionalizing Ambiguity: The Management Review Group and the Reshaping of the Defence Policy Process in Canada* (Kingston: Centre for International Relations, Queen's University, 1986); and *National Defence Headquarters: Centre for Decision* (Ottawa: Dept. of Public Works and Government Services, 1997).

5. The history of staff organization related here is drawn largely from virtually the only published source on the subject: J.D. Hittle, *The Military Staff: Its History and Development* (Harrisburg, PA: The Stackpole Company, 3rd Edition, 1961), 157-158. Hittle was a retired USMC colonel who had served as an instructor at the Marines wartime staff college. He recounts in his foreword how he was astounded to discover, upon his arrival at the staff college, that there was no good history of staff systems to draw upon for instructional purposes. He created one, and in his retirement published it as a book.

6. Hittle, 147 and 158.

7. Ibid., 147. See also, for example, Figures 1-4 in this paper.

8. See Hittle, 142-144.

9. Ibid., 142.

10. British War Office, *Staff Manual* (London: Harrison & Sons, 1912) copy in the RMC library; John R. Grodzinski, *Operational Handbook for the First Canadian Army: Formation Organization, Staff Technique and Administration* (Published by the Regimental Historian, Revised edition 1998) (hereafter cited as "*1 Cdn Army Hbk*"), 16; also Hittle, 159-160.

11. Speaking here of operational field headquarters (army group and below).

12. Nigel Hamilton, *Monty – The Making of a General 1887 – 1942*, (London), 622-625. DeGuingand remained with Montgomery in the role of chief of staff when the latter assumed command of 21st Army Group.

13. It should be noted that as a young brigadier he was quite junior to the corps commanders immediately subordinate to Eighth Army headquarters.

List of Abbreviations

RCAF	Royal Canadian Air Force	RN	Royal Navy
RMC	Royal Military College of Canada	RAF	Royal Air Force
DMAS	Directorate of Management Advisory Services	USMC	United States Marine Corps
ISAF	International Security Assistance Force		

14. Directorate of Management Advisory Services (DMAS), "Canadian Forces Staff System" (DMAS Study No. 1951-100-70/4, October 1971, copy on file in the RMC Library, hereafter cited as: DMAS "Canadian Forces Staff System), Vol. 4, 17.

15. *1 Cdn Army Hbk*, 34-35.

16. Ibid., 26-27.

17. Ibid., 21-23.

18. For a description of the evolution of the Admiralty and the origins of RN staffs, see Leslie Gardiner, *The British Admiralty* (London: Blackwood, 1968).

19. Commander Maria Higgins, "Winston S. Churchill's Legacy to the Royal Navy, 1911-1915" *Naval War College Review*, XXVII (November-December 1974), 69-70.

20. Quoted in A.R.W. "Staff Training and the Royal Navy: World War I and the Aftermath: Part 1" *The Naval Review* (January 1976, pp 9-17), 12.

21. United Kingdom, Admiralty, BR 31/1938. For a more complete summary of British naval staff development, see M.V. Bezeau, "The Role and Organization of Canadian Military Staffs 1904-1945" unpublished M.A. thesis (Kingston: Royal Military College, 1978) 92.

22. Bezeau, 92-93. See also DMAS "Canadian Forces Staff System" Vol 4, 18-21.

23. DMAS "Canadian Forces Staff System," Vol 4, 21.

24. Ibid., 20-21.

25. Ibid., 20.

26. DMAS "Canadian Forces Staff System," Vol 4, 20.

27. See for instance, United Kingdom, War Office, *Field Service Pocket Book, 1932* (London: 1932), 56.

28. DMAS "Canadian Forces Staff System," Vol 4, 21-22.

29. Charles Carrington, *Soldier at Bomber Command* (London: Leo Cooper, 1987), 14.

30. Such as, for example, the BGS in a corps headquarters (see Figure 2 above).

31. *1 Cdn Army Hbk*, 115.

32. Wings and stations were generally commanded by group captains (i.e. colonels), who had three wing commanders (i.e. lieutenant colonels) as immediate subordinates: a "Wing Commander Flying" who handled all operations, a "Wing Commander Administrative" who handled all personnel and misc administration, and a "Wing Commander Technical" who handled all technical issues, including both air maintenance and technical ground based service support such as motor vehicles.

33. DMAS, "Canadian Forces Staff System," Vol 4, 51.

34. See for instance, John Wheeler-Bennett, *The Nemesis of Power: The German Army in Politics, 1918-1945* (New York: St Martins Press, 1954); Gordon A. Craig, *The Politics of the Prussian Army, 1640-1945* (Oxford: Clarendon, 1955); and Walter Goerlitz, *History of the German General Staff, 1657-1945* (New York: Praeger, 1959).

35. One of the first means by which this influence spread was Spenser Wilkinson's The Brain of an Army…

36. This remains the current Canadian Forces approach. In traditional British practice, completion of the Army staff course at Camberley entitled one to include the letters "p.s.c." for "passed staff college" after one's name, or "p.s.a." for "passed air staff college" in the RAF. Reflecting RN hostility towards a formalized staff system, there was no naval equivalent.

37. Hittle, 76-78; and DMAS "Canadian Forces Staff System," Vol. 4, 8-11. The modern German military retain this system today; see for instance Christian Millotat, *Understanding the Prussian-German General Staff System* (Carlisle Barracks, PA: US Army War College, 1992). The author served at ISAF headquarters with a German major from their general staff corps.

38. These scarlet gorgets were the infamous "bloody red tabs" of the Great War. See John Gooch "The Creation of the British General Staff, 1904-1914" *Royal United Services Institute Journal*, CXVI (June 1971, 50-53). Note that the letters "p.s.c." or "p.s.a." described in note 36 above were awarded as post-nominals (like an academic degree), but did not constitute part of their owner's rank as the letters "i.G." did in German practice.

39. Hittle, 77; and DMAS "Canadian Forces Staff System," Vol. 4, 10. Towards the very end of the Second World War a sixth section was added—"party"—which constituted a sort of Nazi party political commissar, but this was scarcely an inherent feature of the classic German staff system.

40. The lowest command level in the Wehrmacht with a fully articulated staff was the divisional headquarters. DMAS "Canadian Forces Staff System," Vol 4, 10, which provides full organizational charts for army to divisional level Second World War German staffs, based upon a study of the German system conducted by the US, British and Canadian Armies immediately after the war and published in April 1946. On the other hand, since only two of the three groups were headed by general staff officers (the operations and supply groups), so those two groups attained a greater significance within the German staff system, thus creating something of a diarchic system in practice.

41. DMAS "Canadian Forces Staff System," Vol. 4, 10.

42. Ibid., Figure 15, 50

43. Hittle, 95.

44. Ibid., 126.

45. Ibid., 124.

46. Ibid., 210-213.

47. Hittle, 215; and DMAS "Canadian Forces Staff System," Vol 4, 2.

48. See note 5 above.

49. Hittle, 78 and 299-300. Hittle believed that the Germans, with their operations dominated system, had been particularly prone to this sin.

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Smart Structure Applications In Aircraft

By **Capt François Dufault,** Directorate of Aerospace Requirement & **George Akhras,** Professor of Civil/Mechanical Engineering Director-Centre for Smart Materials and Structures Royal Military College of Canada

Introduction

The Canadian Air Force relies on relevant and dependable equipments operated by qualified and motivated airwomen and airmen in order to accomplish its mission both domestically and internationally. In order for this equipment to be completely efficient in today's complex operations, the Canadian Forces (CF) needs to bring into service some of the best and latest technologies available. One approach to optimize our aircraft is to deal with the maintenance process, which plays a major role in the availability and the use of these assets

Aircraft Maintenance

Traditionally, the method to schedule aircraft maintenance actions is based on records such as take-offs and landings, flight times, and torque events. These records are compared to a generic baseline with conservative margins. This conservative attitude is adopted by the authorities to guarantee safety, as well as reliability, availability, and to avoid disasters. Since not every aircraft is used in the same flight conditions, this method leads to inefficient timing of inspections and parts replacement, with operational negative impacts such as aircraft unavailability.

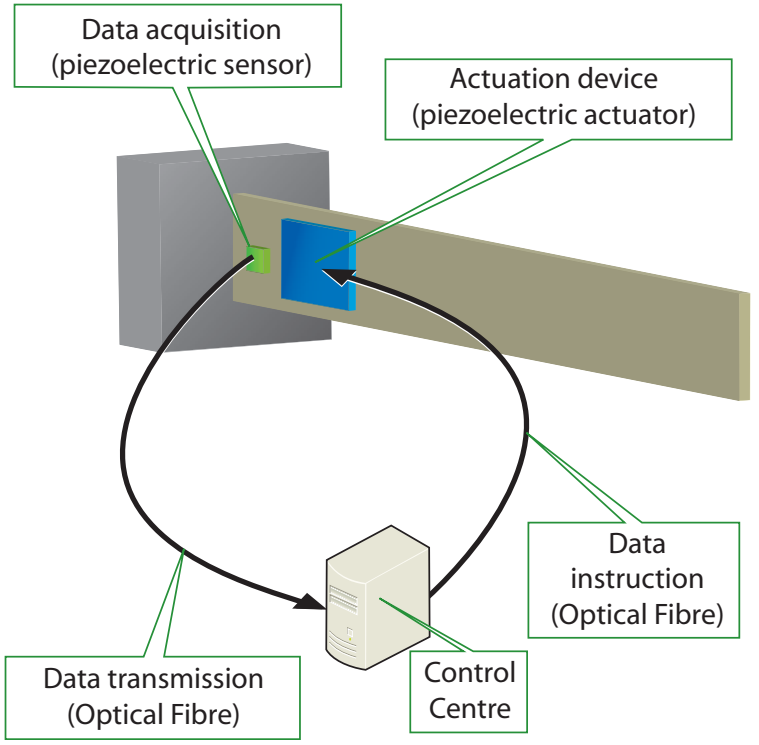
One way to close this gap is to use smart technologies to monitor closely the operational regime of the aircraft, improve its functioning, reduce its maintenance, and finally, enhance its life cycle. With advanced technology in sensors and signal processing, operators can now monitor parts and determine the exact time at which inspections and parts replacement is needed, based on the actual condition of these parts. This is currently possible with the Health Usage and Monitoring System (HUMS) and is called "condition-based maintenance".

The concept of continuous monitoring has been in use in the aerospace community for some time now. For example, in the United Kingdom it is mandatory that all civil registered helicopters carrying more than nine passengers be fitted with a HUMS. They also suggest that the benefits for the system have already surpassed its cost, and that it has eliminated potential fleet unavailability and prevented the potential loss of two Chinook[1] helicopters. Although HUMS is currently used mostly on helicopters, it is also used on some fixed-wing aircraft and unmanned aerial vehicles (UAVs). Typical HUMS are composed of sensors and processing algorithms that enable the monitoring of engine condition and performance, continuous performance, continuous vibrations, engine exceedance, and rotor track and balance[2].

In the CF, the Griffon helicopter is one of the aircraft fitted with a HUMS, which is used for diagnostics and monitoring of critical components. Some of the benefits to the CF are categorized as maintenance credits, and include: extension of main gearbox overhauls, rotor track and balance maintenance flights, drive train monitoring, and flight time logging.[3] However, it is not used for true condition-based maintenance. Maintenance actions timings are still largely based on records of flight hours, take-offs and landings, and so on. Even though the technology is now available to conduct condition-based maintenance, its acceptance by the operational communities—civilian and military—as to its benefits and airworthiness, is still faced with resistance in changing the traditional methods of maintenance.

The next step beyond condition-based maintenance is to exploit the information provided by the sensors that activate actuators dispersed on the aircraft's components, which alleviate loads and vibrations. The net result of this approach is an increase in performance and fatigue life of these components and of the aircraft. This is the essence of a paper on smart structures published in the Canadian Military Journal in 2000.[4]

Figure 1: Vibration suppression of a cantilever beam with the smart structure approach.



DEFINITIONS

In 1996, Spillman, Sirkis, and Gardiner established a definition of a smart structure from a wide variety of sources. It reads as follows: "a smart structure is a non-biological structure having the following attributes: 1) a definitive purpose, 2) means and imperative to achieve that purpose, and 3) a biological pattern of functioning."[5] This biological pattern of functioning has been broken down into five basic components by Akhras[6] (items in paren-

theses represent the equivalent within the human body):

1. Data acquisition (tactile sensing): collects the required raw data needed for an appropriate sensing and monitoring of the structure;
2. Data transmission (sensation nerves): forwards the raw data to the local and/or central command and control units;
3. Control centre (brain): manages and controls the whole system by analysing the data, reaching the appropriate conclusion, and determining actions required;
4. Data instructions (motion nerves): transmit the decisions and the associated instructions back to the members of the structures; and
5. Action devices (muscles): take action by triggering the controlling device/units.

Figure 1 shows a simple example of a smart structure in the form of a cantilever aluminum beam in which vibrations are suppressed systematically. The piezoelectric sensor converts the mechanical deformation into an electric signal. This signal is processed by the control centre, which in this simple case basically inverts the signal and amplifies it. The new signal is then sent to the actuation device, another piezoelectric material that converts electrical energy into mechanical form to reduce the vibration.

