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THE CANADIAN AIR FORCE JOURNAL

PREMIERE ISSUE!

THE CHALLENGE OF THE AUTOMATED FLIGHT DECK

RETHINKING OUR CURRENT NATO RELATIONSHIP

SUPERMARINE SPITFIRE

VIRTUAL REALITY

DEPLOYMENT SUPPORT CENTRE

BOOK REVIEWS:

UNEXPECTED WAR & FIFTEEN DAYS

UNRESTRICTED WARFARE

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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 orginal 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

EDITOR'S MESSAGE

Welcome to the inaugural edition of **THE CANADIAN AIR FORCE JOURNAL**! I sincerely hope that all members of the Air Force will both enjoy and contribute to this Journal, as it can only benefit our Air Force by active participation. While I know that not every article or book review will have an instant appeal to every member of the Air Force, I can only trust that you will find something of value. I especially encourage comments, counter-viewpoints, or conflicting opinions submitted as Letters to the Editor, which will appear in the second edition of the Journal. In this way, the main purpose of the Journal, namely to provide an open forum for the stimulation of innovative and creative thought, can be realized.

As you can appreciate, the production of The Canadian Air Force Journal is due to the professionalism and talents of many individuals. Firstly, I want to thank our CAS, LGen Watt, for his support and endorsement of this publication. As well, the Commanding Officer of the Aerospace Warfare Centre, Col Jim Cottingham, has been a constant supporter of this venture. I also want to thank the editorial board, as well as all the contributors to this first edition. The Editorial Board was very fortunate to receive more articles than could be published in the first edition, so some of the articles that were received will appear in the next edition. And my most sincere thank you goes to the production staff at CFAWC (Anne Pennington, Françoise Romard, Adri Boodoosingh, Lisa Moulton, Denis Langlois, Luc Leroy and Hope Smith). They assisted with all editing, layout, production details, and distribution.

It is my intention that every edition should have contributions from the past, present, and future aspects of the Air Force. As well, by being a peer reviewed publication, I feel confident that many will want to contribute to this endeavour. In this edition you will find articles on achievements from the past (Spitfire Mk-V), present (4 Wing's Deployment and Support Centre plus Exercise Winged Warrior), and the future (new multi-sensor systems, automated flight deck, and future NATO relationships). Finally, you will also find five books that have been reviewed for your perusal.

Enjoy.

Bill Lewis

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

A MESSAGE FROM THE CAS

It is my pleasure to introduce to the men and women of Canada's Air Force the inaugural edition of our new publication, the *Canadian Air Force Journal*. This publication, albeit with a slightly different mission, can trace its history back to 1942. During the period 1942 to 1945, the RCAF published its official newspaper entitled *Wings Abroad*. This publication was followed by the *Roundel* magazine, which ran from 1948 to 1965. The *RCAF Staff College Journal* was published from 1956 to 1960, followed by the *Air Force College Journal* from 1961 to 1964. These were followed by the publication of the newspaper, *Roundel: Canada's Air Force* from 1993 to 1997. While the focus changed slightly with each publication, nevertheless each was the communication tool of the time.

In his initial message in the *Roundel* in 1948, Air Marshal W.A. Curtis stated his vision for the magazine was "an attempt to overcome the restrictions imposed upon our reading by lack of leisure. Drawing from all possible sources, it will contain such material as the Editorial Committee considers to be of particular interest and value to all ranks and trades of the RCAF." These same time constraints exist today, and I envision the current Air Force journal as one of the key enablers to critical thought and examination on such important topics as Air Force doctrine, training concepts, leadership, lessons learned, and many other areas. I would encourage every member of the Air Force to read each edition, and contribute to the ongoing dialogue.

I congratulate the Canadian Forces Aerospace Warfare Centre for taking the lead in the publication of this new journal. As the engine of change for Air Force transformation, the CFAWC is uniquely suited to such an undertaking.

In closing, I wish the Canadian Air Force Journal the best of luck, and hope that all Air Force personnel will actively support this undertaking in order to make it a permanent and vital part of our Service.

LGen Angus Watt
Chief of the Air Staff

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:
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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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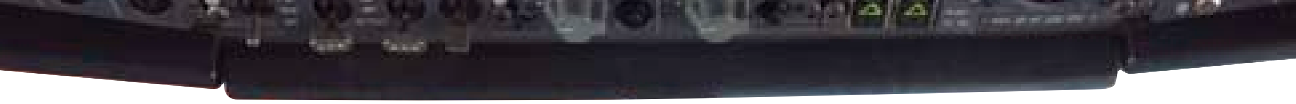

THE CHALLENGE OF THE AUTOMATED FLIGHT DECK

By **Captain Tim Rawlings,** 17 Wing Canadian Forces Air Navigation School

Foreword

The original version of this paper, by Capt Tim Rawlings and (then) Capt Don Barnby, working in Air Force Training and Central Flying School respectively, deserves much of the credit as the catalyst for the Air Force's automation strategy. The Air Division aircraft automation philosophy has now been developed and published, and experienced outside assistance has been engaged and has already started visiting a number selected Wings and units to gain an understanding of our current policies, as well as observe our automation awareness and airmanship. The contractors who have been engaged have done similar work with the United States Marine Corps and United States Coast Guard, and have ensured that those organizations' tactical and operational imperatives have been respected even as they changed themselves to exploit the capabilities of their automated cockpits.

Following the development of appropriate pan-Air Force automation policies and the amendment of our orders, the Air Force's automation strategy will examine type-specific procedures and practices for our specific operations. It is important that the cascading nature of this change strategy be respected to ensure that when new standard operating procedures (SOPs) and checklists are re-published or amended, they reflect and incorporate the overall philosophy and the new orders.

Our Air Force's cascading top-down automation strategy has been described as a world-leading project to synthesize best practices, effective automation procedures, new equipment, an already effective operational culture, and modern crew resource management (CRM). It will involve effort, and it will demand change from all of us; but it will bring us out the other end operating as a safer and more capable Air Force.

Introduction

Automated flight deck technology, on both fixed- and rotary-wing aircraft, has recently been introduced to the Air Force. The training approach and operating philosophies necessary to operate these types of aircraft safely differ from the traditional legacy-pattern aircraft that have until recently dominated the Air Force inventory.

Changing Air Force training and operating practices to incorporate the maximum use of automation within a well-developed set of SOPs that effectively employ automation skill sets and exploit sound CRM practices will not only enhance flight safety, but increase operational effectiveness.

Why Change Is Required

To be sure, the automated flight deck is driving change on many levels. The most obvious and easiest change to witness is how technological advancement has altered the look of the modern flight deck. Gone are the many dial-type trend instruments and electro-mechanical avionics that supplied the pilot with control and performance information. These instruments have been consolidated and integrated into a few flat-panel type computer screens and the information presented to the pilot has increased exponentially. For example, a primary flying display (PFD) can incorporate an artificial horizon, airspeed indicator (ASI), altimeter, heading indicator, turn and slip indicator, vertical speed indicator, angle-of-bank indicator, flight director command bars, a flight-mode annunciator (FMA), as well as approach-track and glide path information for both precision and non-precision approaches. Embedded within the basic information presented on the PFD are all possible warnings, cautions, alerts, and advisories that a pilot will need to know. Examples include traffic alert and collision avoidance system (TCAS) resolution advisories (RAs), wind-shear alerts, radio-altimeter callouts complete with a change in font size below certain altitudes, flight mode changes (for example, to alert the pilot that the altitude capture mode is armed), stall speed depiction, and an up-to-date L/D MAX indicated on the ASI portion of the PFD. It is possible for a PFD-type presentation to have the capability of providing upwards of 250 separate pieces of information to the pilot. To manage and integrate this information in a safe and effective manner within a crew concept in all operational environments, requires training and operational practices to be expanded and re-focussed with emphasis in areas previously unknown (i.e. automation skill set) or poorly understood or employed (i.e. CRM and SOP development).

To date, the Air Force, in conducting the training and operation of multi-crew aircraft (fixed- and rotary-wing), has largely relied on principles developed during WW II. Early military and civilian airplanes had rudimentary flight control and navigation systems. Limited redundancy meant that even a minor problem could create a significant situation. Because of these design shortcomings, when an airborne emergency developed, the aircraft commander was expected to use their experience and skill, which was acquired through time-on-type, to create a knowledge-based solution to address the problem.

The Air Force still employs this knowledge-based approach as evidenced by the lengthy aircraft operating instructions (AOI) components in many of our operational training unit / flight training ground schools. This approach works in a legacy aircraft because these airplanes lack a high degree of information exchange between the aircraft and pilot. In legacy aircraft, aircrew are presented with symptoms that they are expected to synthesize with their extensive AOI knowledge to determine the exact nature of the problem and then produce a solution to recover the aircraft. This fact serves as the philosophical foundation for all legacy-pattern-aircraft training programs and operating methodologies.

However, flight crew in an automated aircraft are overloaded with information and can become distracted to such a degree that flight safety is compromised. The objective for crews operating advanced-technology aircraft is to prioritize the relevant information to effect a safe operation with as little distraction as possible while maximizing the exchange of information between the aircraft and the flight crew so that a shared mental model is developed and maintained. This information exchange is accomplished through a detailed, well-constructed set of SOPs. Modern aircraft internally monitor, assess, and provide solutions to the flight crew. As a result, training and operating methodologies must take on a rule-based method of operation where the analysis process resembles an IF/THEN sequence. Considering the degree of integration in today's flight deck, troubleshooting under a legacy context could exacerbate a problem. Clearly, this is not desirable.

With the modern airplane, understanding and operating the automation in an effective, efficient manner as well as learning and employing the SOPs combine to become the 'new' AOIs.

The Air Force has operated a limited number of automated, integrated technology aircraft platforms such as the CT142 Dash-8, CC144 Challenger, and the CC150 Polaris. As the training on these aircraft is contracted out to civilian agencies, the Air Force, until now, has not had the responsibility to develop and introduce pilot training programs that employ this level of technology. These civilian agencies are continually evolving their training practices to meet operator needs and satisfy regulatory requirements. This means that industry best-practices and lessons-learned are continually implemented. Unfortunately, only the CT142, CC144, and CC150 communities have benefited from this training evolution while the remaining Air Force communities have not had to develop new, more applicable philosophies or modify current training and operating practices because they continue to operate hybrid or legacy-pattern aircraft.

While the Air Force has significant, well respected experience conducting ab initio and post-wings flight training dating back to the British Commonwealth Air Training Plan, this experience falls short when developing and conducting advanced, integrated-technology flight training. Methodologies and philosophies that are effective on analog or legacy-type aircraft are not appropriate in the training and operating of advanced-technology aircraft. In fact, there is ample evidence to indicate that using legacy practices in the automated flight deck is inappropriate and unsafe. The "integration of the human with modern technology in the cockpit remains a significant problem that will continue to appear prominently in accident reports…."[1] Of equal importance is the understanding that with new technology comes the requirement to develop, train, and utilize new skill sets.

What Is Different About the Automated Integrated Flight Deck

The automated, integrated flight deck of today's modern aircraft reduces the crewing requirements to what is commonly referred to as a two-man flight deck. This reference is a

1 Don Spruston, "A Number of Safety Issues Related to Flight Deck Technology Require Our Urgent Attention," ICAO Journal 53(3) (1998): 9-10.

misnomer. By design, the automated aircraft performs as a third crewmember in that the auto-flight technology is so complete that it expertly performs most piloting tasks. As noted earlier, modern aircraft internally monitor, assess, and provide solutions to the flight crew. Out of necessity, the aircraft continually communicates, in discrete fashion, its intentions to the human crew. As a result, the requirement for the human crew to interact with each other, as well as the aircraft, in an efficient, effective manner must be the objective of all advanced-technology aircraft training and operating philosophies and practices. The importance of this requirement cannot be overstated. This interaction is achieved through a well-designed, comprehensive set of SOPs.

Although many advanced-technology aircraft have silent or automatic flight mode changes, the pilot commands the majority of the mode changes. Accordingly, the aircraft only does what it is told to do by the pilot. Needless to say, incomplete or ineffective training can and has resulted in automation surprises at inopportune times. Unfortunately, these surprises have sometimes led to aircraft crashes. Understandably, the maintenance of mode awareness is necessary for the flight crew to operate the aircraft safely in accordance with aircraft operating limitations and air traffic control (ATC) direction. Mode awareness is analogous to situational awareness and the loss of mode awareness can have catastrophic results. For example, the autopilot is considered an automated mode of flight. If training and SOP coverage governing the use of the autopilot is incomplete, there is the potential for the flight crew to become unaware as to the whether or not the autopilot is controlling the airplane. In a situation where the crew becomes distracted (emergency, unplanned manoeuvre or any tactical change) and the mode is active (on), the result could be an internal 'fight' between aircraft and pilot for control of the aircraft if the pilot tries to manually control the aircraft without first disconnecting the autopilot. Recall that the aircraft will do exactly what it is told to do. So if the autopilot is engaged and a situation develops where the pilot tries to manually control the aircraft without turning the autopilot off (i.e. overpower the autopilot), the autopilot will react to maintain the programmed flight parameters. This 'fight' can result in extreme aircraft attitudes resulting in crew disorientation and potential loss of aircraft. A well defined SOP that is trained and properly adhered to will avoid this situation.