BENEFITS

Smart structures applications will provide benefits to the aviation industry and operators. Continuous monitoring, including monitoring of the health status, damages, and possibly mitigation and repair is not the only envisioned benefit. Other benefits include the following:[7]

1. increase passenger and crew comfort by reducing vibrations and noise;
2. increase systems and components structural life;
3. improve precision pointing and sensing of onboard electro-optics and infra-red sensors; and
4. enhance aircraft performance by optimizing aerodynamics and lifting surfaces to mission and flight profile.

All of these benefits will result in either a reduction in manufacturing and operating costs, or an increase in performance of the overall aircraft. It is noteworthy that other vehicles, including trains, trucks, and naval vessels could also benefit from these technologies.

AREAS OF APPLICATIONS

In aviation, the application of smart structure technologies can be divided into four distinct areas[8]: monitoring of composite materials, suppression of structural vibration, noise suppression, and control of surface morphing.

Monitoring of Composite Materials

Composite materials are now widely used in the aerospace industry. They offer great advantages compared to metal alloys, such as reduction in weight, increase in strength, and greater resistance to corrosion. However, composite materials react differently to loads and vibrations. Cracking of metallic components is gradual and predictable, whereas composite

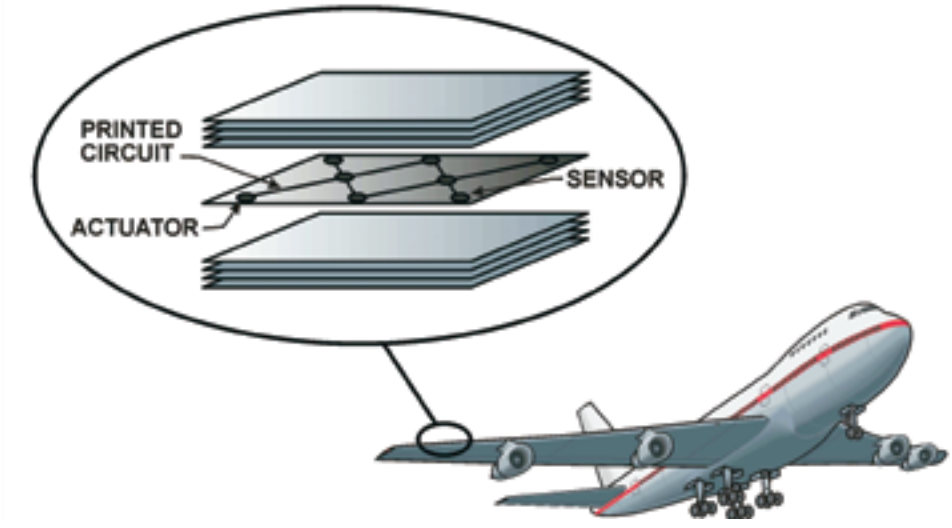


Figure 2: Embedding of smart materials in composite structure using printed circuit technology.

materials suffer from discrete traumas due to accidental damage of an unpredictable, random nature.[9] This suggests that monitoring of composite structures should be done differently than monitoring of alloys.

One method of monitoring a composite structure is to take advantage of its layered composition and of the recent advances in printed board techniques. This makes it possible to embed low-cost sensors[10] into a composite structure, with minimal impact on its overall integrity. Chang and Lin[11] proposed an example of this monitoring technique in the form of the SMART Layers®[12] shown in Figure 2. This method uses a combination of actuators and sensors to detect any modification in the composite material. By exciting the composite, the actuator will generate waves and the sensor will detect any changes to the original structure. When a new crack appears, or an existing crack grows, it modifies the pattern of propagation of the waves and reports this change. In 2006, this method was demonstrated in a few experiments and showed that embedded piezoelectric sensors could detect cracks as small as 0.1mm.[13]

Suppression of Structural Vibration

A second area of application is the use of actuators on components to alleviate the loads and vibrations imposed on these components. Helicopters are probably the type of aircraft that is subjected most to vibrations. This is due to the requirement for helicopters to perform both hover and forward flight. The result is "high vibration and noise, limited payload and speed, high maintenance, and limited component life."[14]

The direct active approach suppresses vibrations at their source, which in a helicopter is the main rotor. The Smart Material Actuated Rotor Technology (SMART) is a project led by Boeing with design goals to achieve 80 per cent reduction in vibrations, 10 decibel (dB) reduction in blade vortex interaction while landing, 10 per cent gain in rotor performance, and automatic in-flight blade tracking. This project is divided into two parts. The first part, the flap actuator, uses a piezoelectric-driven trailing edge flap for high bandwidth vibration, noise, and aerodynamic performance improvements. The second part, the tab actuator, uses a trailing edge trim tab driven by shape memory alloy (SMA) for quasi-static in-flight blade tracking.[15] The key design factors for this project include actuator weight, size, and power requirement,[16] with all of them having a minimum impact on the dimensions and weight of the existing rotor blades.

Results on simulation and bench testing on the flap actuator led to design changes, resulting in significantly improved performance. The use of high-voltage stacks of piezoelectric materials, recently made available, is projected to enable the flap actuator to meet all performance requirements. Tests on the tab actuator, under static and dynamic loading, meet all requirements, with the exception of bandwidth. Forecast is that bandwidth requirements could be met with improved control algorithms or cooling of the SMA elements.[17] The project underwent whirl tower testing in 2004, shown in Figure 3 and 4, with promising results.

Other organizations were also successful in suppressing structural vibration. A successful demonstration flight of a piezoelectric-actuator-driven main rotor trailing edge flaps was done in 2005 by Eurocopter on a BK117

Figure 3: Whirl tower testing of smart rotor.[18]

helicopter.[19] Current implementation dates forecast for these types of systems are as early as 2012.[20]

Another approach is the incorporation of special devices for the adaptive vibration control. These devices use piezoelectric materials to vary the stiffness, the damping, and/or the mass of a dynamic system. A good example is the smart spring of the National Research Council of Canada (NRC), which was tested in a helicopter for the vibration control of the main rotor. However, it has many other potential applications in both helicopters and fixed-wing aircraft, including adaptive engine or gearbox mounts, isolation of cargo floor from fuselage in cargo aircraft,[21] and adaptive seat vibration suppression.[22] Results from wind tunnel tests showed that the adaptive controller of a main helicopter's rotor was able to obtain an overall reduction of 11.9dB[23] under varying wind speed.

Figure 4: Whirl tower testing of smart rotor.

Noise Suppression

The third application deals with the comfort and well being of the users. By interacting properly with the structure, the noise produced from engines, propellers, and helicopter rotors in the cabin can be suppressed. The Active Structural Acoustic Control (ASAC) approach uses speakers embedded within the structure to counter noise with noise.

Microphones distributed throughout the cabin will monitor the noise, and actuators attached to the fuselage at strategic locations will modulate the structural response and reduce the low frequency noise.[24] The Ultraquiet Cabin, developed by Ultraquiet Technologies is already used on several aircraft.[25]

An alternative approach is to suppress the noise by interacting directly with the structure. This was developed and tested by NRC and the setup at their laboratory is shown in figure 5. The sensors in this smart structure, consisting of accelerometers, are attached at various locations along the fuselage, while the actuators are stacked piezoelectric ceramics bonded to the fuselage. The largest reduction of almost 28dB was obtained on the aisle seat in the third row. Results show that the noise reduction was essentially global, with greater reductions occurring in the noisiest areas of the cabin. This approach has the added benefit of diminishing the vibrations on other components of the structure, thereby reducing wear and increasing fatigue life of these components.[26]

Another approach is to deal with noise at one of its main sources – the turbine engines. The Boeing 747-8 may be the first commercial aircraft to fly with an integrated smart component. Figure 6 shows a variable-area engine where the shape memory alloy attached to the chevrons is used to modify the shape of the exhaust, controlling the noise from the engine in the take-off phase. At low altitude and low airspeed, the increase in temperature in the SMA forces the chevrons inward. This operation mixes the fan and core exhaust streams together, and bypasses the flow of the engine with the effect of reducing shear and noise. However, it will decrease engine performance.

Figure 5: NRC Active noise suppression on Dash 8.[27]

On the other hand, at high speed and high altitude, the low temperatures in the SMA will straighten the chevrons and bring them back to their original shape, and consequently improve engine performance.[28] This noise reduction requirement from aircraft comes from more stringent noise abatement procedures found in most airports in large cities around the world.[29]

Figure 6: Noise control on Boeing 777-300ER.[30]

Control of Surface Morphing

The last area of application is the control of surface morphing. The objective is to exploit the technologies of smartness to control, optimize, or rearrange the shape of the surface wing to improve the efficiency of the aircraft. A few projects are looking at the concept of using SMAs to change the shape of the wing for flapping in manners similar to birds or bats. This area is not likely to see any applications in commercial aircraft soon; however, research projects are under way, particularly focusing on applications with high potential such as UAVs.

The DARPA Smart Wing Project is one of these efforts. The goal is to evaluate a SMA-based hingeless trailing edge control surface concept through several series of wind tunnel testing, including some at Mach speeds. Results indicate that deflections over 20 degrees at rates over 80 degrees/second can be achieved. Results also demonstrated improvements in system performance. For example, the rolling coefficient improved approximately by 17 per cent at 15 degrees of control surface deflection. This project also identified the key issues to be addressed before smart wings are implemented into operation aircraft. These issues include long-term fatigue life of the structure, development of feedback-control laws, assessment of aero servo elastic behaviour, development of compact power supplies, and system optimization.[31] Further developments followed in 2006, with the flight tests of the MFX-1, a 100-pound UAV that enables in-flight changes from the wing. Area change of 40 per cent, span change of 30 per cent, and wing sweep varying from 15 to 35 degrees were demonstrated in flight at speeds around 100 knots. In September 2007, flight tests of the MFX-2, a 300-pound, twin-powered UAV, demonstrated area changes of 40 per cent, span change of 73 per cent, and aspect ratio change of 177 per cent.[32] These demonstrations show that the technology to implement such capabilities in operational aircraft, especially UAVs, might not be as distant in time as envisaged a few years ago.

Other types of control of surface morphing are being researched. The control of missile trajectory is studied by a team of scientists from Defence Research and Development Canada – Valcartier. They have conducted simulations as well as wind tunnel testing for this application.[33] Another project worth mentioning is an adaptive spoiler to control the transonic shock using SMA. By changing the aerofoil shape of a wing, the SMA alleviates the impact of shock waves when the aircraft is flying at transonic or supersonic speeds.[34]

IMPLEMENTATION OF SMART TECHNOLOGIES IN AVIATION

Even though a diversity of research projects has successfully demonstrated the viability of using smart technologies in aviation, they are still not implemented in practical applications. This technology is still in its infancy. Many technical issues still need to be addressed, finalized, and fine-tuned to satisfy the stringent and very rigorous standards of the aviation field. On the other hand, while some existing standards could be applied to smart structures, they do not address properly all the particularities of this emerging technology,[35] such as the characteristics of smart materials and their reliability, as well as all the technological aspects of fabrication of smart composites. Any inclusion of these new technologies should satisfy first the airworthiness, followed by specific aircraft certification. Many more theoretical, technological, and numerical, as well as experimental tests are needed before this technology could satisfy all the requirements of safety.

Moreover, three main non-technical issues are delaying this implementation. The first one is the nature of these smart structures, which encompasses many science and engineering fields, and leads implicitly to the second problem of integrating of all these novelties requiring cooperation and time. The grouping of experts to share their knowledge and particular expertise and operate jointly could be a challenge. Established in 1997, the Canadian Smart Materials and Structures Group (CANSMART)[36] mandate is to offer the opportunity for researchers and scientists from academia, government, and industry to exchange views on the common aspects of smart materials and structures, as well as try to alleviate this complexity in general. The third issue is related to the cost of incorporating these smart structure technologies into aircraft production, which currently makes the system more expensive,[37] and therefore less attractive to prospective operators.

Finally, overall acceptance of this new technology by everyday operators will take some time. Some parallels with the implementation of other technologies have been drawn. For example, the introduction of composite mate-

rials into the aerospace industry, which is now widely embraced, took about 50 years.

CONCLUSION

With the expansion of demonstration projects on the capabilities of smart structures in aerospace in general and in aviation in particular, industry and government will realize their benefits and a growing demand for their use will follow. In the meantime, more research, development, and engineering on smart materials and their inclusion in smart aircraft structures need to be pursued. Similarly, particular effort is also required to develop appropriate standards and regulations to deal with their specific characteristics.

There is no doubt that smart structure is a seriously emerging technology in the aviation industry. In a few years we are likely to have aircraft that will tell us their health status, what loads and constraints they are subjected to, and what measures are implemented to alleviate them. In military applications, this would also include damage assessment, as well as corrective action, with capacity for mission delivery. ■

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LIST OF FIGURES

List of Abbreviations

CANSMART	Canadian Smart Materials and Structures Group	NRC	National Research Council of Canada
CF	Canadian Forces	SMA	shape memory alloy
dB	decibel	SMART	Smart Material Actuated Rotor Technology
HUMS	Health Usage and Monitoring System	UAV	unmanned aerial vehicle

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LIPSTICK & HIGH HEELS:
WAR, GENDER AND POPULAR CULTURE

BY EMILY SPENCER

KINGSTON
CANADIAN DEFENCE ACADEMY, 2007
263 PAGES ISBN 978-0-662-46284-2

Review by **Anne Pennington**

Emily Spencer's *Lipstick and High Heels* carries a provocative title, but the content is more apt to make feminists cringe. I have to admit that I winced more than once or twice while reading Spencer's book, though not because of the quality of the author's work. The graphics on the cover of the book are evocative of both Harlequin Romance covers and Bonnie Parker. The front cover illustration depicts a uniformed woman being embraced by a uniformed man. Her high heel shod leg, if not quite raised in the air in suggestion of surrender, is at least ready for the reflex. The back cover includes a photograph entitled "The Bren Gun Girl." The "girl" is a full grown woman, cigarette in hand, smoke billowing from her lips, sitting beside the gun in a casual, but familiar manner. Her posture and facial expression mimic Bonnie's legendary demeanour. Upon further reading, I realized that the juxtaposition of the cover graphics is not the only mixed metaphor or contradiction offered in Spencer's work.

The author has a Ph.D. and Master of Arts in War Studies from the Royal Military College of Canada. Her bachelor's degree in psychology is from Dalhousie University. At the time of publication, she was employed as a researcher at the Canadian Forces Leadership Institute.

Lipstick and High Heels is a study of how women were portrayed in popular Canadian culture, mainly by *Chatelaine Magazine*, during World War II. Spencer claims that her study is unique in that her work includes an almost 30 year span (1928-1956), whereas many similar studies do not include both pre- and post-war periods.

An important assertion that Spencer makes early in her work is that the images Chatelaine projected of women during the Second World War years were unlike those the magazine offered in the 1920s and 1930s. Those earlier images were of a woman who could conduct herself with assurance in both "public and private spheres and her competence was not a direct measure of her femininity."[1] The advent of the war caused a significant about-turn in values. At the dawn of the Second World War, importance was placed on women's role in the home as well as maintaining her femininity and beauty at all times. Women were expected "to marry as part of the war effort."[2] Women (especially white Anglo-Saxon, middle-class women) were made to feel obligated to become mothers to offset the declining birth rate of their group, and counteract the "rise in birth rates amongst other racial groups."[3] Says Spencer, "these ideologies raised the status of motherhood to not only a cultural ideal, but also a racial duty."[4] Pre-war, it was not assumed that any woman would naturally be a "good" mother. With advent of the war, women were

"considered innately good at mothering."[5] At the same time, men began to be depicted as poor fathers.

The reader is informed that in November 1942, the Department of Munitions and Supply for Canada sponsored an advertisement, which was published by *Chatelaine*, that urged women to do their part for the war effort by keeping "that man of yours fit and happy for his job."[6] The advertisement included the catchphrase "Brave men shall not die because I faltered."[7] *Chatelaine Magazine's* articles and editorials laid similar heavy burdens on female readers' hearts during the Second World War.

"Brave men shall not die because I faltered."[7]

"we are the women behind the men behind the guns,"

The editor of *Chatelaine Magazine* during most of the period that Spencer studied was Byrne Hope Sanders (1929-1952). Sanders herself was a contradiction. While she advocated the role of women as homemaker and encouraged that they leave jobs to the men, she was the main breadwinner in her home. Her husband was an artist whose trade left him without a means of steady cash flow for the family. On at least one occasion, Sanders described the motives of married women who worked as "selfish reasons – nice clothes, luxuries."[8] Her own situation, however, told a different story. Spencer cited many other instances when Sanders contradicted herself in print. I smiled at Spencer's narrative when she described the era after World War II as a "schizophrenic period for Canadian women"[9] and stated that "Sanders' editorials were characterised by paradoxical shifts in attitude."[10]

"we serve that men might fly,"

"we serve that men might fight."

Of particular interest to readers of this journal, perhaps, is how Spencer describes the image of enlisted women who formed the women's divisions of the armed forces. She restates others' assertions that "traditional attitudes towards women were ultimately reinforced during the war"[11] and that evidence was provided of this by the wartime mottos of the women's services such as "we are the women behind the men behind the guns," "we serve that men might fly," and "we serve that men might fight."[12] She describes a "whispering campaign"[13] against the Canadian Women's Army Corps and the advertising campaign put into place to counterbalance the notoriety that ensued. Posters of adventurous women were replaced with images of "feminine, patriotic girls."[14] Spencer reports that the "image of women in uniform seems to have been particularly jarring"[15] to *Chatelaine*. An advertisement seeking female volunteers to enlist in the Navy read "they want eager ambitious young women who enjoy homemaking and housekeeping."[16]

Whether or not gender and popular culture studies are of a particular interest to the reader, Spencer's work offers a unique and significant historical perspective. It is important to remember though, that Spencer's work does not describe a female voice, but a hegemonic voice that influenced Canadian females. Byrne Hope Sander's editorial work was a reflection or extension of the same hegemonic voice. Just the same, *Lipstick and High Heels* describes an important facet of Canadian women's history and experience. Emily Spencer's work serves to remind readers that they can become pawns to popular culture whenever they allow themselves to be, and warns them of the potential for manipulation disguised as patriotism. It prompts them to read not only academic works, but any media, with a keener awareness of the writer's motive or with what has been coined a "hermeneutic of suspicion." ■

Anne Pennington is Production Manager at Canadian Forces Aerospace Warfare Centre and is presently Civilian Chair of the 8 Wing Defense Women's Advisory Organization. Her mother was a member of the RCAF Women's Air Division in the Second World War and a peace-time member until her career was ended because of pregnancy in the late 1950s. She remembers her mother's stories of the time span Spencer's work covers including how she missed the Air Force and often wonders how different her mother's story might have been in another era.

Notes

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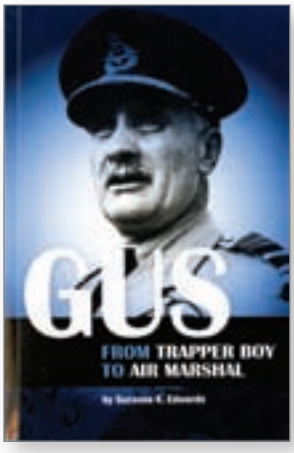


GUS:
FROM TRAPPER BOY TO AIR MARSHAL

BY SUZANNE K. EDWARDS

RENFREW, ONTARIO:
GENERAL STORE PUBLISHING HOUSE, 2007
234 PAGES ISBN 978-1897113745

Review by **Major Bill March**

Suzanne Edwards' book is a rarity in Canadian military history circles; a full length examination of a senior Canadian airman. That this airman happens to be her father, and that the book is not a full-fledged scholarly publication, does not detract from either her accomplishment or the importance of the subject. Although, arguably, Air Marshal (A/M) Harold "Gus" Edwards is a pivotal figure in the history of the Canadian Air Force, it is equally true that he deserves study as a leader whose attributes cut across service boundaries.

A/M Edwards' early career could be used as a primer for the study of air power in Canada. He joined the Royal Naval Air Service (RNAS) as a pilot in 1915 and flew bombing missions in France. Shot down in April 1917, he was taken prisoner by the Germans and despite attempting to escape several times, he remained their "guest" until the end of World War I. As a Captain in the Royal Air Force (RAF), Edwards joined 47 Squadron supporting the Allied intervention against the Bolshevik government in Russia. Finally demobilized in July 1920, he returned to Canada where he petitioned to join the fledgling Canadian Air Force (CAF). For most of the next six years, he would pilot flying-boats on mapping and forestry patrols from various locations in Manitoba. Between 1926 and 1933, he held various staff appointments in headquarters in England and Ottawa before returning to flying operations in the Maritimes. Promoted to the lofty rank of Wing Commander (W/C) in 1936, he was one of the most experienced permanent force officers serving in the Royal Canadian Air Force (RCAF) prior to World War II.

As the RCAF rapidly expanded during the early years of the war, Edwards found his leadership and management skills put to the test as the Air Member for Personnel. He was responsible

for recruiting, manning, discipline, pay, medical, and chaplain services; appointments; promotions; retirements; postings; supervision of the reserve and compilation of staff estimates; amongst other tasks. These duties were made all the more critical as the British Commonwealth Air Training Plan (BCATP) "kicked into full-gear" and thousands of RCAF personnel were shipped overseas. Promoted to Air Vice Marshal (A/V/M) in August 1941, his dedication caused him to work long hours, contributing to an ever-weakening state of health.

A forthright and pragmatic individual, Edwards never turned away from a fight -especially if he felt that it was the right thing to do in the interests of his beloved Air Force. His strength of character and moral courage allowed him to tackle issues such as attempting to eliminate the racial restrictions of the RCAF's recruiting policy. Although ultimately unsuccessful in his attempt to broaden the RCAF's pool of potential talent, his unceasing efforts resulted in a reputation for meeting controversial problems head-on. Therefore, in October 1941 when the Minister of National Defence for Air was looking for someone to take charge of the RCAF Overseas Headquarters, he turned to Edwards. He had recognized in him the combination of leadership and stubbornness that would get the job done.

In part Edwards' task was to bring a sense of purpose and professionalism to the headquarters in London and this he did post-haste. However, his other task was to fashion, in the face of British reluctance, a Canadian identity for the RCAF in the European theatre of operations. Although the majority of RCAF personnel would serve with RAF units during the war, Edwards' pursuit of the so-called policy of "Canadianization" paved the way for the creation of Canadian squadrons throughout the RAF's order of battle. The RAF held to the principle that RCAF personnel, regardless of national desires, would be posted as they saw fit. Edwards fought to ensure that Canadian airmen, and eventually groundcrew, would serve in Canadian squadrons and formations. The crowning achievement for his efforts would be the establishment of No. 6 (RCAF) Group of Bomber Command. Edwards' single-minded pursuit of his goals ruffled official feathers both in London and Ottawa, but it was his failing health that led to his replacement in late 1943 and his early retirement in September 1944. Finally upon his death in February 1952, the RCAF, for the first time in its history, buried an Air Marshal.

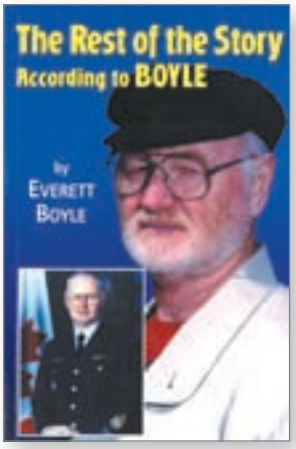
I mentioned at the beginning of this review that *GUS* is not a scholarly publication in its truest sense, but this should be viewed as a strength and not a weakness of the publication. While Ms Edwards has provided ample context by referring to more formal histories of the events that surrounded her father's life, it is her inclusion of personal stories, papers and memories that allow the reader to delve into the more intimate qualities that make a leader. For example, while Volume II of the official history of the RCAF, *The Crucible of War, 1939-1945*, provides an in depth examination of A/M Edwards' efforts with respect to the RCAF overseas and Canadianization, it does not allow the reader to understand what was going through his mind as he accepted such a formidable challenge despite his declining health. Ms Edwards fills in this blank by referring to a letter the A/M wrote to his mother prior to his departure:

> "...although my station is high and my spirit and courage higher I am not unmindful of the task that faces me. There will be danger but I am not unaccustomed to that.... There will be problems to face that I have seldom faced before: there will be battles to fight the like of which I have never heretofore contemplated. There will be matching of wits and a front to put on. The cost in money will tax my meagre resources for governments seldom compensate their servants. There will be great jealousy and a measure of hate from among my enemies of whom, I am thankful, I have many: for most men are made by their enemies. But as I told you when I took on my present appointment 'such are the penalties on them that rise.' I may fail (may God grant that I don't!) and if I do it will not be in consequence of a faltering effort or a baseless conscience. It will not be for want of heart or courage or any of the human things I have striven so hard throughout my life to understand and achieve, but rather, defeat if it comes shall be laid across the threshold of the door which opens and discloses the frailties of human beings."

In short, A/M Edwards was a professional, the sum of his experiences and training, who was able to face any challenge confident not in the knowledge that he would succeed, but in the certainty that he would do his best.

A/M Edwards was a leader in every sense of the word. As such, his story is worthwhile reading by students of history, leadership and command. Although a combat veteran, his battles during the later part of his life were fought against professional lassitude, bureaucratic inefficiency, political myopathy, and imperial superiority - problems which, in one form or another, remain with us today. Ms Edwards is to be congratulated for writing an extremely readable and interesting account that puts a human face behind the "mask of command" of this senior RCAF officer. We can only hope that other authors will be inspired by Ms. Edwards' efforts and seek to examine other Canadian air-leaders in a similar fashion. ■

Major Bill March, a maritime Air Navigator working on unmanned air vehicle concepts and doctrine, has taught Canadian defence and air power history at the undergraduate level. He is currently pursuing his doctorate in War Studies at the Royal Military College.



THE REST OF THE STORY
ACCORDING TO BOYLE

BY EVERETT BOYLE

BURNSTOWN, ONTARIO:
GENERAL STORE PUBLISHING HOUSE, 2002
297 PAGES ISBN 1-894263-49-9

Review by **Major Bruno Paulhus**

Whether it was due to leaks to the media of an embarrassing sexual harassment incident involving a senior officer and a young private under his command or it was simply a good program to initiate, in the late 1990s the Canadian Forces (CF) adopted the policy that all members would receive Standards for Harassment and Racism Prevention (SHARP) training. Through his book, *The Rest of the Story According to Boyle*, Mr. Everett Boyle relates both his involvement in the handling of the sexual harassment incident, which was exposed by Maclean's magazine, as well as numerous other incidents of harassment and ineffective leadership in the Canadian Air Force that he witnessed throughout his career.