Within the context of incomplete training and SOP coverage there is one consideration that must be addressed. That is, how will the autopilot be used? Will its use be mandated at all times, save certain scenarios such as some configuration or engine malfunctions, or will it be used solely at the discretion of the crew? Once this policy is defined the training program can be developed and the SOPs developed to reflect these basic operating policies.

Automated flight decks require a high degree of monitoring by the pilots and unfortunately human beings are poor monitors. Of specific concern with current glass-type aircraft is the requirement for aircrew to monitor the FMA. Monitoring the FMA is crucial because it indicates to the human crew the specific (current and planned) autoflight configuration (mode) of the airplane. Research has classified mode changes into three groups:

- **Manual – those selected by the pilot;**
- **Automatic Expected – automation-initiated mode changes expected by the pilot; and,**
- **Automatic Unexpected – automation-initiated mode changes that are not expected by the pilot.**

While the first two groups are intuitive, the automated unexpected mode change would manifest itself where the automation is commanding a change to the performance of the aircraft (i.e. pilot input is required) yet no change to the aircraft performance occurs. For example, following a take off / go-around (full power) departure, the automation will command a thrust reduction via the FMA at a pre-determined altitude, say 1500' AGL. The command can be annunciated by the font changing colour, the command font blinking, a box forming around the command font or a combination of these annunciations. If the pilot does not reduce the power levers to the appropriate position, their mode awareness would be classified as automatic unexpected. This is not the required terminal behaviour and indicates an insufficient shared-mental-model fidelity between man and machine. Pilots must be aware of these mode transitions and their timing to safely and effectively operate automated aircraft.

Even the traditional "T" pattern of monitoring flight deck indications has changed. Take the PFD–type presentation found on most modern automated aircraft. As specified earlier, the amount of information that can be presented via the PFD to the pilot is staggering. Now multiply that information quantity by six and include the other information panels such as the flight control unit, the flight management system (FMS), and the multi-purpose communication panel and you have a large and very diverse amount of information that must be continually monitored. Monitoring strategies must be developed and trained so that the crew has the tools to effectively monitor the proper information at the appropriate time.

The auto-flight capability of modern aircraft has had a powerful impact on all phases of flight. Specific functions/components within the auto-flight context include the autopilot, flight director, auto-thrust, FMA, flight control unit, and FMS. These systems are fully integrated and can, when engaged, guide the aircraft from a height of 100' on take-off to a full-stop post-landing in adverse weather conditions. While auto-flight capability eases the pilot's active monitoring and physical interaction of flying the aircraft, the technology also increases the pilot workload and requires sound task-management strategies and practices. Traditionally, the enroute/pre-descent phase of flight was a low-workload phase with the largest cognitive effort devoted to timing the top-of-descent point accurately. The approach phase—with navaid tuning, ATC instruction, and flying the approach—was traditionally very busy. With autoflight technology and FMS available, the approach phase now focuses on monitoring duties with the possibility of ATC-directed tactical changes to the planned flightpath in the terminal area. These 'new' crew duties are the result of a purposeful redistribution of task and workload management. Many of the traditional as well as new automation skill-set approach phase tasks such as approach set-up/programming (data entry), approach briefing, approach call-outs, crew communication, automation usage for the approach, as well as landing and go-around considerations have to be re-distributed to the enroute/pre-descent phase in order to ensure a high-level of safety and awareness by the crew during the approach phase. The risk of not recognizing the additional workload and skill sets and the necessity to redistribute these tasks can lead to a loss of mode and situational awareness by the flight crew on approach. The objective is to reduce the cognitive effort required by the crew as much as possible during busy phases of flight (to avoid task saturation), in order to have them ready to effectively handle the inevitable tactical changes or abnormal situations that can occur during a busy phase of flight.

How Do We Adjust

Automated aircraft are relatively new to the Air Force inventory. The good news is automated aircraft have been in use elsewhere. Their associated training programs and operating philosophies have been developed and refined, over the last few decades, in part due to corrective post-accident analysis and research. These same philosophies that guide training and operating practices in industry must be adopted by the Air Force.

The Air Force would be wise to recognize the wealth of experience and adopt the best practices that exist in other aviation organizations. The new automation and crew skills required to manage and exploit aircraft automated systems are generic to all flight operations regardless of the organization or the specific unit mission. By adopting best practices of industry, the Air Force can learn, tailor, and accelerate these training and operating philosophies to meet its specific needs.

The biggest challenge facing the Air Force is in identifying exactly what must be trained, identifying the required resources, and then determining the training methodology.

Recognizing that operating an automated flight deck requires a completely new skill set and understanding that this automation skill set must be trained is crucial. Once the skill sets have been identified, the appropriate training aids must be chosen. The training and operating philosophies that provide the organizational automation guidance must be considered. This consideration is key if the training program to meet its objectives. For example, the design intent of FMS-equipped aircraft, such as the C130J Hercules II, is for the FMS to control the entire operation. This means that the FMS is the main interface for both pilot and aircraft. As a result, FMS knowledge and proficiency must be high and its integration into the operation of the aircraft must be seamless.

Accordingly, FMS training is central to the development and training of the C130J. The question then is one of how to accomplish this training effectively and efficiently. Using a desktop emulator that is identical (in terms of software, tactile interface, and performance) to the FMS found in the aircraft is required. Having a stand-alone FMS trainer, along with a structured FMS training syllabus with defined objectives, allows for focused training and enhances transferability of the FMS skill-sets that will be required in the next level of training.

The follow-on phase of training would integrate the FMS skills into the SOPs in normal and non-normal operations. Again this phase will introduce and train additional automation-skill sets and CRM practices that are embedded into the SOP. Because of the volume of information to learn and the precision required from the SOPs, the actual task of flying the aircraft in this phase of training is not the objective. The objective is to prevent information overload and task saturation of the trainee and maximize the development of basic automation skills. With this objective in mind, it becomes easy to see that a full-flight-simulator (FFS) at this stage is not the preferred training enabler. A fixed-based, fully operational, tactile-accurate part-task-trainer (PTT) or cockpit-procedures-trainer (CPT) will better meet this objective of basic automation skill development.

Only after the trainee has demonstrated the required competence will the FFS phase be introduced. Here, the only new work is integrating what has been learned in the early phases with the task of flying the aircraft. Simulation today is of such high fidelity that all training can and should be conducted using this training resource.

This training program is analogous to the layers of an onion. Take what is central to the operation, train it first then build outward continuing to utilize the desired skills sets as new ones are introduced. This process is layered until the training objective has been achieved.

Automation Philosophy

The first step toward developing, training, and utilizing these automation skill-sets is the creation of a

strategically developed, organizationally supported automation philosophy.

For this philosophy to be effective, pilots experienced in glass cockpit operations must develop it. This prerequisite is essential if the automation philosophy is to lead the Air Force beyond legacy policies and procedures. Once this new automation philosophy is published, it will provide organizational guidance and direction for the training and operation of all advanced technology aircraft in the Air Force inventory.

Although the importance of an Air Force automation philosophy cannot be overstated, this philosophy is really just the beginning of the integration of advanced-technology aircraft into the training and operational environments that the Air Force excels in.

Policies

Air Force policies that govern the operation of our aircraft are communicated through our flying orders, regulations, and standard manoeuvre manuals. In order to ensure that these documents reflect the new reality (in terms of training and operations) that an automation philosophy will deliver, the Air Force requires an integrated approach to ensuring that this transition from legacy to glass is done quickly, efficiently, and above all, safely. Accordingly, this integrated approach should not only include organic resources but also the expertise of an external, appropriately qualified organization. As professionals, Air Force pilots can be justifiable proud of their skill-sets and 'can-do' attitude however, there is ample evidence to prove that legacy organizations cannot complete this legacy-to-glass transition without outside expertise. "One of the most common mistakes…observed, especially for an aircraft whose basic design closely resembles its 'steam' ancestor, is the use of legacy pilots, instructors, managers and evaluators to bring the new aircraft on-board, and to develop the SOPs, training, documentation and checklists both normal and abnormal/emergency. Unintentionally on their part, their culture and legacy background can hinder the proper development of a glass cockpit automation philosophy, SOPs, and checklists. In addition, instructors with a legacy background tend to develop training programs and to teach as they did in legacy aircraft."[2] It is essential then that organizations, such as our Air Force, faced with a legacy-to-glass transition select, as a minimum, individuals who have glass cockpit experience. If the Air Force cannot satisfy this requirement organically, consideration must be given to contracting an external agency to review our documentation, make recommendations on required changes to our operating policies, and assist in the transition.[3]

An example of an automation policy would be the use of the autopilot on approach except when operating visual meteorological conditions (VMC) in low-traffic conditions. Another example of an automation policy is the use of the vertical navigation (VNAV) capability (when provided) for all non-precision approaches.

Once these policies are defined, then procedures and practices can be developed and regulated.

Standard Operating Procedures

SOPs represent the integration of sound CRM / human performance military aviation (HPMA) practices and models with the technical aspects of operating modern automation.

Properly constructed, effective, and efficient SOPs are produced with flight safety, operational capability, and human limitations as the guiding principles. In a two-crew flight deck, duties are divided up along the pilot flying (PF) and pilot monitoring (PM) responsibilities. Appropriately designed SOPs integrate automation to: maximize efficiency and operational capability, enhance crew and aircraft interoperability, provide a high degree of crew monitoring, develop input/output cross-verification, implement operation standardization, and increase crew discipline. The by-products of such a set of SOPs are increased safety and enhanced crew situational awareness. Strict adherence to these SOPs must be enforced.

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2 Christopher J. Lutat et al., "From "Steam to Glass": Essential Elements for Transitioning from Legacy Aircraft Systems to Advanced Technology" (paper presented at the 50th Annual Corporate Aviation Safety Seminar, Orlando, United States, April 26-28, 2005).

3 Ibid.

Effective crew communication is recognized as a critical tool in the successful operation of any flight. Today's flight deck now incorporates the aircraft into this communication loop using verbal, visual, and aural strategies. In addition to human-to-human communication, flight crews must completely understand the methods and meanings by which the aircraft communicates.

Automation use is not a stand-alone tool to be employed discretely when and if the crew desires. Aircraft are designed to use the technology from pre-start to post-shut-down. This means that flight crew must be able to effectively use any and all technology available to meet the challenges posed by the mission or environment. To safely accomplish this requirement, crews must be trained and evaluated in all facets of their respective aircraft's technology.

Ultimately, advanced technology compartmentalizes piloting skill and ability into three elements:

- **the ability to monitor effectively;**
- **the ability to communicate with the aircraft; and**
- **the ability to skilfully operate the available technology in all conditions.**

These elements must be integrated into one guiding operating scheme—a standard operating procedure. An SOP incorporates the elements into a clear, concise, standardized (a crucial attribute), and choreographed interface.

An organization that does not have top-down level support for such initiatives and/or relies on legacy individuals and practices to influence the automation philosophy, SOP development, and implementation process, will fail to meet the fundamental procedural changes necessary to safely and efficiently fly advanced automated aircraft. Holdover legacy flying practices forced onto the automated flight deck will result in unsafe flying situations.

Organizational Behaviour

Within the context of change and change management, understanding organizational behaviour, specifically the resistance to change and strategies to effect the desired change, is crucial to the success of any organization. Technology is one external force that drives change. At the outset of this discussion was the acknowledgement that technology, in terms of automated aircraft, is driving change in the Air Force. The necessity to adapt old training and operating paradigms to meet the challenges posed by modern-day aircraft automation is paramount. Success will come so long as the top command structure is engaged and fully committed to the change process and whole-heartedly endorses the desired goals of the change program.

Perhaps more subtle and insidious is the organizational culture that gives the organization its identity. The Air Force is a 'can-do' organization yet for many years the Air Force has been a 'make-do' organization. While justifiably proud of its accomplishments over the years, the organizational culture that is created can also impede progress. Adapting the Air Force to meet the automation challenge is a long- term commitment. While creative, short-term solutions may initially meet the immediate challenge, the long-term consequences of this approach are often ignored, poorly understood, and create future short-term crisis.

Conclusion

The arrival of additional highly automated aircraft to meet the future operational needs of the Air Force requires a corresponding change from a knowledge-based aircraft training/operating philosophy to a procedural based operating philosophy. The objective of this new operating philosophy is to provide the flight crew with the skill sets required to:

- **effectively and safely manipulate the automation;**
- **communicate with the aircraft; and**
- **vigilantly monitor aircraft automation and its systems.**

These objectives represent the new 'systems knowledge'. Going forward, our training programs must reflect this shift in operating philosophy.

Given that advanced-technology aircraft are designed with the expectation that the automation will be employed to the maximum extent possible, it is necessary that a strong set of SOP's are developed to:

- **provide a safe, effective, efficient, and standardized operational framework for the aircraft and crew;**
- **reflect the philosophy that automation will be used as the baseline operating standard;**
- **embrace the manufacturer's design intent/usage of the automation; and**
- **ensure that, within the bounds of safety and reason, manual-flying skill is preserved.**

The development of an Air Force automation philosophy and the subsequent review and changes to our operating policies will change the way we operate our advanced-technology aircraft. This change is necessary because the aircraft (current and soon to be) in our inventory today do not resemble the legacy aircraft we have flown for so many years. Air Force personnel, in cooperation with an outside consultant, must be tasked to develop new operating practises and SOPs. It will be important that those (within the Air Force) tasked have glass cockpit/automation experience and are ready to challenge our legacy mindsets and practises. Our success with this challenge will be measured in our operational effectiveness, mission accomplishment, and our ability to manage error and risk in our technologically advanced aircraft. ■

List of Abbreviations

		PF	pilot flying
AOI	aircraft operating instruction	PFD	primary flying display
ASI	airspeed indicator	PM	pilot monitoring
CPT	cockpit-procedures-trainer	PTT	part-task-trainer
CRM	crew resource management	RA	aresolution advisory
FFS	full-flight-simulator	SOP	standard operating procedure
FMA	flight-mode annunciator	TCAS	traffic alert and collision avoidance system
FMS	flight management system	VMC	visual meteorological conditions
HPMA	human performance military aviation	VNAV	vertical navigation

Capt Rawlings received his wings in October 1990 and earned his airline transport pilot licence in 1997. He has accumulated over 6,000 hours total time (military and civilian). He has flown the CH136 Kiowa helicopter at 427 and 408 Tactical Helicopter Squadron, and his fixed-wing time includes 2,500 hours on CT114 Tutor at 2 Canadian Forces Flying Training School and 431 (Air Defence) Squadron while 1,800 hours were logged on the Airbus 319/320/321 with Air Canada. Capt Rawlings is currently at 17 Wing Canadian Forces Air Navigation School flying the CT142 Dash-8.

Other achievements and functions held include Deputy Commanding Officer, Flight Commander, Chief Standards Officer, A2 instructional category, and staff officer at Division HQ.

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1 Canadian Air Division Automation Philosophy

Modern aircraft rely on a high level of automation and technical integration to create tactical advantage and achieve operational effectiveness. The acquisition of modern aircraft, and the modernization of legacy aircraft, demands new skills, knowledge, and attitudes to effectively and safely achieve mission success. Adherence to legacy operating practices on highly automated aircraft is ineffective and unsafe.

The employment of aircraft automation must be standardized, disciplined, and fully integrated in all phases of flight. Because the aviator retains authority in determining optimal use of automation, the aviator must be proficient in operating the aircraft in all levels of automation and be fully knowledgeable in the selection of the most appropriate level of automation for the situation.

All Flying Orders, flying training programs, assessment and evaluation criterion, standard operating procedures, briefing guides, checklists, flight manuals, and flying operations shall be in accordance with this automation philosophy.

Note: This Automation Philosophy was published June 22, 2007 by Major-General Bouchard Commander 1 Canadian Air Division.

AN IMPERFECT STORM: AIR FORCE OPERATIONS & MAINTENANCE COSTS TRENDS

By **Major Richard A. Groves (Retired),**
Director of Materiel, IMP Aerospace Group

Lieutenant-Colonel Ross Fetterly,
Director Air Comptrollership and Business Planning 2

The 1980s was a period of significant renewal for the Canadian Air Force that positioned the Canadian Forces Air Command to meet a multitude of responsibilities well into the end of that decade.[1] Current plans to once again modernize the Air Command (AIRCOM) aircraft fleets are even more significant. The Chief of the Air Staff (CAS) has stated that the:

> **Air Force has entered a period of revitalization that is accelerating our transformation into a more effective aerospace force, fully integrated with all components of the Canadian Forces. The recent capability investments announced by the Government of Canada create a remarkable opportunity for enhancing the future of military aerospace power in Canada.[2]**

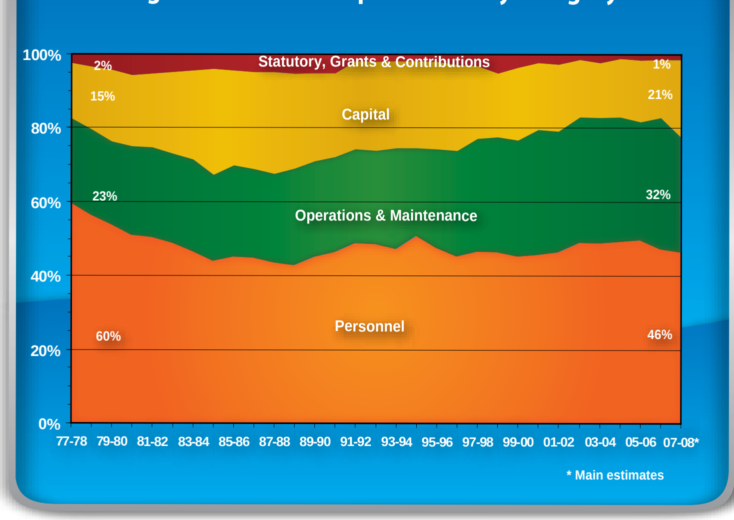
The Canadian Air Force began the transition to the 21st century with procurement of the CH149 Cormorant medium lift transport helicopter, which will be the backbone of the Canadian Forces (CF) rotary wing search and rescue efforts for the foreseeable future. Procurement of four CC177 Globemaster III transport aircraft, the new CC130J Hercules transport aircraft, as well as the acquisition of the new CH148 Cyclone ship-borne maritime helicopter, will greatly enhance AIRCOM capabilities. Further, planned procurement of a heavy-lift helicopter fleet to support the Army will also increase Air Force (AF) capabilities, and provide significant operational improvements to the CF. This considerable re-investment in capital equipment for the AF will also have a substantial impact on infrastructure, personnel, and most significantly Operations and Maintenance (O&M) costs. Of these three distinct categories of expenditure, O&M costs related to this new equipment will likely have the greatest long-term impact on the Air Force.

This paper will examine the influence that O&M costs have on the AF as it shifts to a more modern, capable, and operational posture.[3] The first section will provide an overview of Canadian defence cost trends, followed by an examination of the impacts of modernizing of AF capital equipment. The third section will deal with AF National Procurement (NP) expenditure, while the fourth section will emphasize the combination of pressures that the AF will be confronted with in the coming years. The last section will discuss management of O&M costs over the next several years.

Defence Cost Trends

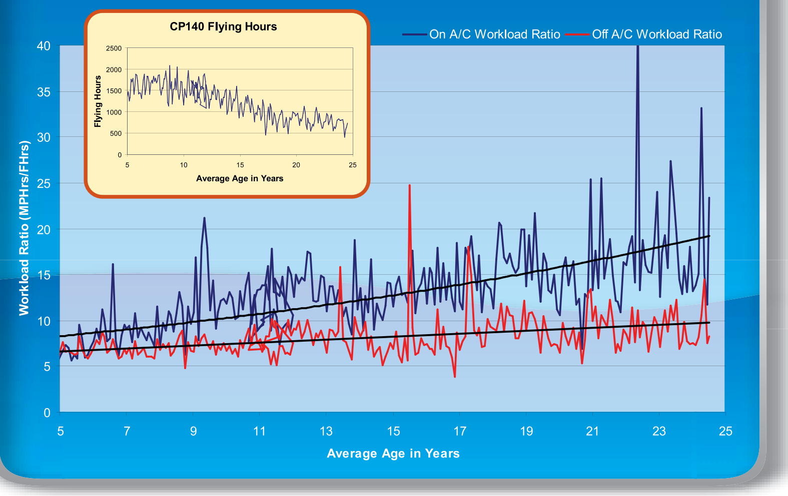
The most distinctive cost trend over the past four decades within the CF and Department of National Defence (DND) has been the persistent growth of O&M expenditures as a percentage of the Defence Services Program (DSP).[4] Figure 1 illustrates this trend from fiscal year (FY) 1977-78 through to 2007-08.[5]

Figure 1 - Defence Expenditures by Category



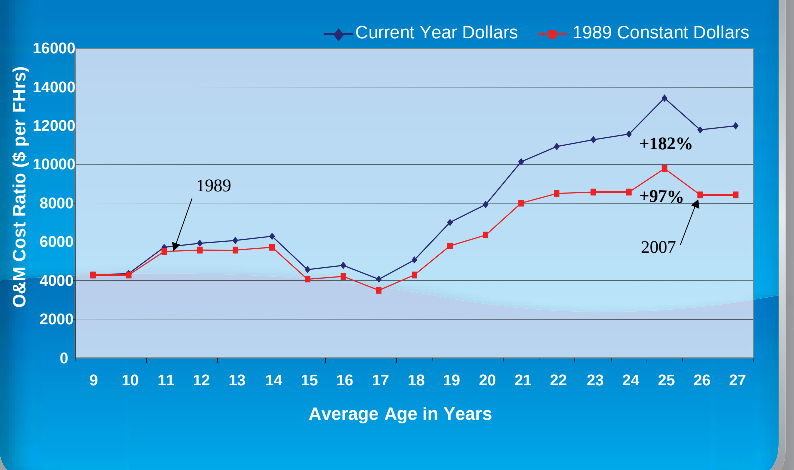
Cost trends for new and existing equipment each have their own distinct characteristics.[6] Weapon system cost trends for new equipment are dominated by the combination of rising unit costs and escalating fixed costs.[7] Operations and Maintenance costs, on the other hand, are impacted by the age of the equipment,[8] as well as their activity rate and operating environment.[9] The United States Congressional Budget Office (CBO) estimates that "spending on O&M for aircraft increases by 1 percent to 3 percent for every additional year of age, after adjusting for inflation."[10] In the case of US military aircraft engine support costs, RAND Corporation reported "annual age-driven growth rates of 4.5 to 5.3 per cent for depot- and base-level engine repairs, respectively."[11] Furthermore, studies on American military aircraft have found that "an additional year of age may increase the time between breakdowns from one per cent to seven per cent and increase downtime from one per cent to nine per cent."[12] Other factors, including spare part shortages due to manufacturers closing obsolete production lines and industry consolidation of repair and overhaul facilities, can also significantly affect O&M costs unexpectedly.[13] Historical DND data on the CP140 Aurora Long Range Patrol Aircraft fleet illustrates the trend noted above in the escalating time required for maintenance for every hour of flight. This ratio increases as the aircraft ages and is illustrated in Figure 2.[14]

Figure 2- Increases in CP140 Workload Ratio with Age



Continuing growth in the annual O&M costs per flying hour for the CP140 Aurora Long Range Patrol Aircraft fleet demonstrates an even more pronounced trend as the aircraft fleet ages,[15] and this is illustrated in Figure 3.[16] Indeed with a CP140 Aurora aircraft fleet that averages approximately 27 years of age, the average workload ratio has increased by nearly 137 per cent between 1985 and 2007, and the average O&M cost ratio has increased by close to 182 per cent in terms of current dollars, and by about 97 per cent in terms of 1989 constant

Figure 3 - Increases in CP140 O&M Cost Ratio with Age



dollars.[17] This observation is in keeping with studies from the Royal Air Force (RAF) where it has been noted that with increasing age comes an increased risk of structural damage, corrosion, and general wear of systems such as utilities, flying controls, and landing gear.[18] For the CP140 Aurora and other aging Canadian Air Force fleets, the challenge then becomes how to reduce or stabilize support costs where maintenance is increasingly dominated by parts obsolescence, fatigue, and a growing proportion of emergent work driven by unforeseen airframe, avionics and engine problems.

Another aspect of the impact of age on aircraft supportability costs is the fact that costs will increase regardless of the airframe or the manner in which the aircraft are operated. Recent research for the United States Air Force (USAF) using commercial aircraft data[19] has shown that "age effects are the same regardless of the airline or the type of aircraft. Different age effects for different types of aircraft are statistically insignificant."[20] This conclusion has important implications for the Canadian Air Force. Whereas this conclusion does not mean that maintenance costs of different aircraft fleets will be identical, it implies that the maintenance costs across fleets will generally expand at a similar rate. The significant inference that can be taken from this RAND study is that notwithstanding how CF aircraft fleets are operated or maintained, they will all suffer similar age-related O&M cost growth.

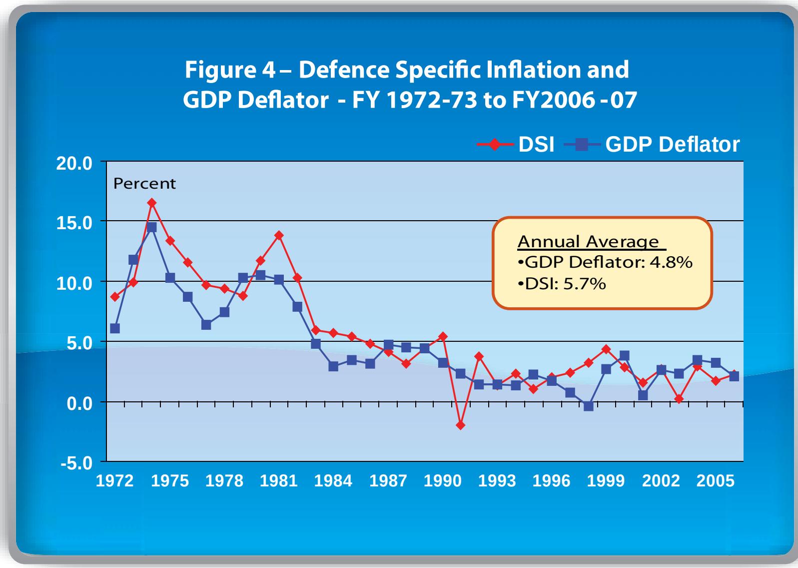


Figure 4 – Defence Specific Inflation and GDP Deflator - FY 1972-73 to FY2006-07

O&M costs in the Canadian Forces are also impacted by factors other than the portfolio of equipment. The particular mix of goods and services in defence[21] can give rise to a defence specific inflation (DSI) that is distinctive from general price increases in the non-military public sector and in the private sector. The significance of DSI is that "even the relatively small differences in inflation rates"[22] can produce considerable cost differences over the long term. This can have a negative effect on the relative purchasing power of defence related goods and services. The problem of DSI is not unique to Canada. Indeed, for "decades the annual cost of a given unit of defence capability in most European countries has been growing considerably faster than the year-on-year inflation figure."[23] Figure 4 illustrates the difference between general inflation in the economy and DSI.[24] Although the two rates have grown closer in recent years, this trend could reverse in the near term, in part, due to the significant current and planned capital expenditure program.