CWO Everett Boyle (Retired) served the CF for 37 years. Through the course of his career he gained a reputation of being "a hard-nosed disciplinarian who would not stand for any sort of abuse of power, authority, rank, or position, especially if the abuse was directed at defenceless subordinates."[1] As a result of his willingness to fight for what he believed was right, the last years of his highly successful career were marred.

In the first five chapters of the book Mr. Boyle relates the circumstances of the sexual harassment incident and the ensuing investigation that, as the Base Chief Warrant Officer, he was involved in. Mr. Boyle speaks of his discussions with his own superiors and the two subordinates he was attempting to help through their personal ordeal. Beginning in Chapter Six, he recounts experiences with other officers from earlier in his career that he believes contributed to the unfavourable manner in which he was treated and the lack of support he received during the investigation of the sexual harassment incident. He also

1 Everett Boyle, *The Rest of the Story According to Boyle* (Burnstown, Ontario: General Store Publishing House, 2002), 6-7.

provides examples of good leadership that he experienced while serving in an Army unit and emphasizes that the problems of ineffectual leadership are more prevalent within the Air Force than the CF as a whole. Mr. Boyle ends the book with his conclusions and recommendations on how the CF could address the problems he has cited in order to improve the leadership in the Air Force.

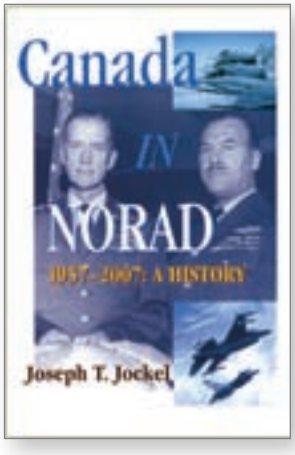
This book would have benefited from being edited by an independent and unbiased individual. Many segments are long, tedious monologues by the author. As a result the points that he is making can be lost to the reader. As well, Mr. Boyle repeats his views of the officer corps numerous times. He believes that they resemble a herd of elephants that will circle themselves around the wounded, face outwards, and defend the injured to their own death.[2] Even though the metaphor is appropriate, in his view, and one that some readers will agree with, by the time that it is repeated the fourth and fifth times, it has become tiresome and will sway the opinion of the unbiased reader.

Putting aside the poor editing, this book will provoke military members, both those who served before SHARP training and also those who joined after the program was made mandatory, to reflect upon their own careers (before and after SHARP) and make a personal assessment on whether the military has been successful in reducing harassment and racism in the workplace. It will also encourage readers to form their own opinions of the leadership in the CF, consider how it has evolved during their careers, and judge whether the changes were good or bad.

Overall, this book deserves to be read, preferably with an open and unbiased mind. A reader will come to either agree with Mr. Boyle or will vehemently deny that such incidents could be true. But it is certainly a book that can incite lively discussions among serving and retired military members. ■

2 Boyle, 56.

Maj Bruno Paulhus has spent the past 28 years flying the C130 on global operations and is currently employed with the Concepts and Doctrine Development Branch at the Canadian Forces Aerospace Warfare Centre.



CANADA IN NORAD 1957 - 2007: A HISTORY

BY JOSEPH T. JOCKEL

KINGSTON, ONTARIO:
MCGILL-QUEEN'S UNIVERSITY PRESS, 2007
225 PAGES, ISBN 978-1-55339-134-0

Review by **Major Bill March**

Dr. Joseph Jockel, currently with the Department of Canadian Studies at St. Lawrence University in New York state, is no stranger to the melodrama that is the Canada - US defence relationship. He has authored, or co-authored, several excellent books on the subject and *Canada in NORAD 1957– 2007: A History* is an important addition to his body of work. It is a well-researched and very readable examination of the history of the North American Aerospace Defense Command (NORAD); which, for the last fifty years,

has arguably been the centre-piece for defence cooperation with our neighbours to the south.

Dr. Jockel begins in his first chapter, as they say, at the beginning by looking at the signing of the original air defence agreements in 1957 and 1958. Agreements is not a "typo." In September 1957, NORAD was officially stood-up as a bi-national command with United States Air Force (USAF) General Earle E. Partridge as the Commander-in-Chief (CINC) and Air Marshal C. Roy Slemon as the Deputy CINC. As agreed to by the fledgling Conservative government of John Diefenbaker, NORAD was designed to integrate the air defences of both countries to defend against a Soviet bomber attack. However, in the mid-1950s both attack and defence meant a reliance on nuclear weapons with Canada as the potential battleground. Therefore, the Department of External Affairs (DEA) sought to make NORAD more than just a military-to-military body. In May 1958 an exchange of notes between the DEA and the US State Department emphasized the need for "the fullest possible consultation between the two Governments on all matters affecting the joint defence of North America."[1] Debated and approved by Parliament in June, this "diplomatic" NORAD agreement provided, so it was believed in Ottawa, a conduit for a Canadian voice in issues that might have a direct impact on national survival.

As Jockel points out in the subsequent two chapters, titled "Air Turbulence 1958 – 1968" and "Trudeau and Aerospace Defence," the issues of nuclear weapons and bi-national consultation dominated Canada's approach to NORAD throughout the 1960s and 1970s. Although NORAD provided an element of protection for the US North American-based strategic nuclear deterrent, it was the need to employ nuclear weapons in this role that caused the greatest angst in Canada. Notwithstanding the acquisition of the CF101 Voodoo interceptor and Bomarc surface-to-air (SAM) missiles, both of which required nuclear weapons to be effective, successive Canadian governments attempted to distance themselves from the entire subject.

Bi-national consultation was also a thorn in the Canadian government's side. Although Ottawa felt that the NORAD agreement made such consultation mandatory, the US did not have the same view. Therefore, a perceived lack of communication between the two nations during the 1962 Cuban Missile Crises and the 1973 Yom Kippur War (both events triggered an increase in the alert status of US forces) generated an element of concern within Ottawa. With Canadian and US air defence forces "joined-at-the-hip," it appeared impossible, especially during the Cuban Missile Crisis, to increase the alert status of one partner in the bi-national defence apparatus without automatically doing the same for the other. For this to happen without Canadian government approval of or, at a bare minimum, input into the decision was a continuing source of frustration. As a partial remedy to this situation, coupled with Trudeau's focus on national sovereignty, there was a gradual "repatriation" of Canadian assets and the eventual formation of the Canadian NORAD region.

Even while the political ramifications of these issues were being dealt with, NORAD was evolving. As the potential threat to North America swung from the manned-bomber to ballistic missiles, NORAD downgraded its manned-interceptor role and gradually adopted space surveillance and missile-warning/assessment tasks. Canada had concerns with these new roles, specifically how NORAD would fit in to the US anti-ballistic missile (ABM) system and the potential weaponization of space, but nevertheless approved in the early 1980s an official change in name (and focus) to North American Aerospace Defense Command.[2]

Chapters Four and Five look at the growing importance of space within NORAD and, with the end of the Cold War, the acquisition of additional roles. Jockel highlights the struggle to balance the military requirement to build upon the NORAD relationship to safe-guard Canadian Forces' access to space-related information and services, with the Government's desire not to become engaged in the strategic sefense initiative (SDI) and missile defence. At the same time, NORAD had to adjust to the reduction in the Soviet (now Russian) threat to North America. Counter-drug operations was added to NORAD's lexicon as a new responsibility partly in an attempt to find a new raison d'etre for the bi-national command, but also partly in response to the challenging reality of asymmetric threats.

Just how real these threats were was brought home to the world on 11 September 2001. Oriented to defend against an external attack on North America, Jockel notes in Chapter Six that NORAD was neither designed nor prepared

1. J.T. Jockel, *Canada in NORAD 1957 - 2007: A History* (Kingston: McGill-Queen's University Press, 2007), 36.

2. From its inception in 1957, the original name was North American Air Defense Command. The 1980 name change reflected the growing importance of space within NORAD operations.

to deal with an airborne terrorist threat from within. NORAD would implement a series of operations dubbed NOBLE EAGLE that saw US and Canadian fighter aircraft providing top-cover over select cities and vital installations within their respective countries. Both Canada and the US also instituted changes within their military organizations to deal with the new threats. The Americans created a new unified command, United States Northern Command (USNORTHCOM) which for the first time had North America as its operational focus. In 2006, Canada followed suit with the establishment of Canada Command (Canada COM) which has a similar focus to that of USNORTHCOM. With the creation of these two bodies, the relevance of NORAD was called into question. However, as both countries adapted their respective defence organizations in order to increase the importance of homeland defence, the governments of both nations found it difficult to relinquish the practical ties and bi-national trust represented by NORAD. In 2006 the NORAD agreement was re-signed, this time without a formal expiration date. Undoubtedly, the relationship between NORAD, USNORTHCOM and Canada COM will continue to evolve, but at least for the foreseeable future, argues Jockel, NORAD will continue to exist.

With only a few minor editorial errors, Jockel has laid out in an easy to follow chronological format a history of NORAD. In tracing the evolution of NORAD, he provides some contextual background with respect to Canadian and US political issues that were prevalent during the various periods in which he breaks down the story. And although he does the same for the US Air Force, Jockel does not provide the same level of detail on the internal organizational pressures facing the Royal Canadian Air Force (RCAF) and its successors within the Canadian Forces. For example, although he goes to great lengths to explain how the US grappled with the control of air defence assets assigned to NORAD and national commands, there is scant mention of organizational changes to Canada's Air Force, such as unification or the creation of Air Command in 1975, and how they might have impacted NORAD. This level of detail may have been beyond the scope of this publication, but it is a significant gap in the narrative.

Why should this book be of interest to members of the Canadian aerospace community? My minor criticisms aside, Jockel's book chronicles an agency that has been the cornerstone of Canada's defence relationship with the U.S for over fifty years. As such, a more thorough understanding of how politics, organizational pressures and personal relationships combined to influence its evolution is beneficial. Aerospace defence remains a critical element of national security and it behoves us to ensure that NORAD continues to play a relevant role and that these concerns are addressed where appropriate. Therefore, knowledge of how NORAD evolved may stand us in good stead as the nation attempts to forge new defence relationships with the US in general and USNORTHCOM in particular. ■

Major Bill March, a maritime Air Navigator working on unmanned air vehicle concepts and doctrine, has taught Canadian defence and air power history at the undergraduate level. He is currently pursuing his doctorate in War Studies at the Royal Military College.

JAPCC

Joint Air Power Competence Centre

NATO's CENTRE OF EXCELLENCE

By Lieutenant-Colonel Jim Bates

In the three years since its formation, the Joint Air Power Competence Centre (JAPCC) has established itself as a leading advocate for the transformation of North Atlantic Treaty Organization's (NATO) joint air and space power.

The JAPCC is NATO's Centre of Excellence working to support Allied Command Transformation (ACT), our primary customer, on numerous joint projects and participating in (and often leading) working groups, standards boards and fora within the Alliance,

with industry and with academia. The aim of this article is to provide the broader air and space power community with an update on the work of the JAPCC, to underline its accomplishments to date and to discuss our programme of work for 2008.

Background

Why did JAPCC form? The NATO command arrangements today do not provide a central, strategic-level entity for the promotion of combined and joint air and space power interests. That expertise is spread across the NATO command structure without the required degree of organizational integration or collaboration. JAPCC was formed to provide NATO that needed focal point for integration and collaboration, a centre of expertise to develop and champion innovative visions, concepts and value-added solutions for the transformation of air and space power within the Alliance and within the nations.

The JAPCC is located on the von-Seydlitz Kaserne, at Kalkar Germany (near the Combined Air Operations Centre 2 [CAOC 2] at Uedem) and about 100 km north of the NATO Airborne Early Warning and Control Wing at Geilenkirchen. Sponsored by the German Ministry of Defence, JAPCC is made up of approximately 76 senior officers from 17 NATO nations, including Canada, working within a memorandum of understanding (MOU) framework and guided by the Air Chiefs of each nation through the Director of the JAPCC, General Roger Brady (USA), the multi-hatted Commander of Component Command-Air (CC-Air) Ramstein. The Director is supported by the Executive Director, Lieutenant General Friedrich Wilhelm Ploeger (DEU) (also Commander CAOC 2), Air Commodore Garfield Porter (GBR) as Assistant Director Transformation, and Air Commodore van Hoof (NLD) as Assistant Director Capabilities.

The staff is functionally organized along traditional air power lines, although projects are managed in a matrix fashion. Table 1 illustrates the JAPCC organizational structure, broadly divided into two functional divisions, each headed by one of the assistant directors and the six branches are each headed by an OF-5 colonel. The majors and lieutenant colonels that make up the subject matter experts (SMEs) are each assigned to a specific air power discipline within the branches.