Modernization of Air Force Capital Equipment

The responsibilities of the Canadian Air Force are broad and diverse. Not only is the AF responsible for providing strategic and tactical lift for the CF, it must also provide combat aircraft, airspace surveillance and control, as well as search and rescue operations. These roles include domestic, bi-national through

NORAD, and expeditionary through NATO and the United Nations. Managing AF assets, personnel and operating costs is a complex, iterative process that involves balancing current and future capabilities. In this regard, the Canadian Air Force has already entered a period of dramatic change. This can be framed in the perspective of transitioning from an extended period of "acquisition" that the AF is in now, to the more long-term, upcoming period of "ownership". The budgetary dynamics inherent in the ownership of a broad array of military weapon system fleets is distinct and more complex.[25] Indeed, the portion of the defence budget allocated for the purchase of new or replacement equipment "that goes toward highly visible and well documented major weapon systems allows reasonable analysis – while the rest going toward amorphous 'support' areas is more difficult to analyze."[26]

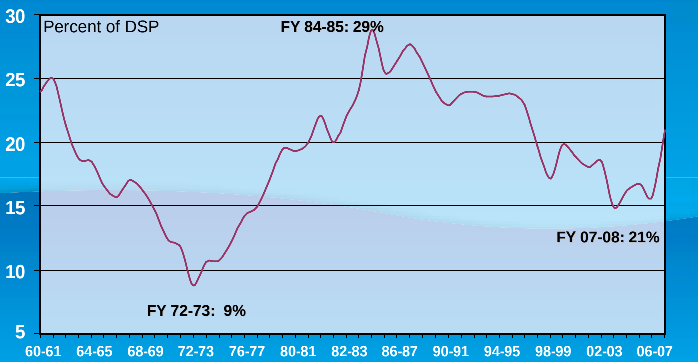
The capability of military forces is derived, to a significant extent, from capital equipment.[27] Multi-million dollar military weapon systems tend to remain in service for decades, with regular system upgrades to improve capabilities. As a result, overall national military stocks are built up over numerous years. Consequently, in the short term, the cost of operating this equipment at certain established readiness levels is relatively uncontrollable (without force structure and posture changes) due to the specific requirement for a certain level of support. Nevertheless, the ability to purchase new equipment is constrained by a number of factors. This includes the availability of capital investment funds, the political will to get new capital acquisition projects approved, the capacity of the department to manage multiple complex capital projects simultaneously, and the ability of the Canadian defence industrial base to respond to the capital equipment requirements of the Canadian Forces.

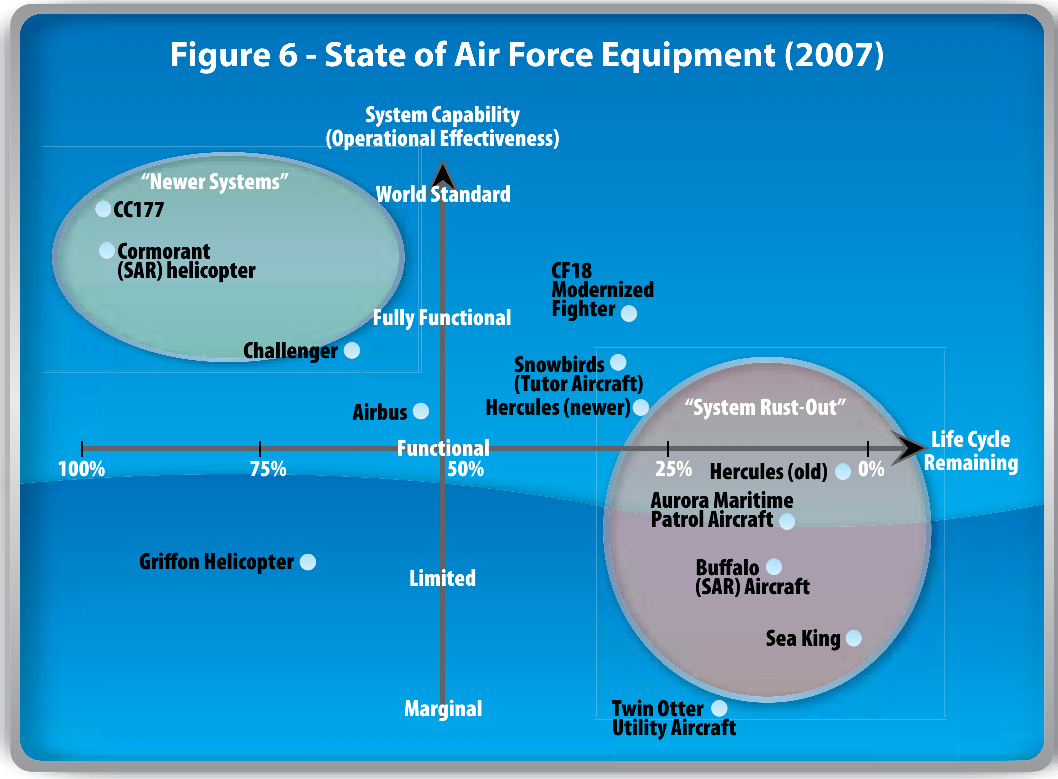
The percentage of the defence budget expended annually on the procurement of new military weapon systems has fluctuated significantly over the past four decades. Figure 5 illustrates this fluctuation.[28] Of particular interest is the impact that this fluctuation in capital spending has on AF O&M costs. This cost relationship in the case of aircraft is summarized succinctly as follows:

Historically, new aircraft and other weapon systems have typically cost two-or-three times more to acquire than the systems they are intended to replace, while operations and support (O&S) activities have experienced consistent and persistent cost growth. Although next-generation aircraft are frequently projected to have lower O&S costs than the aircraft they are intended to replace, such savings have seldom materialized.[29]

Indeed, to a large extent, the capital equipment stock held by Armies, Navies and Air Forces determines the need for O&M funding.[30] O&M costs are a combination of fixed and variable costs, with variable costs shifting in response to activity levels, readiness requirements, age of the equipment and level of technology. In the case of the CF, an internal

Figure 5 - Capital Expenditures In Percent of the Defence Service Program FY 1960-61 – FY 2007-08





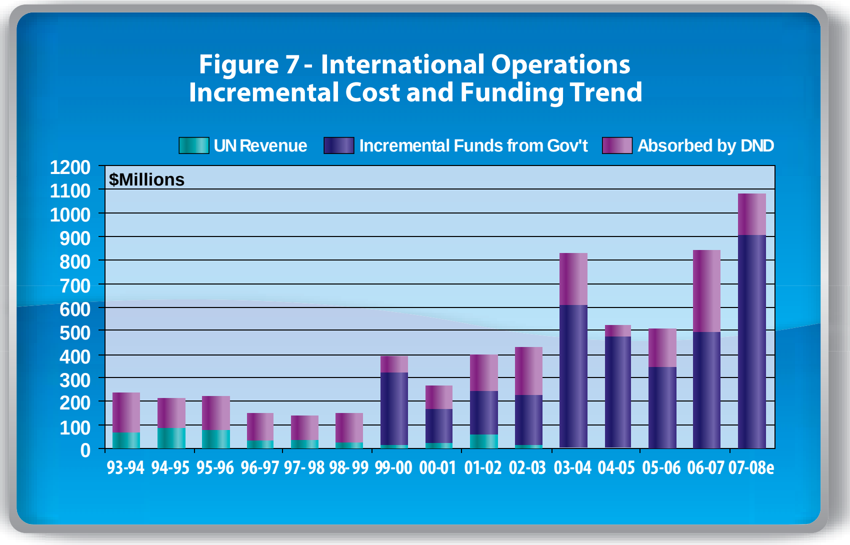
DND study concluded "only 27 per cent of annual national procurement costs for all fleets are variable with respect to activity levels."[31] Moreover, newer aircraft such as the CH149 Cormorant and the CC177 Globemaster III are generating higher in-service support costs that are primarily fixed in nature, putting upward pressure and decreasing flexibility on the AF's O&M budget.

Figure 6 depicts the state of AF aircraft along two qualitative dimensions: system capability (or operational effectiveness) (Y-axis), and per cent life-cycle remaining, typically measured as remaining technical useful life (or airworthiness) (X-axis). The preponderance of AF aircraft have an estimated 30 per cent or less technical life cycle remaining, and are either in the system rust-out phase of their respective life cycles, or about to enter it. It is well documented that aircraft sustainment costs increase over time because of aging (airframe fatigue) and pricing factors (parts or component obsolescence), and these become contributing factors to ever-rising O&M costs.[32] Similarly, the desire to maintain world-class or fully functional operational capability of those aging CF aircraft exacerbates O&M cost growth, while the effects of increasing age act to decrease overall aircraft readiness levels.

An Imperfect Storm

The current acquisition phase will include the introduction of several new or replacement aircraft fleets, in addition to maintaining a number of aging aircraft fleets. A follow-on acquisition program in the subsequent decade will likely include that of the next generation fighter aircraft[33] and Canadian multi-mission aircraft project for long-range maritime surveillance,[34] to complete the renewal of the major aircraft fleets. Likewise, significant upgrading of AF infrastructure will occur in Trenton and Shearwater, together with the combined challenge of maintaining an aging portfolio of AF bases spread out across the country. This will be done while a generational change occurs in AF personnel, as those recruited in the Post-Cold War environment assume positions of increasing responsibility and authority. The background for all these transformations will be an expected continuation of the current intense operational tempo. All these factors will drive demands for increased O&M costs while simultaneously contributing to deteriorating aircraft fleet readiness levels in the near term. This is the essence of the imperfect storm; rising O&M costs (faster than the rate of department budget growth) while simultaneously experiencing declining equipment readiness levels.[35]

The effect of the heightened operational tempo on the DND is illustrated in the growing incremental cost of international deployed operations to the CF as presented in Figure 7.[36] Air Forces have a distinct role in deployed operations.[37] Air power provides commanders with flexibility, responsiveness, and mobility. Consequently, the demand for AF platform employment in future peacekeeping operations will likely increase; further exacerbating an already tenuous ability to meet aerospace demands.



National Procurement – Rising Costs and Lower Readiness Levels

The National Procurement (NP) budget provides the wide variety of support services that allows CF equipment to function while on deployed operations, during training or in support of Canadians during natural disasters. The NP budget is a centralized budget (apportioned amongst the Army, Navy, AF and common/joint environments), managed by specialists, which acquires the materiel and services necessary to support existing equipment or systems that are life-cycle managed centrally. This wide-ranging responsibility includes procurement of spare parts and contracting for such services as maintenance, repair, overhaul contracts, or technical support. The NP budget is the component of O&M funding related to equipment. Figure 8 illustrates the overall NP expenditure trend over the past 19 years.[38]

This figure highlights the recent dramatic growth in demand for NP funding and the significant and growing gap between NP budgets (shown as the initial allocation) and NP demands. In fact, NP demand growth has averaged about three per cent per year since FY 90-91, while funding growth has barely managed to average 1.5 per cent per year over the same period and only since FY 03-04 when large baseline increases in the initial budget allocation started. The figure clearly illustrates that the NP demand/resource mismatch remains a serious concern despite recent large funding injections, and continues to be a recurring theme within the NP budget due to the widening gap between future year NP demand estimates for in-service support costs and available funding. A major contributing factor to this plans/resource mismatch has been the lack of alignment between new capital acquisition (capability replacement or renewal) and the subsequent in-service

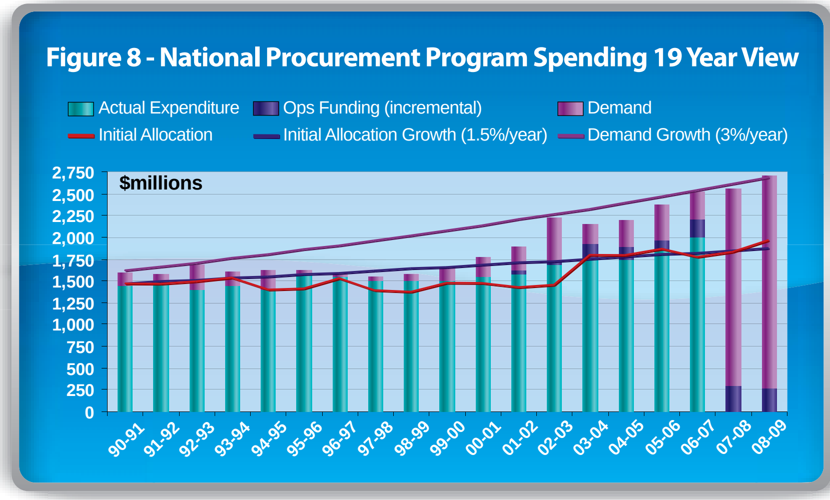


Figure 8 - National Procurement Program Spending 19 Year View

support costs. This can largely be attributed to the limited Total Cost of Ownership (TCO) affordability analysis for new equipment within the department. Within the DND evidence suggests that capital acquisition projects routinely understate their follow-on in-service support costs in an effort to facilitate project approval decisions.[39] One possible cause of this imbalance is the limited historical requirement for the sponsor of a project to demonstrate in-service support affordability during the project review, selection, or approval process. It should be noted, however, that this deficiency is now starting to be recognized in the development of a defence acquisition plan. Nevertheless, the existence of a weak linkage between the capital acquisition approval process and the subsequent determination of annual NP budget reference levels has also compounded this under-estimation bias.