The JAPCC MOU provides the organization with its mission and responsibilities:[1]

> *In general, the JAPCC will provide support to concept development and experimentation, doctrine development, standardization and interoperability issues, capabilities and defence planning, education and training, exercise, evaluation assistance and lessons learned activities as well as military co-operation with partners on transformational issues. Further, the JAPCC will assist HQ SACT [Headquarters Supreme Allied Commander Transformation] in the coordination of NATO Joint Air Power Transformation related activities, as directed by SACT.*

Table 1 – JAPCC Staff Organization

TRANSFORMATION		CAPABILITIES			
Policy and Concept Development Branch	Future Capabilities Branch	Combat Air Branch	Combat Support Branch	Combat Service Support Branch	C4ISTAR Branch
Joint Interoperability, Doctrine, Integration	Future Technology	Suppression of Enemy Air Defences, Electronic Warfare	Air Transport	Survive to Operate and Force Protection	Intelligence, Surveillance, Target Acquisition and Reconnaissance
Joint Defence Planning	Space Operations	Manned Air including Attack Helicopters	Air-to-Air Refuelling	Medical, Civil-Military Cooperation	Airborne Early Warning and Control, Airspace Control
Concept Development, Vision	Future Operational Scenarios	Unmanned Combat Air Vehicles, Precision Guided Munitions, Cruise Missiles	Support Helicopters, Combat Search and Rescue, Special Operations	Logistics	Alliance Ground Surveillance and Unmanned Aerial Vehicles
Training, Exercises, Experimentation	Future Organisations and Structures	Ground-based Air Defence, Theatre Missile Defence			Air Command and Control, Data Links, NATO Network Enabled Capability
	Promotion of Air Power Transformation	Maritime Air including Carrier Operations			Space Systems, Deployable Communication and Information Systems, Navigation Aids and Meteorological and Oceanographic Centre
	Intelligence Support		76 total OF-posts 42 joint eligible		Information, Intelligence and Knowledge Management

In accomplishing that mission the JAPCC has developed numerous products, a few of which are described here.

JAPCC's Air C4ISR Roadmap for NATO

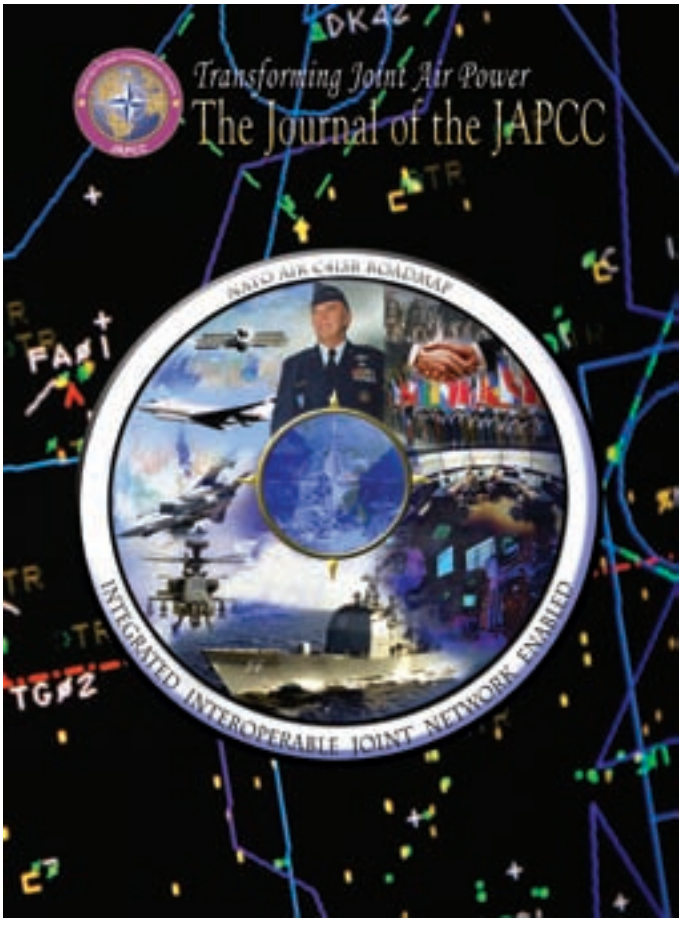
Command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) within NATO resembles a patchwork quilt thrown together through operational and political necessity rather than by design. Consequently, it has been shaped by good intent and cooperation rather than through strategic direction. The background to this situation is complex, historical, and mostly understandable; nevertheless, C4ISR enlightenment, at all levels, is essential if NATO is to meet contemporary security and defence challenges, hence the need for the Roadmap. The vision that guided the team members through the Roadmap development is a fully interoperable and interdependent net-centric joint C4ISR capability, which enables a commander, through decision superiority, to achieve the desired effect. To accomplish this, the JAPCC Air C4ISR Roadmap builds a baseline picture to show where NATO is today and, based on the current plans and programmes, how the Alliance is going to meet future demands. The Roadmap describes the air C4ISR landscape, highlights the opportunities presented by the challenges, and identifies the gaps along with the appropriate corrective measures. By taking our findings as a starting point for change, NATO can identify the areas of alignment that are working effectively, along with those that demand urgent, near-term and increasingly long-term attention.

As a result of working the Roadmap, we generally see in NATO a convergence of C4ISR activities,[2] for example the delivery of projects and programmes, training, doctrine and standards development, that collectively bring added capabilities to the Alliance in the form of "effective intelligence", "effective command, control and communications (C3)" and "effective engagement."[3] While this convergence is relatively slow moving, due to the complex nature of air power,[4] and is more an evolution than an end state, the warfighters in the International Security Assistance Force (ISAF) theatre are seeing capability improvements from one rotation to the next.[5] Improvements are made possible

through standards compliance, better strategies through improved governance, and a more effective operational capabilities' life-cycle (requirements refined through experimentation, demonstration, exercise leading to improved or new operational capability). It doesn't stop there though. Feedback from the warfighter is essential to close the loop (for example adapting tactics, techniques and procedures) which is a vital aspect of organizational learning.

General Tom Hobbins (USA), previous JAPCC Director, approved the document and briefing in November 2007 for publishing and public presentation.[6] JAPCC began a series of high profile presentations on the product in January 2008 to advocate for change and to increase awareness of NATO air C4ISR progress and opportunities.

Positive feedback from an early Roadmap release to ACT indicates they are poised to use the gap analysis presented to solidly justify requirements to the NATO nations in the defence requirements review (DRR) and long term capability requirements process. Progress towards the Roadmap's vision is seen on numerous fronts across NATO's joint intelligence, surveillance and reconnaissance (JISR) community including the work of the JISR Integrated Capability Development Team (JISR ICDT), led by ACT/C4I division, to unite the C4ISR efforts across the Alliance. Three principles bind the JISR ICDT's actions: use best practice; do not re-invent the wheel; and ensure NATO network-enabled capability (NNEC) compliance in all products.[7]



Unmanned Aircraft Systems Flight Plan for NATO

The proliferation of unmanned aircraft systems (UAS) throughout the Alliance nations and in all theatres of operation is impressive.[8] In 2007, the JAPCC completed the Flight Plan for UAS in NATO to bring cohesion to the multitude of issues associated with UAS operation, issues that are common throughout the Alliance.[9] The 26 significant issues highlighted and their associated recommendations were accepted for action by ACT and are now being addressed through a Bi-Strategic Command agreement with Allied Command Operations (ACO). The effort on the Flight Plan brought significant attention to JAPCC's overall activities, earning it an award as "The Outstanding NATO Centre of Excellence in Europe." JAPCC will continue to contribute to this process and will incorporate progress into the Flight Plan updates in 2008 and beyond.

As part of its 2008 programme of work, at the request of CC-Air Ramstein and Supreme Headquarters Allied Powers Europe (SHAPE), JAPCC is developing a UAS concept of employment for ISAF operations. The concept was identified as one of the UAS Flight Plan's 26 gaps.

Air-to-Air Refuelling Interoperability

JAPCC led the drafting and coordination of Allied Joint Publication (AJP) 3.3.4.2, Air-to-Air Refuelling Procedures, from a fixed-wing perspective, which was ratified by the nations in April 2007. In addition, the Director approved the JAPCC report on "Future Air-to-Air Refuelling in NATO" in August, which included as key findings the need to re-energize the Prague Capability Commitments as they relate to refuelling, the need for NATO to change refuelling planning procedures, and the need for an overarching NATO aerial refuelling doctrine.

The aerial refuelling SMEs have instituted a "one stop" aerial refuelling website[10] for mission clearance support and have already submitted a validation proposal to the nations for future doctrine development as follow-on to that report.

Force Protection Doctrine for NATO Air Operations

The operational requirement for force protection of airfields in NATO-led ISAF operations and the reliance on those few nations with specialist and deployable airfield defence capabilities have highlighted a NATO doctrine gap. In February 2007, the JAPCC hosted an air forum with 30 representatives from 16 nations and 5 NATO HQs. They agreed with the requirement and endorsed a first study draft doctrine, which was then submitted to NATO HQ, and circulated to the nations. The nations that NATO HQ now lists as having endorsed this proposal at the time of writing are BEL, CAN, CZE, DNK, HUN, ITA, NLD, PRT, TUR, GBR, ACT and SHAPE. Although a couple of nations have taken issue with the proposal, it is expected that the doctrine work will continue based on majority rule as that is the basis for doctrine development in NATO.

Airbase Activation

NATO force generation experiences in Pristina, Kosovo and Kabul, Afghanistan, in which NATO sought a lead nation to conduct the airport of debarkation task, proved time-consuming to the point of being abandoned in favour of a patchwork approach.[11] These experiences identified vital lessons for NATO expeditionary operations, lessons that would have to be addressed if the NATO Response Force (NRF) was to be successful due to its extremely short ready to move requirement. Facing this shortfall, the JAPCC developed and proposed its Deployable Airbase Activation Wing concept to support the NRF readiness requirement and has continued to use the concept to inform NATO defence planning efforts.[12] Through engagement in the DRR, the Combined Joint Statement of Requirements for the NRF and other NATO programmes, the JAPCC continues to support NATO's expeditionary capability.

Air Defence 2020

The genesis of this task was to provide NATO a vector with regard to air defence. This evolved in terms of support to the Conference of NATO Armament Directors (CNAD) and the primary policy advisory body for air defence matters in NATO, the NATO Air Defence Committee (NADC). The JAPCC chaired the Holistic Air Defence Exploratory Study Working Group—a group researching the whole playing field of Air Defence in NATO—which produced a report presented to both the CNAD and the NADC, recommending ways forward to deal with air defence and air power matters in a more efficient way within NATO. The report was noted in both bodies and the NADC took action to implement most of the recommendations. JAPCC is actively supporting the NADC drafting groups that are producing NATO's vision for air defence.

The six projects discussed are a sample of the work that goes on at the JAPCC. Above and beyond these projects, the JAPCC promotes NATO air and space power through its annual conference and biannual journal.

JAPCC Air and Space Power Conference

The JAPCC Conference, held annually during the month of October, provides the NATO air and space power community an opportunity to focus on topical issues, normally organized around a theme of specific and timely interest. Each year a different capstone project is selected and studied, which serves to set the conference agenda. Papers, reports and articles prepared on that subject are publicized.

The purpose of the 2007 Conference, as the Director explained in his opening remarks, was to consider how to best exploit the attributes of air power in expeditionary security and stability operations as characterized by NATO-led operations in ISAF and coalition operations in Iraq.[13] A major product from the conference was a paper on "Air Power in Irregular Warfare,"[14] released by JAPCC to ACT in final draft form pending its presentation to the Allied Joint Operations Working Group and to the Air Operations Working Group. The paper highlights doctrinal gaps and engages the key stakeholders.

During the conference, General Egon Ramms, Commander Allied Joint Force Command Brunssum, gave the keynote address and spoke openly about the challenges for NATO with respect to operations, and in particular air operations, in Afghanistan. The four panel discussions (The Comprehensive Approach, Air C4ISR, Physical and Cognitive Effects, as well as The Role of Air Power in Reconstruction and Development) that followed provided lively interaction amongst all participants.[15]

The JAPCC Conference 2008 is set to take place 14-16 October at the same venue[16] in Kleve, Germany and, in line with the JAPCC capstone theme for 2008—battlespace management (BSM)—will focus on Decision Superiority in the 21st Century. SACT, General Mattis, has been invited as keynote speaker for

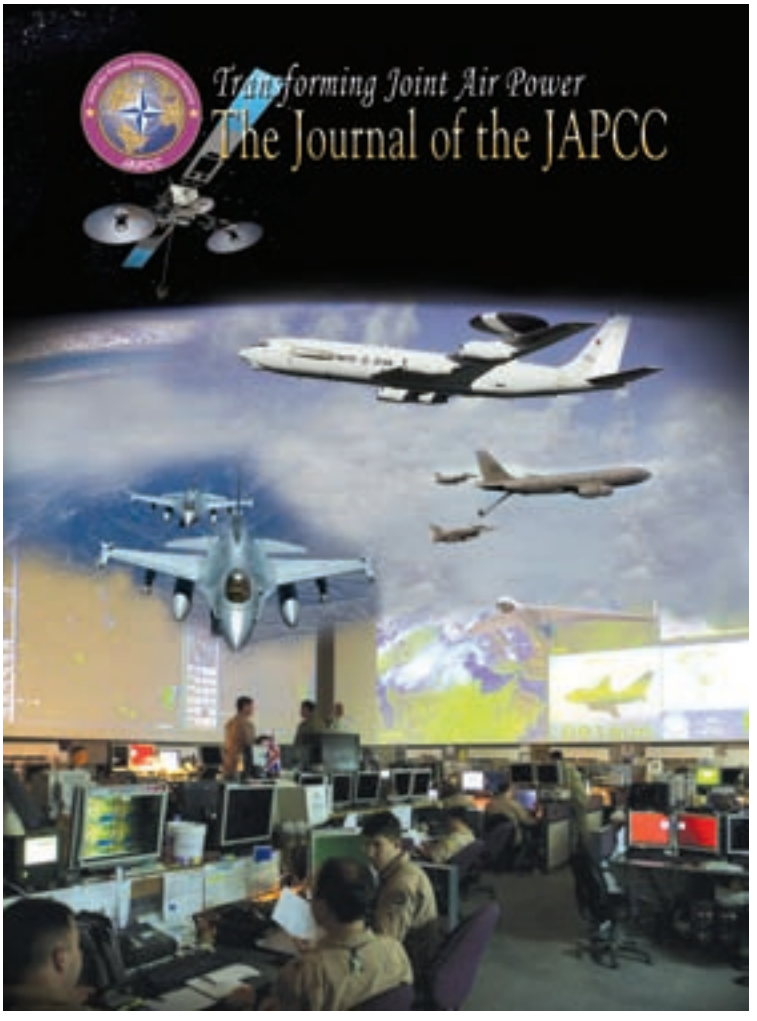
the event and four high-level panel discussions are being convened.