Within the department there is definite lack of rigour in the determination of in-service support (O&M) cost estimates. This is, in part, due to the limited understanding of current cost relationships in new generation weapon systems. For example, future NP costs in procurement decisions are often based on historical averages of existing equipment escalated into the future, which themselves are not independently assessed during the project approval process. The focus within the department's capital acquisition review, selection, and approval process has traditionally been on achieving procurement cost accuracy on a weapon system. Consequently, less effort is devoted to estimating and then assessing the assumptions behind subsequent operating costs, thereby permitting poor long-term O&M estimates to be included in procurement approvals. Further compounding the under-estimation bias: in cases where there is a lack of information on future operating costs when procuring replacement systems, historical NP spending averages or 1:1 ratios are used when describing the in-service support cost portion of the total cost of ownership for a new weapons platform.[40] Table 1 illustrates FY 2006-07 ratios for several AIRCOM aircraft fleets.[41] The financial ratio outlined in the table represents the annual straight-line amortization (or depreciation) expense recorded for the specific AF asset class compared with the associated annual NP spending for spares and repairs.

A higher ratio (greater than 1:1) indicates a situation where annual NP-funded maintenance costs exceed the annual amortization rate. If such ratios were calculated annually and tracked over time for each AF platform, they could provide a useful life-cycle cost benchmark from which to better determine when to commence capital investment to modernize, replace or continue to repair. Also, this provides a benchmark from which to develop a more fact-based life-cycle costing/estimating relationship. Table 1 shows that two of the oldest AF fleets, the CP140 Aurora and the CC130 Hercules, exhibit the highest ratio which is indicative of the increasing NP costs associated with aging aircraft assets. Meanwhile, one of the newest AF fleets, the CH149 Cormorant, exhibits a ratio of almost 2 times the annual NP costs to the corresponding annual amortization expense. This suggests that newer, more sophisticated aircraft are, contrary to conventional wisdom, not less, but more expensive to maintain than some of the older aircraft.

Weapon System / Platform

FY06-07 Actual Ratio of Annual Amortization Expense to Annual NP Spending

CP140 Aurora	1: 3.02
CF188 Hornet	1: 1.09
CH148 Griffon	1: 0.78
CH149 Cormorant	1: 1.8
CC130 Hercules (E/H Models)	1: 3.43

Table 1 - Ratios of Annual Amortization Expense to NP Spending

Managing the Imperfect Storm

This article has emphasized the growth in both workload and budgetary demands as military aircraft age. It must also be emphasized, however, that "maintenance requires both human and material capital, which must be acquired and trained, to develop the maintenance capacity needed for those growing workloads."[42] Collectively the trends outlined in this paper have the potential to create a reinforcing dynamic that generates the optimal conditions in the AF for NP costs to grow at a rate faster than the NP budget, while simultaneously contributing to deteriorating equipment readiness. As a consequence, future relevant and credible forces could be placed at risk unless either baseline NP funding increases or the deliberate re-prioritization and targeted re-allocation of NP spending occurs. In particular, it is the NP component of the O&M budget that is exhibiting the most visible manifestation of the imperfect storm (rising costs and declining equipment readiness), and consequently where the most urgent O&M funding pressure exists. This pressure was recently recognized and NP funding for aircraft fleets was increased in-year by $45 million in FY 2007-08.

To address the observations and orresponding unrelenting NP cost growth within the CF, and in particular the AF, the following near-term management actions should be considered. This includes more in-depth analysis of potential O&M costs and enhanced management of existing resources.

Of primary importance is ensuring that the total cost of ownership of equipment and infrastructure is the focus of AF and Material Group planners. The total cost of ownership (TCO) approach is needed in order to illustrate the full cost of acquiring and operating a weapon system.[43] Together with the CAS, Assistant Deputy Minister (Material) (ADM [Mat]) financial planners must be engaged by the Vice Chief of the Defence Staff (VCDS) and Assistant Deputy Minister (Finance and Corporate Services) (ADM [Fin CS]) staff in the preparation of project submissions to central agencies, such as the Treasury Board of Canada Secretariat (TBS), to corporately validate NP cost estimates as well as to review and validate all assumptions. In addition, more appropriate ratio measures for preliminary NP estimates of equipment during the procurement process need to be developed. As an interim measure, for new equipment, annual amortization expense to annual NP spending ratios could include a range of 1:1.5 – 1:3.0 for complex weapons platforms (aircraft, ships with large amounts of embedded software), 1:1 – 1:2 for land combat (direct, indirect fire) systems and 1:0.5 – 1:1.0 for land non-combat vehicles. Further research could estimate annual costs over the life cycle of the equipment for greater precision of estimates. Defence economic literature on weapon system cost growth should be utilized to negotiate with central agencies to obtain an increase to the departmental inflation compensation rate specifically for the NP program. A commitment to a consistent baseline and subsequent moderate funding growth in NP will be crucial to stabilizing the NP program and thus making in-roads to resolving equipment sustainability pressures.

The departmental project approval/ management process needs to be reformed to incorporate comprehensive costing analysis and screening over the estimated life of the equipment/system. Such independence could be achieved by moving away from the current process of project cost validation during specific project milestones, to mandating and resourcing the Director Strategic Finance and Costing (DSFC) within ADM (Fin CS) to conduct project costings concurrently. This would be accomplished by working closely with project staffs as a source of independent advice and recommendations.

New or replacement systems must specify how their future NP requirements will be met, either through increased NP funding, or through re-allocation from lower priority in-service systems which may be phased out or reduced. Similarly, modernized systems need to specify if the projected NP requirements will be the same, less than, or greater than the current level of expenditures, and seek increased NP funding requirements through offsets or increased funding levels. Furthermore, efforts need to be made to develop greater understanding of in-service support cost behaviour of existing weapon systems/platforms and relate those costs to equipment readiness measures. From this research should flow strategic performance indicators that combine both financial and non-financial parameters on equipment life cycle management with predicates to guide the department in making replace, repair, or modernize decisions.

Affordability is also an issue; in the event that a project is deemed to be unaffordable within current or projected NP reference levels, actions must be taken to either modify the project requirements to ensure NP affordability, defer/delay the project until NP funds are available, obtain an increase in reference levels, or terminate the initiation of the project. In addition, departmental project approval/management policy manuals must adopt a life cycle management perspective, and require projects to account for and diligently report potential increases or fluctuations in NP expenditures over the estimated system useful life as a result of equipment aging, technology insertion or system obsolescence.

The trend towards increased contractor support for more technologically complex weapon systems must be addressed with an affordability strategy to ensure any potential personnel/infrastructure/operating savings are corporately reallocated, where appropriate, to cover higher expected NP costs. Finally, it may be unreasonable to expect projects to deliver substantive NP cost estimates at the departmental Effective Project Approval (EPA) stage of a capital project. Therefore, a revised project approval/ management policy is needed, where in-service life cycle cost estimates at the departmental EPA stage are presented by the project within a range for a given level of confidence. The cost estimates would be updated at each subsequent departmental Senior Review Board (SRB) meeting. The aim would be to produce substantive NP cost estimates by the initial operational capability (IOC) of the project in order to ensure appropriate levels of NP funding are in place by full operational capability (FOC).

DND should seriously consider strengthening the ongoing management of in-service support costs through the implementation of a more rigorous methodology for estimating, tracking, and reporting actual equipment operating costs over the equipment's life cycle.

In addition to the above, DND should seriously consider strengthening the ongoing management of in-service support costs through the implementation of a more rigorous methodology for estimating, tracking, and reporting actual equipment operating costs over the equipment's life cycle. The departmental champion for this reinvigorated life cycle costing process, and the one who should subsequently embed such rigour into DND's investment planning and project management business processes, should be the VCDS, with integral support of ADM (Mat) and ADM (Fin CS). By incorporating the requirement for both the users and maintainers of equipment to critically analyze and report such data, the department would, for the first time in recent memory, be adopting a fact-based approach to capital equipment management where economic, along with operational and technical criteria are considered when decisions to modernize, repair, or replace are taken.

Conclusion

The Canadian Air Force is transforming into a more modern, capable and effective organization. The current capital equipment procurement plan will establish the AF as a key resource of the CF for the upcoming decades. This will necessitate the shift in attention from acquiring and integrating new aircraft fleets into service, to managing, operating, and maintenance costs of those fleets. That will be a key challenge for AF leaders starting in the next decade.

To begin to address the issue of consistently poor in-service support cost estimates, ADM (Mat), with the support of Director General Operational Research (DGOR), recently established a dedicated team to perform acquisition costing analytical support to major capital equipment projects. While the use of this team's expertise is not yet mandated, they have started to provide value-added in-service support costing analysis to several projects, such as the CC177 Globemaster III. In addition, the National Procurement Oversight Committee (NPOC) is taking steps to address the lack of alignment between NP funding levels and the mitigated or executable NP demand. They are doing so by gaining department acceptance to program sizeable increases in the baseline NP funding levels starting in FY 2008-09. NP is a critical component of the Defence budget. Sustainability of the Defence budget will be reliant, to a significant extent, on the ability of matching funding growth to cost growth. With a large, complex equipment portfolio, combined with minimal in-house repair and overhaul capability, the AF is arguably more reliant on a stable, predictable NP funding model geared to compensating the AF for executable NP demand growth that is able to accurately reflect growth in executable demand. ■

List of Abbreviations

ADM	Assistant Deputy Minister	DSI	defence specific inflation
AF	Air Force	EPA	Effective Project Approval
AIRCOM	Air Command	FY	fiscal year
CAS	Chief of the Air Staff	NP	National Procurement
CBO	Congressional Budget Office	O&M	Operations and Maintenance
CF	Canadian Forces	TCO	Total Cost of Ownership
DSFC	Director Strategic Finance and Costing	USAF	United States Air Force
		VCDS	Vice Chief of the Defence Staff

Endnotes

1 Leading this renewal was procurement of a fleet of new CF188 Hornet aircraft, as well as a fleet of CP140 Aurora long-range patrol aircraft.

2 Director General Air Force Development. Air Force Strategy: The Flight plan for Canadian Forces' Aerospace Power (draft) (Ottawa: Director General Air Force Development, 2007), iv.

3 This paper does not address personnel or capital issues. For a detailed analysis of changes to the management of capital assets see: Fetterly, Ross and Richard Groves) Claxton Papers #9 – Accrual Accounting and Budgeting in Defence (Kingston: Queen's University School of Policy Studies, 2008).

4 The Defence Services Program is defined as departmentally approved activities and projects in fulfilment of government policy.

5 This chart was produced by the Economics section in the Directorate of Strategic Finance and Costing (DSFC) at National Defence Headquarters, using DND financial information.

6 This paper provides a number of statistics in respect to United States military aircraft operating costs, as well as decreases in the time between breakdowns and increases in down time. Note that there can be differences in national usage and maintenance regimes, and that could result in a variation between Canadian and American statistics.

7 Kirkpatrick, David L.I. "Trends in the Costs of Weapon Systems and the Consequences" in Defence and Peace Economics 15:3:259.293 (2004): 259.

8 Keating, Edward G. and Matthew Dixon. Investigating Optimal Replacement of Aging Air Force Systems (Santa Monica: RAND, 2003). http://www.rand.org/pubs/monograph_reports/2005/MR1763.pdf accessed 12 April 2007, and CBO, The Effects of Aging on the Costs of Operating and Maintaining Military Equipment (Washington: Congressional Budget Office, 2001) http://www.cbo.gov/ftpdocs/29xx/doc2982/AgingCostsO&M.pdf accessed 12 April 2007.

9 Korb, Lawrence J., Max A. Bergmann and Loren B. Thompson. Marine Corps Equipment After Iraq (Arlington: Center for American Progress, Washington and Lexington Institute, 2006). http://www.americanprogress.org/issues/2006/08/marine_equipment.pdf accessed 12 April 2007.

10 Congressional Budget Office. The Effects of Aging on the Costs of Operating and Maintaining Military Equipment (Washington: Congressional Budget Office, 2001), 21-22. http://www.cbo.gov/ftpdocs/29xx/doc2982/AgingCostsO&M.pdf accessed 11 November 2007.

11 Greenfield, Victoria A. and David M. Persselin. An Economic Framework for Evaluating Military Aircraft Replacement (Santa Monica: RAND, 2002), 3. http://www.rand.org/pubs/monograph_reports/2005/MR1489.pdf accessed 11 November 2007.

12 Congressional Budget Office. The Effects of Aging on the Costs of Operating and Maintaining Military Equipment (Washington: Congressional Budget Office, 2001), 26. http://www.cbo.gov/ftpdocs/29xx/doc2982/AgingCostsO&M.pdf accessed 11 November 2007.

13 A summary of research and literature on aging aircraft issues can be found in Chapter Two of a RAND publication by Dixon in Dixon, Matthew: The Costs of Aging Aircraft: Insights from Commercial Aviation (RAND, Santa Monica, 2005). http://www.rand.org/pubs/rgs_dissertations/2005/RAND_RGSD194.pdf accessed 12 November 2007.