• **Command, Control and Shared Situational Awareness**. This theme looks at the relationship between command, control and shared situational awareness, both today and in a future NNEC environment. Of special interest is interoperability between NATO nations and the use of common doctrines, procedures, standards and the integration of (Air) C2.

• **Battlespace Management.** The discussion will explore the nature of activities in the battlespace and overall BSM. In particular, it will focus on how the changing relationship discussed in the first panel might impact on any future air tasking cycle. The discussion will also explore the nature of activities on the environmental "seams." Here we discuss the joint integration of air and space, land, maritime, and special operations forces, with regard to battlespace requirements, planning and execution, from both a process and systems view.

• **Gaining Intelligence and Information Superiority**. This discussion looks at efforts to improve our shared understanding of the battlespace through, among other things, NNEC and the fusing of intelligence as a perquisite for establishing decision superiority. It looks at the information and human domains, and their interaction, with regard to NATO's information management policy, strategy, concepts, human-machine interface and, ultimately, "sensemaking" which is our ability to understand our environment based on the deluge of information.

• **Space as a Critical Enabler of NATO's Operations**. The discussion will look at the various ways that space based capabilities have become a critical enabler of today's operations, whether military or civil. Space activities should be conducted as a joint operation, which contributes significantly to BSM. As NATO becomes more dependent on, and our enemies have access to, space capabilities, those systems must be monitored and protected. At present, there are many gaps in space capability and integration. NATO must continue to work towards better integration and sharing of information, which invariably transits space, and to provide direction to the member nations as to NATO's operational space capability requirements.



The Journal of the JAPCC

The JAPCC produces two journals annually, each focusing on a specific aspect of air and space power, and are usually aligned with the JAPCC's capstone and conference themes. They provide a valuable forum for discussion and debate amongst the air power community. Recent editions focused on C4ISR and air power in expeditionary security and stability operations, which was the 2007 conference theme. The latest edition, which focuses on BSM, hit the street on 1 May 2008.[17]

Several new projects have been introduced into the JAPCC's programme of work for 2008 and are well underway.

NATO Space Operations Assessment

Atop the list of new projects is the space effort. The JAPCC sponsored a NATO Space Workshop, which took place on 22 April 2008. The purpose of the workshop was to gather key stakeholders to discuss a draft "NATO Space Operations Assessment" written by the space experts at JAPCC with input from the nations. Because NATO does not have a space policy, many questions about NATO's involvement in space are unanswered.[18] The paper, due to HQ SACT Deputy Chief of Staff (DCOS) Transformation by 1 June 2008, argues that NATO guidance on space is required in order for NATO to transform to an expeditionary, network-enabled capable entity. It offers an analysis of the gaps and recommendations providing a foundation for discussion that may lead to a NATO space policy.

NATO's Future Joint Air and Space Power

Although NATO declined to endorse the Concept for Alliance Future Joint Operation (CAFJO), a Bi-Strategic Command (ACO and ACT) paper, JAPCC remains convinced, as a result of the CAFJO discussions, of the need for a future air and space environmental piece. It has been decided, however, to decouple the work from CAFJO and as such, JAPCC will aim to publish a "non-Paper" with the same focus of expanding the AJP-3.3 (NATO's Joint Air and Space Operations Doctrine) and further developing NATO's transformational goals and objectives on future air and space.

The JAPCC envisages the environmental piece, "NATO Future Joint Air and Space Power (NFJASP)," as a capstone concept, which will inform and guide future subordinate JAPCC conceptual work. This document and its vision of network enabled, de-centralized mission command intentionally pushes the boundaries of conventional thinking on C2. It is geared specifically to initiating an informed discussion on future possibilities for C2 in the NATO air

and space environment. The NFJASP draft document is currently with the staff at CC-Air Ramstein, CC-Air Izmir and HQ SACT DCOS Transformation for review. This is not intended to be a consensus document but rather an independent JAPCC view of the best way forward.

Close Air Support / Fratricide Prevention

In the ISAF theatre, smaller and more dispersed Alliance ground forces depend on training, superior technology and overwhelming firepower from close air support (CAS) to defeat the enemy. CAS is a force multiplier upon which ISAF forces routinely depend for survival; however, "the benefits of CAS can be greatly diminished by a few bad experiences."[19] Improved training and standardization in air-to-ground operations are vital to avoid fratricide in CAS operations.[20]

JAPCC co-hosted with CC-Air Ramstein a Forward Air Controller – Joint Terminal Attack Controller Symposium in October 2007 bringing together ISAF CAS-FAC leaders and the various forward air controllers (FAC) schools throughout the Alliance for the first time in more than 13 years. The symposium addressed ISAF lessons learned and the Bi-SC Analysis and Lessons Learned (BALL) report findings to incorporate into the FAC school curricula. An interim report on actions related to all BALL Report action items was signed out to HQ SACT DCOS Transformation in December 2007.

JAPCC also hosted two STANAG custodial meetings in 2007 to review standardization agreements governing CAS and FACs. While progress was made there were still areas of disagreement, primarily in the training requirements and on some operational message formats. Those issues were resolved at a STANAG meeting held in February and on 17 April, 2008, NATO's Air Operations Working Group (AOWG) agreed to staff the CAS STANAG forward for promulgation. Also discussed amongst the AOWG was the use of simulators and the need for simulator standards in NATO STANAGs. JAPCC agreed to lead the work on this issue.

Support to Defence Requirements Review – 2011

NATO's DRR is a mid-term process to forecast the Alliance's future capabilities. The JAPCC was asked to collaborate on specific DRR-2011 Aerospace Work Packages that were identified as relevant by both JAPCC and ACT, which has primary responsibility for heading the task. JAPCC provides SME support to ten of the Aerospace Work Packages. SMEs took part in the Aerospace Capability Area Group meetings as well as Planning Harmonization Group meetings. Apart from traditional topics, some new topics such as NATO Space Capabilities were established in which JAPCC can apply its unique expertise.

Conclusion

In only three years, the JAPCC has ramped up to become a major player in NATO's joint air and space power community and it is fulfilling its role as a central, strategic-level entity for the promotion of air and space power interests. Based on its battlespace management capstone theme for 2008, JAPCC is leading and supporting numerous projects, conferences and fora. Important to its work is the strong relationship with similar, like-minded organizations throughout the Alliance. The JAPCC welcomes all visitors to its facility in Kalkar and welcomes contributions to its Journal. This is an open invitation to come and join the discussion and debate at the JAPCC Conference, 14-16 October 2008 in Kleve, Germany. ■

List of Abbreviations

ACO	Allied Command Operations	GBR	Great Britain
ACT	Allied Command Transformation	HQ	headquarters
AJP	Allied Joint Publication	HUN	Hungary
AOWG	Air Operations Working Group	ICDT	Integrated Capability Development Team
BALL	Bi-SC Analysis and Lessons Learned	ISAF	International Security Assistance Force
BEL	Belgium	ITA	Italy
BSM	battlespace management	JAPCC	Joint Air Power Competence Centre
C3	command, control and communications	JISR	joint intelligence, surveillance and reconnaissance
C4ISR	command, control, communications, computers, intelligence, surveillance and reconnaissance	MOU	memorandum of understanding
C4ISTAR	command, control, communications, computers, intelligence, surveillance, target acquisition and reconnaissance	NADC	NATO Air Defence Committee
CAFJO	Concept for Alliance Future Joint Operations	NATO	North Atlantic Treaty Organization
CAN	Canada	NFJASP	NATO Future Joint Air and Space Power
CAOC 2	combined air operations centre 2	NLD	Netherlands
CAS	close air support	NNEC	NATO network-enabled capability
CC-Air	Component Command Allied Air	NRF	NATO Response Force
CNAD	Conference of NATO Armament Directors	PRT	Portugal
CZE	Czech Republic	SACT	Supreme Allied Commander Transformation
DCOS	Deputy Chief Of Staff	SHAPE	Supreme Allied Powers Europe
DEU	Germany	SME	subject matter expert
DNK	Denmark	TUR	Turkey
DRR	defence requirements review	UAS	unmanned aircraft system
FAC	forward air controller	USA	United States of America

Notes

1. The 17 participating NATO nations have agreed to the JAPCC MOU.

2. General Hobbins (USA), "Air C4ISTAR Roadmap: Convergence of Capabilities towards Net-Centricity," *The Journal of the JAPCC* 5 (Spring 2007): 6. The article highlights key NATO C4ISR programmes and activities. All JAPCC Journals are available on the Journal tab of www.japcc.org (accessed May 7, 2008).

3. NATO document MC 400/2 "Military Committee Directive for the Military Implementation of Alliance Strategy." According to MC 400/2, the essential operational capabilities that the Alliance requires, which are mutually supportive and which support the NATO defined military functions, are, among others, "effective intelligence," "effective C3" and "effective engagement."

4. Lieutenant General Meulman (NLD), "Challenges of Air Command and Control in Expeditionary Operations," *The Journal of the JAPCC* 6 (Autumn 2007): 6. Lt Gen Meulman talks about Air C2 and related challenges in the ISAF theatre.

5. During the JAPCC Air Forum 22 April 2008, veterans of multiple ISAF tours spoke about some significant C4ISR improvements over time in the ISAF theatre.

6. The JAPCC Air C4ISR Roadmap for NATO (document and briefing) is available on the JAPCC website at www.japcc.org on the Projects tab.

7. Captain Steve Kenny (GBR), "Joint Intelligence Surveillance Reconnaissance (JISR)," *The Journal of the JAPCC* 5 (Spring 2007): 17. C4ISR was the theme of the Journal's fifth edition.

8. Wing Commander Pete York (GBR), "The Psychology of Remote Control Warfare," *The Journal of the JAPCC* 7 (Spring 2008): 51. "During 2007, the United States conducted approximately 250,000 hours of UAS operations in theatres around the globe, a fraction of that expected in years to come."

9. The JAPCC UAS Flight Plan for NATO can be viewed at www.japcc.org on the Projects tab.

10. The aerial refuelling website is available at www.aarclearances.blogspot.com

11. Lieutenant Colonel Ton Pelsner (NLD), "Improving NATO Deployability: The Deployable Airfield Activation Wing," *The Journal of the JAPCC* 1(Spring 2005): 18.

12. Recommended is an article by Lieutenant Colonel John Spaulding, "Airbase Opening in Force Generation," *The Journal of the JAPCC* 4 (Autumn 2006): 26.

13. The JAPCC Air and Space Power Conference opening speech of General Hobbins, past Director JAPCC, and all other presentations and panel discussions are available on the JAPCC website at www.japcc.org on the Events tab.

14. The JAPCC draft paper "Air Power in Irregular Warfare" was released to the JAPCC member nations in the first quarterly report of 2008.

15. "JAPCC Conference 2007," *The Journal of the JAPCC* 7 (Spring 2008): 21. Also, refer to the JAPCC website (Events tab) to read the notes taken during the panel discussions.

16. Registration for the conference can be completed online at www.japcc.org on the Events tab.

17. Current and past editions of the Journal are available online at the JAPCC website www.japcc.org. Hard copies are available on request.

18. Major Tom "Solo" Single, "What is NATO's Position on Space?" *The Journal of the JAPCC* 7 (Spring 2008): 38.

19. Colonel Dan Lewandowski, "Training and Standardisation as Means of Avoiding Fratricide in Close Air Support," *The Journal of the JAPCC* 6 (Autumn 2007): 18.

20. Ibid., Col Lewandowski discusses NATO's effort to improve CAS and FAC training and standardization.

Lieutenant-Colonel Jim Bates joined the Canadian Forces in 1986 as an Air CELE officer. He has served in various appointments at 4 Wing Cold Lake, Director Aerospace Equipment Program Management – Radar and Communications Systems Ottawa, 22 Wing North Bay, CFB Penhold, and CFS Sydney. In 2002, he deployed as the G6 in support of the Canadian Battle Group in Stabilization Force – Bosnia and Herzegovina. LCol Bates is presently a member of the C4ISTAR team at the Joint Air Power Competence Centre in Kalkar, Germany. He will leave that post during APS 2008 to take up the A6 position at 1 Canadian Air Division Headquarters in Winnipeg. LCol Bates is a graduate of the Canadian Forces Command and Staff College in Toronto; he holds a Diploma of Electrical Engineering Technology, a Bachelor of Electrical Engineering and a Master of Business Administration.