14 DND CP140 AEPM: Performa (Assistant Deputy Minister (Material), Ottawa, 2007). On-A/C means that the work is carried out on the aircraft itself, and therefore the aircraft is not available during that time. Off-A/C means that the aircraft itself was not being worked on and therefore the work should not have directly affected the availability.

15 Note that a portion of the increasing maintenance hours, and declining availability, may be attributable to the aircraft modernization program that has been undertaken since 2001.

16 The hourly cost of the CP140 flying hours were obtained from the annual DND Cost Factors Manual, and include Petrol, oils & Lubricants (P, O & L), engineering services, Repair and Overhaul (R&O) and spare parts.

17 The CP140 Aurora aircraft is analyzed in more detail in, Desmier, P.E. and A. Sokri An Economic Evaluation for CP140 Aircraft Replacement (Ottawa: Defence R&D Canada, 2007). The objective of the study is to identify the optimal replacement strategy for a fleet of aircraft, holding technology constant.

18 Dye, Peter J. "Maintenance Support Strategies", 2002 Logistics Challenges: Issues and Strategy for Today's Air Force, (Air Force Logistics Management Agency, Maxwell AFB, 2002), 33-52. http://www.aflma.hq.af.mil/lgj/Log_challenges.pdf accessed 12 January 2008.

19 Note that the commercial aviation industry tends to replace their aircraft by the 20-year point. The average age of both Canadian and American military aircraft fleets exceeds 20 years.

20 Dixon, Matthew. The Costs of Aging Aircraft: Insights from Commercial Aviation (Santa Monica: RAND, 2005). http://www.rand.org/pubs/rgs_dissertations/2005/RAND_RGSD194.pdf accessed 23 November 2007.

21 Solomon, Binyam "Defence Specific Inflation: A Canadian Perspective" Defence and Peace Economics 14:1:19-36. (2003).

22 Fordham, Benjamin O. "The Political and Economic Sources of Inflation in the American Military Budget" Journal of Conflict Resolution 47:5:574-593. (2003). 576.

23 Alexander, Michael and Timothy Garden "The arithmetic of defence policy" International Affairs 77:3:509-529. (2001): 510.

24 The Economics section in the Directorate of Strategic Finance and Costing (DSFC), at National Defence Headquarters, produced this chart. The sources of information were the DND Historical Economic Model and the GDP Deflator from Statistics Canada.

25 Ownership costs include Operations & Maintenance costs of the equipment, as well as the military personnel required to operate and maintain that equipment.

26 Clark, Rolf "Defense Budget Instability and Weapon System Acquisition," Public Budgeting & Finance 7, Summer, 24-36. (1987): 25.

27 For more detail see Hildebrandt, Gregory G. The Economics of Military Capital (Santa Monica: RAND, 1980).

28 The Economics section in the Directorate of Strategic Finance and Costing (DSFC) at National Defence Headquarters, using DND financial information, produced this chart.

29 Kosiak, Steven. Matching Resources with Requirements: Options for Modernizing the US Air Force (Washington: Center for Strategic and Budgetary Assessments, 2004), 2. http://www.csbaonline.org/4Publications/PubLibrary/R.20040801.AirForceMods/R.20040801.AirForceMods.pdf accessed 12 November 2007.

30 Congressional Budget Office Operation and Support Costs for the Department of Defense (Washington: United States Congressional Budget Office, 1988), xiv. http://www.cbo.gov/ftpdocs/55xx/doc5542/doc03b-Entire.pdf accessed 9 November 2007.

31 DND National Procurement: Assessment Study (Ottawa: Chief Review Services, 2003), 34. http://www.dnd.ca/crs/pdfs/npas_e.pdf accessed 10 November 2007.

32 For example, early model United States Air Force F-15 aircraft have recently been grounded a number of times due to age related problems. See Harrington, Caitlin, "F-15 Eagles grounded for third time in five weeks," Jane's Defence Weekly 44:50:7 (12 December 2007).

33 Granatstein, J.L., Gordon Smith and Denis Stairs. A Threatened Future: Canada's Future Strategic Environment and its Security Implications (Calgary: Canadian Defence & Foreign Affairs Institute, 2007). http://www.cdfai.org/PDF/FSE2007.pdf accessed 12 January 2008.

34 DND. "Significant Equipment Investments Help Prepare Future Navy" Canadian Navy Strategic Issues (2008). http://www.navy.dnd.ca/cms_strat/strat-issues_e.asp?id=620 accessed 12 January 2008.

35 This phenomenon was first articulated by Dr Jacques S. Gansler, Under Secretary of Defense for Acquisition, Technology and Logistics from November 1997 until January 2001. Dr Gansler defined the Death Spiral as a pattern of deferring modernization, retaining and supporting obsolete systems and the facilities to support them, as well as shifting scarce procurement resources to operations in support of existing systems. He pointed out that such a pattern of defence spending must be reversed or it would bring Fiscal Death to the US DoD. The increasing O&M costs for aging equipment, along with increased operations tempo, causes us to rob from modernization to feed current O&M needs. This delays or stretches modernization and reduces the quantities that can be purchased by making it more expensive. This causes further delays in fielding new weapons systems, causing older equipment to remain in use, costing more to maintain, stealing from modernization and continuing the cycle.

36 DND. International Operations – Incremental Cost and Funding Trend (Ottawa: Director Strategic Finance and Costing, 2007).

37 This is derived from the broad spectrum of capabilities that air assets can bring to a theatre of operations. Specifically, airlift can support international operations on both a strategic and tactical basis throughout the deployment, sustainment and redeployment phases. Air assets can also directly support specific deployed land or naval operations. For more detailed information, see: Fetterly, Ross. "The Cost of Peacekeeping: Canada," Economics of Peace and Security Journal 1:2:47-53. (2006). http://www.epsjournal.org.uk/pdfs/eps_v1n2_fetterly.pdf accessed 10 January 2008.

38 This chart was produced by the Comptroller Branch within the Assistant Deputy Minister (Material) at National Defence Headquarters, using DND financial information (note that this slide does not provide the actual expenditure for fiscal year 2007-08 as final expenditures are not yet complete).

39 In this regard, the under-estimation bias of DND is similar to the United States Department of Defense and other Western defence departments. See for example: (2007) Long-Term Implications of Current Defense Plans: Summary Update for Fiscal Year 2008 (Congressional Budget Office, Washington). http://www.cbo.gov/ftpdocs/88xx/doc8844/12-13-LT-Defense.pdf accessed 12 January 2008.

40 For example, a 1 to 1 ratio equals an annual ownership cost over the 20-year life of an asset equals $400 million annually comprised of $200 million annual amortization, or depreciation expense, and $200M annual in-service support costs.

41 This table was produced by the Comptroller Branch within the Assistant Deputy Minister (Material) at National Defence Headquarters, using DND financial information.

42 Pyles, Raymond A. Aging Aircraft: USAF Workload and Material Consumption Lifecycle Patterns (Santa Monica: RAND, 2003), xix. http://www.rand.org/pubs/monograph_reports/2005/MR1641.sum.pdf accessed 23 November 2007.

43 In DND the Total Cost of Ownership (TCO) is defined as the sum of all costs associated with the research, development, procurement, personnel, training, operation, logistical support and disposal of an individual CF asset. This cost includes

the total supporting infrastructure that plans, executes and manages that asset's programs over its full life, as well as the cost of requirements for common support items and systems that are incurred because of introducing that asset into the CF. The TCO is made up of the following cost elements:

a. All Life Cycle Costs (which comprise all Personnel, Operations and Maintenance, All Direct Research and Development, and All Direct System Acquisition costs) plus;

b. Common Support System Costs;

c. Linked Indirect Costs (e.g. Overhead, Facilities used by more than one equipment system);

d. Less residual values of equipment systems once disposed of.

(DND. Materiel Acquisition and Support (MA&S) Concept of Operations Life Cycle Costing V.1.3.1, 7 October 2003).

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MEASURES OF EFFECTIVENESS FOR SEARCH & RESCUE:

Airborne Integrated Multi-sensor System

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Recent developments in sensing technology show great promise in an increasing number of airborne applications. The Advanced Integrated Multi-sensing Surveillance (AIMS) system is an example of a sensing system being investigated by the Canadian Air Force for application in domestic terrestrial and maritime Search and Rescue (SAR). The USN/CF joint multi-mission electro-optic system (JMMES) joint capability technology demonstration (JCTD) is another advanced multi-sensor system intended for SAR and other intelligence, surveillance & reconnaissance (ISR) missions, and is particularly relevant to UASs (unmanned aircraft systems). However, before any significant acquisition investment can be made in a particular sensing technology, it must be shown that the advanced sensor technology substantially enhances overall system operational effectiveness relative to current systems and procedures; the new system's operational effectiveness must be rigorously evaluated. This paper describes the approach taken to evaluate the AIMS multi-sensing system through the development of criteria which includes measures of effectiveness (MOEs) that are meaningful, quantifiable, and objectively measurable for SAR.

Introduction

In the 20th century, one of the first multi-sensor platforms was equipped with side-looking airborne radar (SLAR), an infrared scanner, radiometers, and aerial cameras, which were mounted on a modified B-25 "Mitchell"[1]. Nowadays, surveillance systems are equipped with more advanced technology. As an example, the advanced integrated multi-sensing surveillance (AIMS) system is a fully integrated multi-sensor system in an airborne stabilized platform and includes an active imager integrated with thermal imaging and visible colour cameras, a geo-referencing system to precisely locate targets on the ground and an advanced operator work-station. This system will extend CF capability to conduct diverse missions around the clock and in adverse weather conditions. It will also optimize the detection and identification of small objects[2] and improve the effectiveness of current airborne search vehicles by increasing surveillance and reconnaissance capabilities.[3] Along the same line of thinking, the joint multi-mission electro-optic system (JMMES) is a "tactical electro-optical, passive, sensor suite comprised of several spectral sensors with tailored software and mission-specific algorithms" including those related to SAR, "in a 15-inch turret" and is particularly relevant to UASs (unmanned aircraft systems).[4]

The main body of this paper aims to present the evaluation criteria developed to assess the utility for Canadian Forces to use advanced air-borne integrated multi-sensor imaging systems for SAR missions. As an example, this paper describes an approach to evaluate the AIMS multi-sensing system through the development of measures of effectiveness (MOEs) that are meaningful, quantifiable, and objectively measurable for SAR applications and through the development of other evaluation criteria.[5] Finally, the MOEs are summarized and a brief conclusion is provided. The approach and the criteria introduced in this paper could be further used to evaluate the SAR capability of other airborne sensing systems, such as the JMMES system.

EVALUATION CRITERIA

In this paper, the effectiveness of the system is represented by a combination of the effectiveness of the sensor suite and the effectiveness of the operator. However, some evaluation criteria cannot be decomposed below the system level. Therefore, the author summarizes the evaluation criteria required to demonstrate the effectiveness for each component of the system and for the combination of these components. This concept is shown in Figure 1.

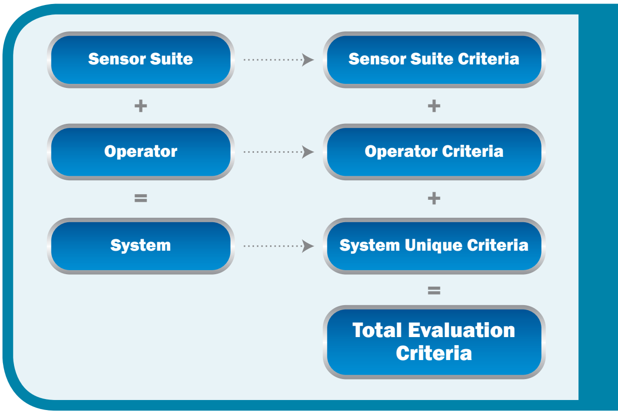

Figure 1: Types of criteria for the sensor suite system

The aim of this section is to explain the evaluation criteria to be used to evaluate the AIMS system.[6] The sensor suite evaluation criteria include the following: tracking capability, data processing time, search planning time and ability to archive information collected on an incident. The operator evaluation criteria contain the following: operator experience and operator comfort. Finally, some criteria evaluate the combination of the performance of both the operator and the sensor suite; i.e. the system criteria. These evaluation criteria are related to: maximum search flight speed, target location precision, target confirmation time, time lost to return on target, target detection capability, time lost due to reduced visibility, ability to disseminate information on a target, and finally effectiveness of the human-machine interface.

SENSOR SUITE EVALUATION CRITERIA

The evaluation criteria presented in this section are related to the sensor suite because they are not influenced by the performance of the operator. Several criteria are suggested, among them, six MOEs are related to the tracking capability, the data processing time, the search planning time and to the ability to archive information collected on an incident.

Tracking Capability

Because the airplane is constantly moving and the target may also move during a SAR mission (for example a person floating in the water), a tracking capability would allow the operator to follow more easily a target of interest. If the aircraft is able to follow the target at any time, several MOEs are proposed to evaluate the effectiveness of the tracking device. First, the alignment error between the actual location of the target and the one given by the tracking device could be measured for a period of time while both the aircraft and the target are moving. Second, the maximum time that the sensor is able to stay on the target could be monitored. Finally, the average time it takes for the sensor to recover the target when losing it could be determined.

The capability to follow a target is very important and its effectiveness can be further improved by accounting for the aircraft's flight path (if known) in the tracking algorithm. The tracker can be coupled with a moving map and specially designed software that recognizes features like highways, routes, etc. This could be an asset but is not mandatory.

Data Processing Time

If images are not displayed in real time by the imaging sensor, the time lag could be caused by a delay in the image pre-processing required before the image displays so that it permits operator detection of the target. There could be a significant interval of time (loss) between the fly-over and detection. Moreover, if a call-around is needed, the delay caused by image processing would also impact the time before detection because the aircraft will have to fly a greater distance to reach the site of interest. The time interval from fly-over to detection could be measured during trials on the ground or during flight trials.

With AIMS, images from the various imaging devices will be pre-processed before being displayed on the operator workstation, all done in real time with no delays expected.

Search Planning Time

Some information on search planning methods is available in the National SAR Manual.[7] The manual states that searches may be planned manually or with the help of appropriate computer programs and that usually five sequential events are followed to develop a search plan.

They are:

- "**estimating the datum** – determining the position of the emergency and in maritime cases determining the effect of wind and current on the survivors;
- **determining the size of the search area** – allowing for errors in position estimates, navigation errors of search units and drift variables;
- **selecting appropriate search patterns** – considering size of area, type of terrain and capabilities of search units;
- **determining the desired area coverage** – considering factors affecting the probability of detection, track spacing and number of sweeps; and
- **developing an optimum and attainable search plan** – considering the number of search units available and other limiting factors and circumstances".[8]

Planning searches involves many factors and takes time. The search plan has to be periodically reviewed and updated. Other parameters such as weather, availability of the search units, limitations of time, and safety factors need to be considered. A planning tool incorporating the AIMS system could consider the evolution of the parameters of search in real time, which could possibly make updating of the plan easier and faster. When evaluating different SAR sensors, it is important to compare the effectiveness of the planning tool incorporated in the system. The time required to plan an optimal search could be evaluated for different scenarios.

Ability to Archive Information Collected on an Incident

In actual SAR incidents, pictures are taken using hand-held cameras with zoom capabilities. These capabilities should already be integrated and made available to the operator of the system. The use of additional advanced sensors such as thermal imagers or image intensifiers that are offered in a system like AIMS, would be advantageous. The quality and usefulness of the system's archival abilities could be measured by the quality and number of hours of data that can be stored in the system. This is dependant on two factors: the resolution and the volume of the data that it is possible to archive. Both the capability to store captured images and to register data for the different sensors could be specified as a system requirement.

OPERATOR EVALUATION CRITERIA

An evaluation criterion related to the operator is a criterion that is not or almost not influenced by the performance of the sensor suite. For example, several capabilities incorporated on a sensor suite, such as an active imager and a thermal imager, could influence the detection capability, but will not change the number of hours of experience that an operator has before the flight trials. The number of hours of experience will be more influenced by the availability of the equipment, the budget availability for training, the capability of the operator to learn and the availability of the operator. In the same line of thinking, the performance of AIMS is related to the capability of the sensor suite to detect targets, which does not influence directly how much time the operator can work effectively using the sensor suite. Thus, this sub-section presents the MOEs related to: operator experience and comfort. Note that the same MOEs apply whether the operator is on board or in a ground station.

Operator Experience

We assume that the operator using the SAR sensor suite will have a sufficient knowledge of it to use it correctly and will have sufficient training before he comes to the flight trials. If the operator is not well trained on the sensor suite, poor results can be obtained during flight trials which will not reflect the actual capability of the system. As well, when comparing the results obtained between different SAR sensors, the SAR operator's experience using the sensor suite and his experience in the past as a SAR tech/spotter might influence the results. The MOE suggested would be to determine before each flight trial takes place the number of hours of experience the operator holds both as a SAR tech/spotter (spotting with naked eyes) and as an operator using the sensor suite.

Operator Comfort

Another important MOE suggested is related to operator fatigue. During searches, spotters usually alternate every twenty minutes to combat fatigue. Before the real trials, field tests should be carried out and according to the opinion or experience of operators, the maximum time that the sensor suite can be used without significant operator fatigue should be determined.

Airborne assessment of this MOE is problematic in that some factors which could influence the level of operator fatigue during a search are dynamic and cannot be controlled for between different assessments when actually flying. (e.g., changing operators). Thus, the approach we suggest to evaluate the level of fatigue would be to give the operator video sequences to be analysed, with these experiments being performed on the ground. One drawback to this approach would be that the motion sickness factor (i.e. the effect of actual airborne motion sickness upon operator fatigue and performance) is removed; while it is then controlled, the results might be more favourable than would occur in an actual airborne environment.

There are both advantages to this approach and factors to consider:

• it provides the ability to control and easily fix some parameters, and it would be significantly less expensive than flight trials. For example, parameters such as the background and the continuity in each sequence of video could be fixed - this way, each operator doing the experiment would be given the same 'search environment,' and the use of continuous video would be similar to a real flight search;

• the number of targets to be found could be proportional to the length of the sequence, thus giving the operator approximately the same average of time (rate) to find each target. For example, in a 10 minute sequence, there could be 2 targets to find, in a 20 minute video sequence 4 targets to find and in the same manner, and a 30 minute video should contain 6 targets. If in the first sequence we have an average of 5 minutes per target (10 minutes total, 2 targets) and in the second sequence an average of 1 minute per target (20 minute total, 20 targets), the chances are very high that the operator will be more fatigued after the second video, not only due to the increased time of search, but also because the number of targets to find is 10 times higher;

• different types of targets could be used: parachute, fuselage, dummy with life preserver, white panel marker with identification numbers, canoe, etc.. For example, the spotters could be looking for a group doing an expedition on a river. While looking for the group, the spotters might not see the canoe but there could have other indices like a life jacket floating on the water or a fire on the shore. Since the spotters in real SAR operations don't know in advance what they will find, the operator doing the experiment should not know the targets in advance. However, before the experiment the description of the scenario should be provided to the operator as it would for a real SAR mission;

• the operator should ignore the types of target he is looking for. In a real search, some information is known about the type and colours of the aircraft and the number of people, but since the aircraft might not be visible, the spotters are looking for many indices like broken top trees, parachutes, and anything that is unusual for the type of environment they are searching in. The operator doing the experiment should be looking for anything that is suspicious in the 'environment.' If he knows in advance the target is a white parachute, everything that is not white will probably be rejected and thus, the operator might be less "busy."

• There should also be a period of time for the operator to rest between each analysis. The duration of the sequences could be as follows: 10 minutes - rest - 15 minutes - rest - 20 minutes - rest - 30 minutes - rest - 45 minutes - rest - 60 minutes. The period of rest should be sufficient for the operator to recover completely from possible annoyances. (e.g., from headaches).

We expect from the experiments that the type of search will influence the level of fatigue of the operator using the sensor suite. There are primarily two reasons for that: overload[9] and vigilance fatigue.[10] Also, the effectiveness of the human/machine interface (more information is given on this subject in Effectiveness of the Human-Machine Interface), the flight conditions and the general health of the operator could influence the operator's fatigue level. If the result from the experiments shows that the operator cannot use the AIMS system for a long period of time with full concentration (less than one hour for example), it might identify the requirement for multiple operators to alternate throughout a SAR mission.

SYSTEM EVALUATION CRITERIA

The MOEs and specifications presented in this section evaluate simultaneously the operator and the sensor suite effectiveness. They are related to: maximum search flight speed, target location precision, target confirmation time, time lost to return on target, target detection capability, time lost due to reduced visibility, ability to disseminate information on a target and effectiveness of the human-machine interface.

Maximum Search Flight Speed

Using a sensor suite on board will probably change the search area covering time. When doing a search, the search parameters/tactics/flight profile are optimized or at least biased to provide the best combination of detection range and probability of detection. This means that if AIMS is much better than any other sensor system, it may very well alter aircraft track spacing or speed. For example, when using AIMS, the speed of the aircraft suggested by the search standards could be too high for the operator to capture the data and identify the targets quickly. Thus, the MOE developed is to establish a maximum flight velocity for the operator to be able to analyse effectively the data in real time (whether the operator is on board or in the ground station). Another factor to be considered in this evaluation is the fact that the operator is viewing the scene on a display and that a restricted field of view might influence his capability to cover the entire area while flying over. This factor is explained in detail in Target Detection Capability.

The data related to this criterion should be collected during the first AIMS flight demonstration. Two scenarios may be envisaged. In the first case, the pilot could increase incrementally the aircraft velocity for a while and at each selected speed the operator would tell him when he is not able to analyse the data effectively. In the second case, the operator could analyse video sequences passing with different speeds on the screen and determine an approximate velocity where he cannot analyse efficiently the data anymore. Again, the advantages of ground trials are the possibility to control many parameters during the experiments and to reduce the cost of the experiments. Although the second method is not as reliable, it will give an estimate of the maximum image velocity the operator can analyse. Other indicators could be developed to determine the maximum range velocity.

Target Location Precision

When comparing different sensor systems, one criterion to be evaluated is the degree of precision of the location. The position of the target should be as precise as possible, particularly when fixed-wing SAR aircraft are used, as they cannot hover over targets and obtain as accurate locations as can rotary-wing SAR aircraft.

In fact, even small errors in target geo-location data provided to ground rescue teams by SAR aircraft can lead to important lost time for those on the ground reaching the target in adverse terrain such as mountains or dense forest. Furthermore, surveillance of individuals may be compromised if the positional accuracy of the system is insufficient for it to accurately disseminate and acquire the correct surveillance target in a crowd. Hence, the precision of target geo-location as determined by the system should be evaluated by comparing it to the actual GPS position as truth data.

Target Confirmation Time

The target confirmation time corresponds to the time between the detection of an element and the confirmation that this element is the object of interest. This can be done by seeing the identification (registration) number of the aircraft, receiving distress signals from survivors, observing damages on the scene, etc. Since it can be difficult to evaluate separately the average time required between the detection and the identification[11] and the detection and the recognition,[12] it is suggested that no distinction be made between the two terms. The MOE suggested would rather be simply the average time required between the detection and the identification/recognition of a target. The time will start as soon as someone sees a target but is not able to either identify or recognize it right away, and will stop when there is a confirmation by one member of the crew (usually a SAR tech or a spotter) that it is or is not the target. The operation could imply a call-around or not. With this MOE, it will be possible to verify if it is preferable to have a reduced number of false alarms with a longer average time to confirm or not a target, or on the contrary, a higher number of false alarms, but a shorter time for target confirmation. If the time of search is limited, it is possible that some targets will not be well identified or recognized. To avoid that problem, enough time should be allowed to adequately cover the search area.

Two specific types of target information are the primary enablers of target confirmation: shape and colour. The ability of the sensor suite to provide contrast on colours and well defined shapes could help to more quickly confirm a vehicle concealed in a forest.

Time Lost to Return on Target

During a search, it is expected that many false detections will be made before finding the true search object. When a potential target is detected but cannot be rapidly confirmed or dismissed, a call-around is required. The total time spent on call-arounds depends on the number of such incidents and on the time required to do each call-around. It is also limited by the allocated time to fly the search area, which will control the number of call-arounds that can be performed. We are interested to know if the use of a SAR sensor suite will influence the number of targets to be identified during a search and if this will consequently change the number of call-arounds required. When searching for a specific vessel in a busy sea where there are many ships, usually multiple call-arounds are required to check out each vessel. We expect a new sensor suite like AIMS to reduce this number.

The suggested MOE is to determine the number of call-arounds required. Because the time spent doing one call-around is generally related to the type of aircraft, the same aircraft type should be used when comparing different SAR multi-sensor systems to ensure consistency of results.

Target Detection Capability

One of the main objectives of SAR missions is to be able to detect targets of interest. Time loss due to missed targets can vary enormously between missions. Time can be lost if a target is not detected on the first flyover and the time elapsed before the next pass will depend on many variables (weather, fuel consumption, crew fatigue, etc.). Considering that the probability of finding survivors after a crash is reduced by half every period of 8 hours,[13] it is of great importance to maximize the chance of target detection. The detection of targets could be performed by an operator of the system and/or could be helped by an automatic detection algorithm. One way to measure the ability of a sensor to see the target when flying over is the probability of detection. The National Search and Rescue Manual defines the probability of detection as the odd of detecting the target.[14]

The use of an automatic detection algorithm might bring an improvement in the ability to detect targets. However, one interesting thing to know is the possibility that the automatic detection algorithm be overloaded and consequently misses other targets of interest. This could also be the case for the operator using an advanced multi-sensor system. Therefore, the average number of false positives per unit of area could be measured.

In Figure 2, it is possible to see the relationship between the probability of detection (POD) and the sweep width.[15]

At closer range, more targets are detected than at the maximum range except for the area below the aircraft. This is because it is difficult for SAR techs/spotters to see right under the aircraft. The use of a SAR sensor suite mounted on a platform located under the aircraft would eliminate this problem. The new SAR sensor suite is thus expected to increase the POD within the same detection range or, if the POD is similar, then a larger detection range is expected from the use of this sensor suite.