CELEBRATING 50 YEARS OF NORAD

By Karen Christiuk

CF Photo Sgt Sylvain Bourget

May 12, 2008 marks the 50th anniversary of the most significant military agreement between Canada and the United States—the North American Aerospace Defense Command—more commonly known throughout the world as "NORAD." Although originally created during the Cold War to defend North America against possible air invasion, NORAD's structure, name and complexity have evolved throughout the years, particularly in response to the 2001 World Trade Centre attacks.

CF Photo by Cpl Steven Bigue

NORAD's mission is to provide aerospace warning and aerospace control for North America through the command center at NORAD-United States Northern Command (USNORTHCOM) in Colorado and three regional headquarters: 1 Canadian Air Division / Canadian NORAD Region (1 Cdn Air Div / CANR) inside 17 Wing (Winnipeg), Alaskan NORAD Region (ANR) inside Elmendorf Air Force Base, and Continental NORAD Region (CONR) inside Tyndall Air Force Base (Florida).

"Through CANR, Canadians play a major role in NORAD," explains Maj Jason Proulx, Assistant Deputy at NORAD-USNORTHCOM Public Affairs. "When you look at a map that shows the NORAD airspace, you will notice that the Canadian region comprises the largest area to cover and protect—nearly 10 million square kilometres. This air coverage is particularly vital in less populated areas such as Canada's vast Arctic."

Although the main NORAD jubilee celebrations take place in Colorado Springs, a Canadian public celebration took place in Winnipeg on May 30th on the south grounds of Manitoba's Legislative Building at 10:00 a.m. The event included a military parade and dramatic flypast by the Snowbirds and CF18 Hornet National Demonstration Teams. In honour of the jubilee, the Snowbirds have "NORAD 50" imprinted on their tails, while the CF18 demonstration team has made the Golden Jubilee one of its themes for the 2008 season.

"Activities surrounding the 50th anniversary of NORAD are designed to remind all Canadians that NORAD plays a vital role to the security of North America," notes Maj Proulx.

"Canadians and Americans work together 24 hours a day, 365 days a year to watch the skies over both countries. We've also recently added a maritime warning mission which is meant to enhance, not replace, the important roles played by other organizations such as the Navy and Coast Guard, by improving information sharing on both sides of the border. Defence is a team effort, and we are proud to be a part of the team."

CF Photo by Capt Steve Neta

Unquestionably, the modern NORAD of today is vastly different from what it looked

CF Photo

like five decades ago. During the early days of the organization, one of Canada's main contributions came in the form of the Distant Early Warning (DEW) Line, a massive engineering marvel of radar stations that stretched across the Arctic and remained in operation for 30 years. Two other radar systems (the Pinetree Line and the Mid-Canada Line) also worked in conjunction with the DEW Line as additional sites for detection. For air defence fighter aircraft, Canada relied on nine Royal Canadian Air Force squadrons headquartered at Air Defence Command in St-Hubert, Quebec.

Today, in addition to the Canadian NORAD Region Headquarters in Winnipeg, NORAD is also supported in Canada by the Canadian Air Defence Sector at 22 Wing North Bay. CANR also maintains CF18 Hornet aircraft on standby at 4 Wing (Cold Lake, Alberta) and 3 Wing (Bagotville, Quebec).

Although its general mission to protect and watch the skies over North America has remained constant for the last 50 years, recent events such as the 2001 attacks on the World Trade Centre have had a significant influence on NORAD. One person who can speak with first-hand knowledge about NORAD's post 9/11 evolution, and the new spotlight on homeland security, is Col Christopher Coates, the current Director of Operations for 1 Cdn Air Div / CANR.

"We've developed procedures and means to look inward to extend our air defence capabilities over the continent," explains Col Coates. "Operationally, our protection used to start at the edge of our continent and we focused outward and tried to keep the threats at a distance. We've now learned to integrate our military air defence with the civilian air traffic control, and so we've developed links with domestic agencies. It's a whole set of capabilities that didn't exist prior to September 11—both personnel and procedures."

Col Coates says that another major outcome of 9/11 has been the implementation of "Operation Noble Eagle" also known in military circles as "O-N-E." The mission of Operation Noble Eagle is to look for potential air threats from within the continent, particularly by civilian aircraft and assist with homeland defence.

"Since 9/11, when there is suspicious activity within our country, we will investigate,

sometimes with fighter aircraft, or by other means."

Furthermore, NORAD has also taken on public responsibly for providing air defence coverage for special events inside North America.

"NORAD has provided aerospace warning and control for recent events such as the North American Leaders' Summit in Montebello, Quebec," says Col Coates. "Working closely with the RCMP and other agencies is critical to providing a safe and secure environment for these special events. Similarly, the 2010 Winter Olympics in Vancouver will be a very important event for us."

With its long and complicated history, and new threats occurring continually throughout the world, it is difficult to imagine what NORAD will look like in the next 50 years. Nonetheless, with the thick backbone of the first five decades behind them, the future of NORAD definitely looks bright for both Canada and the U.S. "The strength of NORAD comes from a team—a bi-national command—it increases the voices of both countries," says Col Coates. "NORAD will continue to evolve to meet the needs of Canada and the US as we face the threats of the future—whatever they may be." More information about the NORAD 50th anniversary celebrations is available at ***www.norad.mil/50*** ■

Karen Christiuk is the communications advisor for 1 Canadian Air Division / Canadian NORAD Region Headquarters.

List of Abbreviations

1 Cdn Air Div	1 Canadian Air Division
ANR	Alaskan NORAD Region
CANR	Canadian NORAD Region
CONR	Continental NORAD Region
DEW	Distant Early Warning
NORAD	North American Aerospace Defense Command
USNORCOM	United States Northern Command
FOL	forward operating location

Photos 1 & 2: In recognition of the jubilee, Canada's CF18 Hornet National Demonstration Team is proud to feature the NORAD 50th Anniversary as one of its themes for the 2008 air show season. These photos were taken on a recent team flight over the Saguenay region in Quebec, Canada.

Photo 3: Canadians and Americans working together inside the Air Operations Centre, 1 Canadian Air Division / Canadian NORAD Region Headquarters (1 Cdn Air Div / CANR HQ) in Winnipeg, Manitoba. Photo by Cpl Steven Bogue.

Photo 4: A CF18 Hornet from 4 Wing Cold Lake flies next to a Russian Tu-95 Bear bomber on September 5, 2007. The Canadian NORAD Region aircraft visually identified and monitored Russian aircraft as they passed through the North American Air Defence Identification Zone (ADIZ) in international airspace. The Russian aircraft were taking part in a publicly announced exercise. All aircraft returned to their bases without incident. DND Photo

The Evolution of

AIR MATERIEL COMMAND

By AIR VICE MARSHAL C. L ANNIS, OBE
Air Officer Commanding, Air Materiel Command

I spent the first 22 years of my RCAF career in a variety of operational and staff appointments far removed from Air Materiel Command or its forbears. The four years I have since passed within AMC itself have been fascinating years of discovery. It is mostly having in mind our RCAF personnel who have never served a tour in AMC that I am composing this article at the request of The Roundel.

Reprinted from Roundel Volume 4, Number 4, May 1962

Air Materiel Command Headquarters, Rockcliffe, Ont.

Expressed in the most modern terms, the role of AMC is to accomplish, with utmost economy, an adequate materiel logistic support of the RCAF's operating and training commands, i.e. of the stations and other units which comprise them. In tabloid form, we in AMC express it as "the right thing in the right place at the right time—with utmost economy".

It is the US Armed Forces who, from the old French term "logistique', have in recent years developed highly for the West both the art of logistics and the meanings the term now generally conveys. One trend is that whereas 'logistics' used to convey also the idea of food and quarters it now tends, unless qualified, to denote material goods and services.

In US practice the four broad fields which are combined to produce a logistics organization are maintenance, supply, transportation and procurement. It has been RCAF practice, so far, to regard transportation as an element of supply; and thus logistics to be the product of grouping maintenance, supply and procurement into a package under one head.

The RCAF, however, has only a limited though essential part to play in procurement. In 1921 there was a technical directorate in the Air Board which conducted air force engineering, supply and procurement. The responsibilities for contracts and purchasing were transferred in 1923 to a director of contracts outside the air force. The only parts of the procurement function which have remained with the RCAF have been provisioning and quality control. Provisioning is the computing, specifying and budgeting for what the procuring agency is to procure; quality control is the inspection and other technical precautions to ensure that the specifications have been met before the materiel is accepted into RCAF inventory and paid for.

Because logistics comprises maintenance, supply and procurement it will be apparent that it is anything but a function exclusive to AMC. Almost every component of the RCAF from AFHQ downwards and outwards is also engaged in some or all elements of logistics. It will be obvious, then, that AMC's role is distinctive not so much because almost its entire pre-occupation is with logistics as that the *portion* of RCAF logistics which AMC performs is distinct.

To generalize, it can be said that what AMC does is too specialized and complex technically for the operating and training commands to do without deflecting them unduly from their main roles; and too much an "operating" function for AFHQ to be involved in without vitiating AFHQ's duty of thinking out and providing policy guidance to the field.

Air Materiel Command was born out of Maintenance Command merely by changing the latter's name. Maintenance Command came into being in 1945 by the creation of a new unit—one eventually to become its largest, namely Maintenance Command Headquarters—through withdrawing from

AFHQ not only the major portion of the detailed responsibilities for maintenance engineering, supply administration, materiel provisioning and direct control of all the specialized logistics units then existing, but also most of the actual personnel who had been performing these functions at AFHQ; and by grouping all the specialized logistics units in the RCAF under the command and control of the MCHQ thus fashioned. It will therefore be obvious that to trace the maturing of the RCAF towards the formation of Maintenance Command, it will be necessary to review both the previous history of the pertinent elements of AFHQ as well as of the types of units which eventually came under the control of MCHQ. Let us first examine the types of units.

The first purely logistics unit of the Air Force in Canada precedes the RCAF. It was an (un-named) Air Stores Park of the Canadian Air Force (CAF) located at Camp Borden about 1921. Little seems to be recorded about it except that it burned down early in 1923. The place where it stood can still be seen in the form of a rather large concrete-paved gap near the north end of the old line of Besserer hangars at Camp Borden.

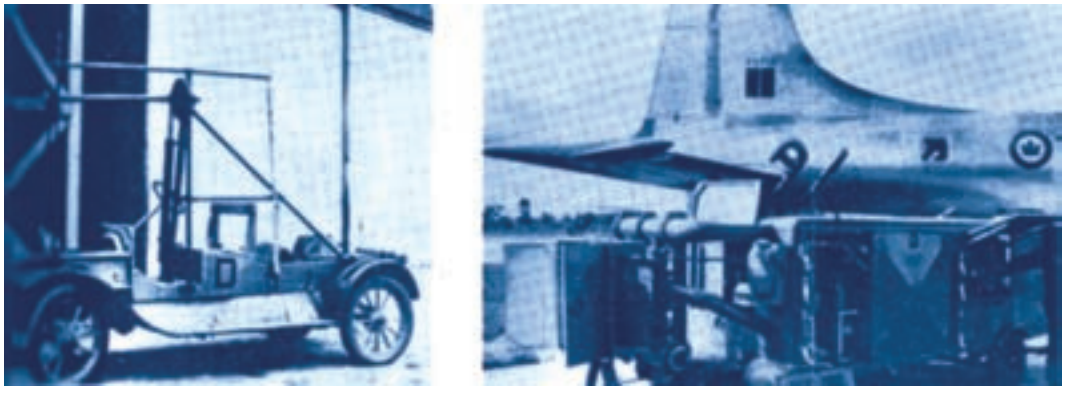
This fire apparently induced the CAF in 1923 to take over from the Department of Public Works a site on Victoria Island in Ottawa, which had been successively a mica factory, carbide plant and boatyard; and there to establish what became the RCAF's No. 1 (Aircraft) Depot.

It is interesting to note that the RCAF's first logistics unit was a Depot; and that it was both a Repair and Supply Depot. Its terms of reference read:

1. Repair all aeronautical equipment which could not be undertaken by other Air Force stations, and,

2. Receipt of technical stores off contract, and issue of same to all Air Force stations. Reference 1, above, is even today a fairly accurate statement of the role (and the relation to the maintenance work done by RCAF stations) of AMC's No. 6 Repair Depot at Trenton and repair contractors. The precise extent of "repair . . . which could not be undertaken by . . . stations" has changed with the years and circumstances, but the *spirit* has remained the same. This is that the main purpose of squadrons and sections on stations is to operate equipments rather than to maintain them. Thus front line or "first line" maintenance is, in principle, confined to such processes as servicing, testing by operating, minor inspections, simple repairs-by-replacements, etc., of the aeroplanes, vehicles, radars, kitchen equipment and so on which they may be operating. The "second line" or station level is more complex, requires more costly and specialized tools, test equipments and personnel, and takes longer. In principle it comprises such things as major inspections, repair-by-replacement of major components, embodiment of moderately complex modification kits, simple repair-by-rebuild and the like. The "third line" or "depot level" maintenance is so complex as to require returning the equipment to AMC for major repair, modification, rebuild, etc; and having it replaced at the station by equipment which is in running condition.

Engine starters—then and now. On the left is a Huck starter at Camp Borden Air Stores Park in 1922. On the right is an Argus starter unit in 1962.



Reference 2, above, is also still a fairly accurate statement of the role of AMC's supply depots, although there have been changes. No. 1 Depot did not receive or stock other than technical spares. The few RCAF stations then existing made demands for their barracks equipment, clothing, motor transport and such on the nearest Army Ordnance Depot. It was not until about 1939 that the RCAF began to stock and issue such equipment through its own provisioning. Another change is that AMC's supply depots issue spare parts not only to RCAF stations but also to repair depots and repair contractors for embodiment into RCAF materiel being repaired. From 1923 to 1936 No. 1 (Aircraft) Depot remained the sole permanent wholly-logistics unit of the RCAF. In 1936 the first supply depot, No 2 (Equipment) Depot, was formed at Winnipeg. In 1937 the first repair depot, No. 3 (Repair) Depot, came into being at Vancouver.

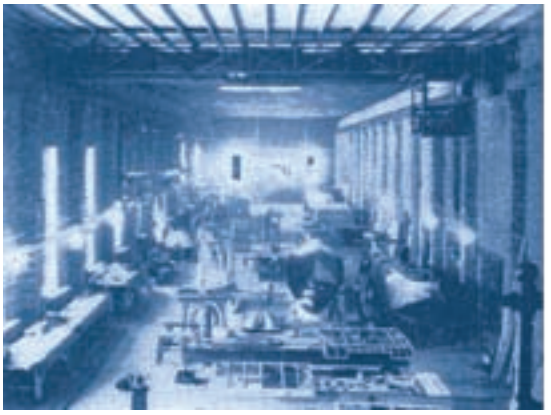
The RCAF's repair contractors are commercial firms, the first of which entered into contract in the early 1920s. Their number grew steadily through the late '20s and the '30s; and since World War II they have displaced all but one of the RCAF's repair depots. The intimate and detailed planning, control and surveillance which AMCHQ must exercise over the RCAF materiel entering and leaving their plants, and over operations within them, is very similar to that applied to AMC's own units. Among the 103 different companies which now have contracts for repairing our materiel are many who have been thus engaged continuously for decades—so long that they have become in many ways a part of the AMC "family of units".

The emergence in growing quantities of companies having production or repair contracts with the RCAF was the cause of bringing into being two additional types of logistics units-to-be in AMC. One was what is now our Materiel Laboratory; the other our Technical Services Units.

Late in 1927 an aeronautical inspection Test House was set up as a separate element of No. 1 (Aircraft) Depot. Its purpose was to preside over the inspection of all military aircraft construction and maintenance with the Test House having a master gauge section and other devices to enable verification of the quality of the materiels and their processings. After a varied history of locations and names it became an element in Maintenance Command in 1945 and a full-fledged unit of AMC in late 1954. The present roles of the Materiel Laboratory are directed more towards assessing the capabilities and performances of the laboratories of companies having production or repair contracts than in the direct sampling of those companies' materiel. Our laboratory also does, or arranges to have done at other specialized government laboratories, "arisings" from within the RCAF itself which require analyses.

By 1938 the amount of production and repair for the RCAF had so grown in volume that it was decided to set up RCAF units in the areas where contractors were most concentrated in order that technically experienced RCAF personnel could assist the contractors in interpreting specifications, report technical progress back to AFHQ, inspect the quality of work as

Repair shops—then and now. On the left, an interior view of No. 1 Aircraft Depot, Victoria Island, in the mid-1920s. On the right, aircraft repair shop at No. 6 RD,Trenton, today.



Launching a Vickers Viking at Montreal on 25 July 1923. Canadian Vickers, Ltd. was one of the first of many civilian firms to handle RCAF repair and overhaul contracts.

At the launching were (1.) F/L (later A/C) A. L. Johnson, RCAF resident inspector; (2) W/C (later A/V/M) E. W. Stedman, RCAF acting director; (3) Mr. Desbartes, deputy minister of national defence; (4) Mr. A. R. Gillham, managing director of Canadian Vickers, Ltd.; (5) S/L (later A/M) G. O. Johnson, RCAF headquarters staff officer; (6) Brig. (later Lt. Gen.) A. L. McNaughton, director of training.

it progressed, safeguard the Crown in RCAF materiel being supplied to the contractor, etc. The first such unit, No. 11 (Technical) Detachment, was formed in Montreal in 1938 and shortly after No. 12 TD was formed in Toronto. During the war this type of unit was re-named "Aeronautical Inspection District" and is now known as "Technical Services Unit".

Until the mid-1930s the RCAF stock of ammunition and bombs was tiny. But the rise of Hitler accelerated the RCAF towards a more military posture. Among other steps it brought into being in 1938 the first RCAF explosives depot, No. 21 (Magazine) 226 Detachment [*sic*]at Kamloops B.C. These depots combined the roles of a repair and a supply depot but, of course, for explosives only.

During the war years four additional kinds of units which still are represented in AMC came into being. The decision to transfer the responsibility for receipt, custody and issue of publications, forms and stationery from DND's Printing and Stationery Branch direct to the RCAF caused No. 1 (Publications and Forms) Store to be formed at Victoria Island in April 1941. Today its descendant, now at Rockcliffe, is called No. 3 (Supply) Depot, even though its role and stock-in-trade are unchanged.

As the volume of aircraft production and repair and opening of new RCAF stations, schools, and repair depots rose so did the need for a unit to conduct the specialized role of ferrying aircraft. Accordingly in January 1942, No. 124 (Ferry) Squadron was formed at Rockcliffe under the direct control of AFHQ. Responsibility for aircraft acceptance and ferry operations was transferred to AMC in January 1949. Our No. 129 (A&F) Unit formed in February 1953 now performs this role.

The huge construction program, much of it in quite remote areas, compelled the RCAF to undertake certain portions itself, using men in uniform. The major role of the Construction and Maintenance Units which grew out of this need was to carry out actual construction or major maintenance where civilian contractors were not practicable; and to administer contracts where they were. The first to become established was No. 9 CMU at Vancouver in July 1942. The only RCAF CMU which remains in AMC today had its name changed just a few weeks ago to No. 1 Construction Engineering Unit to reflect a greater emphasis on engineering.

From the early months of the war onwards the RCAF received increasing amounts of materiel by way of the US Army Air Forces and the US Navy; and by the fifth year it became necessary for AFHQ to provide focal points for close-to-hand liaison with the US agencies concerned. Thus in August 1944 No. 1 (Requirements) Detachment was established at the HQ of the USAAF's Air Services Command—the direct parent of the later USAF AMC, and recently re-named Air Force Logistics Command—near Dayton, Ohio; and a second at the US Navy's Air Stores Depot in Philadelphia. Today they are called Requirements Units.

As World War II drew towards a close the physical management of the vast stocks of materiel which had been accumulated became a major problem. Accordingly Reserve Equipment Holding Units (and satellites) for storing aircraft and vehicles, and Surplus Equipment Holding Units (and satellites) for other materiel were located on many of the flying stations from which aircrew training was withdrawn. There was a peak of 23 such units in 1945/46. The REMUs later became called Storage Sites. There are still five in AMC today: Lethbridge, Alta; Macdonald, Man; and Mountain View, Dunnville and Picton, Ont.

In the late 1940s RCAF activity in the Arctic increased, largely through the mapping and joint weather station programs. Each summer AMCHQ sent a detachment to Montreal to marshal and ship the freight being assembled from various sources for these remote stations. When the RCAF's European Air Division began build-up, the detachment was employed year-round. Therefore, in 1952 No. 1 Materiel Movements Unit was organized in Montreal. In 1955 its name was changed to No, 4 Movements Unit (Materiel).

This completes our quick review of the times and circumstances which brought into being each of the types of field units which are fully organic to present-day AMC.

Let us now look at the origins of Maintenance Command Headquarters. To do so we must delve into the beginnings and growths of the pertinent technical staffs at AFHQ.

As already mentioned, the history of technical staffs in the RCAF began in 1921, with the technical directorate of the Air Board located in Ottawa. This directorate consisted of a technical section and a stores section, and in 1932 was named the directorate of aeronautical engineering, its two components becoming branches. In 1936 a signals section was established with the AE branch of this directorate; in 1937 a works and building section was formed within the supply branch; and in 1938 an armament section within DAE. In November 1938 the directorate gained the new status of division with the title of aeronautical engineering and supply division, and its two directorates became subdivisions. In May 1939 works and buildings also became a directorate and that September the three main components of logistics appeared together, as staff entities for the first time. They were formed with the supply subdivision with the status of directorates and the titles of procurement, equipment administration and equipment maintenance, respectively.

In November 1940 the two subdivisions were each raised to division status and two years later the works and buildings directorate gained the same AFHQ staff rank. By November 1944, in line with the general contraction being applied to the RCAF, the aeronautical engineering, supply and construction engineering divisions were merged, together with the organization division, all as sub-divisions under a single Air Member (AMSO).

At least one each of most of the types of field units which now comprise AMC had been created before or early in the war. Because all of them were controlled directly from AFHQ, their effect was to involve AFHQ's staffs deeply

AIR MATERIEL COMMAND UNITS

Supply Depots
1 SD, RCAF Stn. Downsview, Ont.
3 SD, RCAF Stn. Rockcliffe, Ont.
5 SD, Moncton, N.B.
7 SD, Namao, Alta.

Repair Depots
6 RD, Trenton, Ont.

Stations
RCAF Stn. Rockcliffe, Ont.
RCAF Stn. Lincoln Park, Calgary, Alta.

Requirements Units
1 RqU, Wright Patterson AFB, Dayton, Ohio
2 RqU, Philadelphia, Pa.

Technical Services Units
10 TSU, Calgary, Alta.
11 TSU, Montreal, Que.
12 TSU, Toronto (Weston), Ont.

National Defence Medical Centre, Ottawa.

Materiel Laboratory, Rockcliffe.

No. 11 Technical Services Unit, Montreal, Que., is the oldest logistics unit still existing in the RCAF.

in the detail of technical and supply operations; and thus to generate large staffs. Although administrative control at least of the depots and CMUs was later decentralized to the six air commands, AFHQ was unable to relegate functional control except by forming some appropriate sort of functional command — a step considered too disruptive to be ventured during the mid-war years. But by July 1945 the pressures to form a Maintenance Command Headquarters were intense, partly to help achieve a sizeable reduction in the physical size of AFHQ and partly to help free AFHQ's hands of much detail in the immense task which lay ahead in the transition of materiel management from all-out war and huge, precipitously-assembled inventories of materiel back to a peacetime air force — then planned by the government to be a mere 14,000 in personnel and eight squadrons. AFHQ wished to devote as much of its energies as possible to policies and planning for the post-war period. Intentions in the technical field had taken shape. They were to retain at AFHQ the management of design, development and procurement of major equipment and capital plant and to decentralize to Maintenance Command the provisioning and supplying of technical instructions, spares and other direct and indirect support materiel to the other commands which would enable them to do their own first and second-line maintenance; managing and performing the RCAF's third-line maintenance; inspecting and accepting all contract materiel into the RCAF's inventory; and operating for the RCAF its third-line (or wholesale level) supply system.

To this end first an R&D Division was created at AFHQ in May 1945 from AE elements in the AMSO Division, and preparations were then begun to form MCHQ by extracting and transferring the majority of the remaining technical elements from AMSO. Thus when MCHQ was established its principal functional staffs were maintenance engineering, construction engineering and supply.

Maintenance Command was established to become effective 6 August 1945—the same date the first atomic bomb was dropped on Hiroshima. I think the latter event got a wider notice.

The first day MCHQ officially functioned was on 1 Oct. 45. It had required the intervening period to rehabilitate wartime buildings at Uplands, to make and implement detailed organization establishment and procedural decisions, and to segregate and shift the appropriate elements of the various AFHQ staffs and voluminous records from their longtime AFHQ offices.

Engine test stands—then and now. On the left is a test stand of the early 1920s. On the right an engine is tested on a mobile stand, nicknamed "Oscar", at No. 6 RD, Trenton.

Maintenance Command moved to No. 8 Temporary Building, in downtown Ottawa, on 1 April 1947. Exactly two years later Maintenance Command was re-named Air Materiel Command and, on 1 September 1954, AMC moved to its present location at Rockcliffe. It would appear, therefore, that AMC can rightfully claim to be not only the RCAF's oldest *functional* command continuously extant as such but also the RCAF's oldest command, in original terms of reference.

(In a later issue A/V/M Annis will trace the evolution of AMC's logistics management techniques and examine their future.—Editor.)

No. 7 Supply Depot, Namao, Alta.

List of Abbreviations

A&F	Acceptance and ferry
AFHQ	Air formation headquarters
AMC	Air Material Command
AMCHQ	Air Material Command Headquarters
AMSO	Aircraft Maintenance Support Officer
CAF	Canadian Air Force
DND	Department of National Defence
MCHQ	Maritime coastal headquarters
R&D	Research and development
RCAF	Royal Canadian Air Force
USAAF	United States Army Air Force
USAF AMC	United States Air Force Air Material Command