Several factors that might influence the PODs were found in different documents[17] and were relevant in this study. They are explained below:

- **Weather and time of day (clouds, lighting, fog, precipitation).**
- **The background contrast and the environment.**
- **Search and aircraft parameters (e.g. size of the area to search, type of aircraft, airspeed, altitude, track spacing, time flying).**
- **Condition of the crew (crew fatigue, crew motivation, experience of the crew members is not constant within a team and between teams).**
- **Number of spotters on board.**
- **Target characteristics.**
- **Operator familiarity with the environment.**

An additional issue influencing the PODs is related to the capability of the sensor to quickly scan the entire area being covered as the aircraft flies over. Since aircraft speed would be determined by the needs of spotters working visually, it is possible that a sensor with a limited field of view (FOV) would be unable to scan the selected area as required, thus covering only a portion of it. Alternatively, a narrow FOV sensor might be able to sweep the entire area covered by the aircraft, but only at a high sweeping rate that lowers the chance of detection. Moreover, if the sweeping rate is too high, the images might be blurred. Such an inability to sweep an entire viewing area as the SAR aircraft flies by would essentially influence the time required to find a target by lowering the POD.

Time Lost Due to Reduced Visibility

An advanced sensor suite will ideally minimize the impact of adverse visibility conditions on surveillance capability. The minimum visibility conditions where the sensor is still effective and the minimum illumination where the sensor is still operational were MOEs. However, it is difficult to evaluate those parameters during flight trials since nobody controls the weather. Therefore, instead of measuring the minimum visibility conditions and illumination during flight trials, the authors suggest a qualitative response to the following question: In what situations will the use of a new sensor provide improvement to the SAR missions? The answer should include the region (land/sea/mountainous region), the weather (with precisions on the visibility and illumination conditions), the time

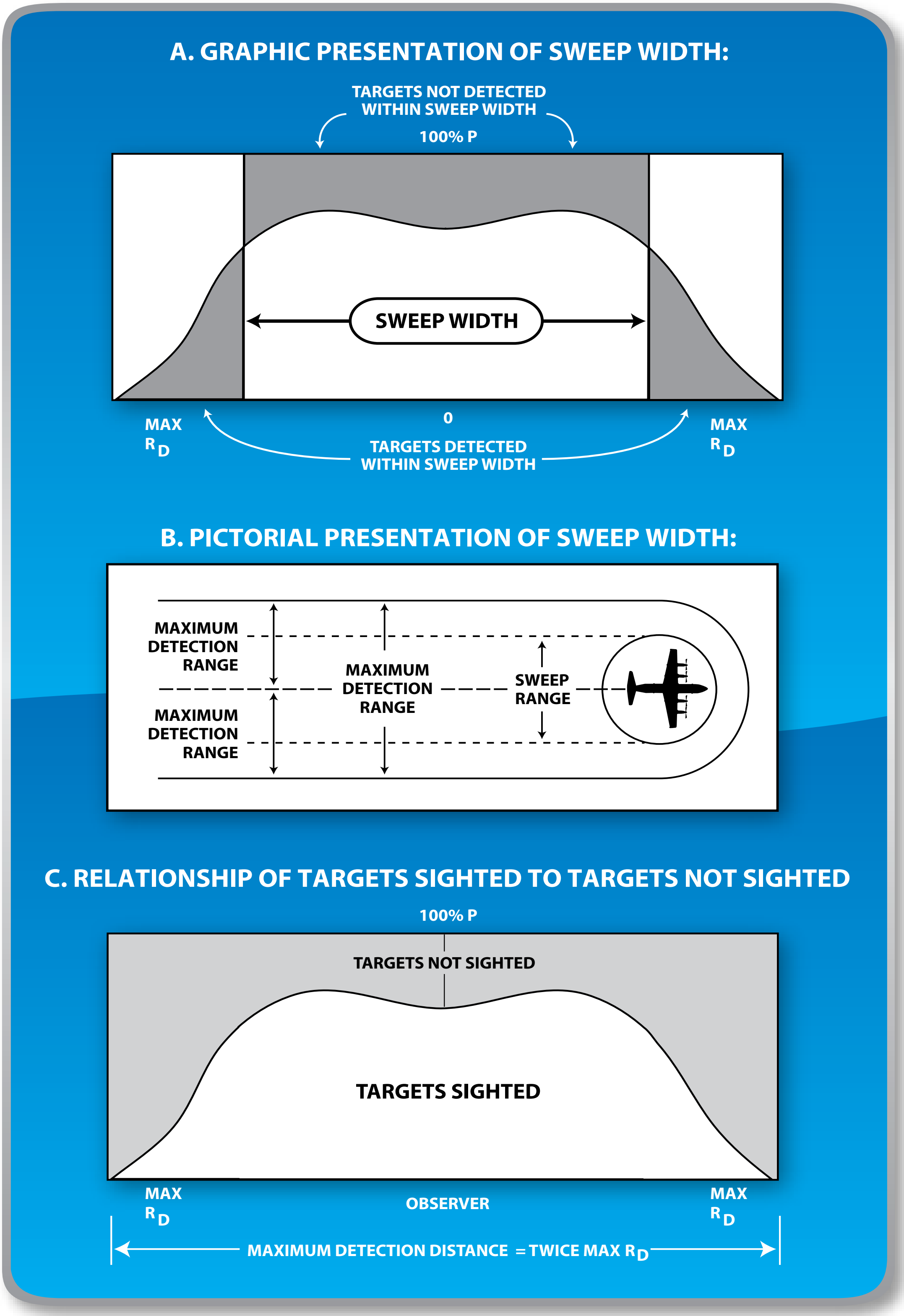

Figure 2: Sweep width versus POD[16]

of day and the types of scenarios. The question could be addressed to a scientific team with expertise in the same field who would answer based on experience, experiments already done and on the potential of the system. This would provide an idea of the ability or effectiveness of the sensor suite to remain effective under different weather conditions related to visibility and illumination. The detection range plays an important role in the evaluation of sensor systems and consequently, the minimum detection range providing high confidence that the target is in the search area could be provided for each visibility and illumination conditions mentioned above.

The answer to the previous question and the detection range values could help determine the influence of reduced visibility and condition of illumination on the effectiveness of the searches during day and night. However, if possible, some future flight trials should be conducted under different weather conditions and at night time to demonstrate the improvements provided by the use of a new sensor system like AIMS.

In short, due to harsh environmental conditions, searches can be stopped or simply delayed with the consequent time loss, but the use of a new SAR sensor system could enable searches in those conditions.

Ability to Disseminate Information on a Target

The ability to disseminate information on a target is related to the performance of the communication link for transmitting images. The effectiveness of this transmission link could be evaluated through the three following measures:

1. **The availability of a communication link (e.g. availability of the communication link in the North to transfer information).**

2. **The quality and characteristics of the communication link. As an example the bandwidth could seriously limit the type of information to be sent from the aircraft to the ground or to another platform. Also, the bandwidth could impact the time it takes to send the information.**

3. **The quality and size of the transmitted images/videos (i.e. high resolution of the imagery). The presence and the effectiveness of these abilities on an airborne system could be considered as an asset and could be used to compare different sensor systems.**

Effectiveness of the Human-Machine Interface

It is important to evaluate the effectiveness of the human-machine interface. In fact, if a sensor system is very effective, but is too complicated for an operator to use it properly, poor operational performance may result. In the same line of thinking, if it takes twice the time to train an operator on one system compared to another and the results obtained are equivalent, then the system with the lower training time is likely preferable. Examples of factors that should be addressed in the design of the hu-

man-machine interface and that should help to evaluate its effectiveness could be those captured in the function and performance specification (FPS) development guide. Those factors are: anthropometric (displays and controls), sensory (use of colour, visible brightness and contrast), physiological (noise) and psychological factors. those captured in the function and performance specification (FPS) development guide.

The MOE proposed in this document is the time it takes to train an operator to use the system effectively. The objective is to minimize the learning curve, to maximize the simplicity of using the interface, while maximizing the effectiveness of the sensor system.

Conclusion

The aim of this paper was to present the evaluation criteria developed to assess the utility for Canadian Forces to use advanced airborne integrated multi-sensor imaging systems for SAR missions. In that regard, criteria have been developed to evaluate the effectiveness of the operator, the sensor suite and the effectiveness of both the operator and the sensor suite. The evaluation criteria contain a list of measures of effectiveness (MOEs) and specifications. The MOEs are summarized below:

1. **The alignment error between the actual location of the target and the one given by the tracking device.**
2. **The maximum time that the sensor is able to stay on the target.**
3. **The average time it takes for the sensor to recover the target when loosing it.**
4. **The time from fly-over to detection.**
5. **The time necessary to plan an optimal search.**
6. **The number of hours of data that it is possible to archive.**
7. **The number of hours of experience as a SAR tech/spotter (spotting with naked eyes) and as an operator using the sensor suite.**
8. **The maximum time that the sensor suite can be used without significant operator fatigue.**
9. **The maximum flight velocity for the operator to be able to analyse effectively the data in real time.**
10. **The precision of target geo-location as determined by the system.**
11. **The average time required between the detection and the identification/recognition of a target.**
12. **The number of call-arounds required.**
13. **The probability of detection.**
14. **The average number of false positives per unit of area.**
15. **The minimum detection range.**
16. **The time it takes to train an operator to use the system effectively.**

Other criteria were mentioned and considered as assets for airborne integrated multi-sensor systems in this paper. They are:

17. **The ability of the sensor suite to provide contrast on colours and well defined shapes.**
18. **The ability or effectiveness of the sensor suite to remain effective under different weather conditions related to visibility and illumination.**
19. **The availability of a communication link.**
20. **The quality and characteristics of the communication link.**
21. **The quality and size of the transmitted images/videos.**

All the criteria mentioned above will be helpful to evaluate the utility of the AIMS system during SAR missions and could be further used to evaluate the SAR capability of other airborne sensing systems, such as the JMMES system.

New MOEs to evaluate the knowledge and the effectiveness of the operator using the system should be developed. In the future, these MOEs could help the AIMS project scientific team to develop a training program for operators. ■

List of Abbreviations

AIMS	advanced integrated multi-sensing surveillance
FOV	field of view
FPS	function and performance specification
ISR	intelligence, surveillance and reconnaissance
JCTD	joint capability technology demonstration
JMMES	joint multi-mission electro-optic system
MOE	measures of effectiveness
POD	probability of detection
SAR	search and rescue
SLAR	side-looking airborne radar
UAS	unmanned aircraft systems

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6 Ibid.

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8 Ibid.

9 When the intensity of work is high.

10 When there is not much going on but the operator must remain constantly vigilant over a long period of time.

11 Time elapsed between the detection of a vessel or aircraft wreck and the point where their names can be read.

12 Detection would be the point in time when an object is seen, and recognition, the time when signs of distress are noticed.

13 V. Larochelle, P. Mathieu and J.-R. Simard, Two generations of Canadian Active Imaging Systems: ALBEDOS and ELVISS, SPIE vol3698: Infrared technology and application XXV, paper 31. (1999).

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16 Department of National Defense.

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Rethinking Our Current NATO Relationship Within the AEROSPACE (AEW) DOMAIN

A proposal for a possible NATO AWACS Forward Operating Base (FOB) in Canada

By **Major Mike Collacutt**, CC-NAEWF Geilenkirchen

Canada plays a significant role within both the current North Atlantic Treaty Organization (NATO) Air Defence and NATO security investment domains. Specifically, we directly contribute approximately $33 million annually (based on 2004 Canadian Forces (CF) figures) and over 113 personnel to Geilenkirchen, Germany, E-3A Airborne Warning and Control System (AWACS) Component, an organization considered the crown jewel within the NATO Airborne Early Warning Force (NAEWF). This investment is significant, making us the third largest contributor to both the capital and annual operating budgets of the NAEWF E-3A AWACS program.

Of equal fiscal importance, but much less apparent, is that Canada also contributes millions (a further $43 million annually) to NATO via a separate infrastructure and capability fund referred to as the NATO Security Investment Program (NSIP). This article attempts to analyse these separate albeit important and perhaps interrelated NATO programs, the NATO Security Investment Program (NSIP) and NAEWF, with the intent to stimulate discussion regarding future options toward a better, cost-effective alignment of NATO aerospace resources within the current Canadian Forces transformation framework.

My contention is that our government should better transition from merely accepting the high cost of NATO participation (paying our NATO membership dues) and its poor rate of return on its significant investment, and perhaps establish a clearer goal to exploit a greater, more effective slice within both NAEWF operations as well as the redefined NSIP. I believe there is significant rationale and considerable benefit for Canada to leverage better return on its NSIP spending (exploiting NSIP required "over and above" rationale). A relatively effective solution may be to simply pursue designation of a NATO AWACS FOB location in Canada to provide increased opportunities for NATO E-3A as well as E-3D, E-3F (NAEWF) training visits.

Furthermore, a second solution might be to challenge our nation's apparent "blind faith" approach, generally implying NATO is effectively conducting an "away game" campaign to defend our nation against possible asymmetric/external threats.

Finally, a third option is to better promote the idea to NATO, in particular the NAEWF, to refocus required training and protection on NATO's equally vulnerable western front, namely Canada.

NATO Airborne Early Warning Force (NAEWF)

For over 50 years the tangible dividends of Canada's significant investment in NATO have included access to strategic information, exercises with allied forces and an equal voice in high-level decisions affecting Euro-Atlantic security and stability. Since 1949 Canada has been the sixth largest contributor to NATO's military and civil budgets. Since the early 1980s, Canada has also been one of the original participants and is currently the third largest supporter of the NAEWF, more specifically, the NATO E-3A Component, an organization very much in transition and continuing to redefine itself within the current NATO Response Force (NRF) framework.

Like many other aerospace organizations, NAEWF E-3A Component is in a perpetual search mode for quality training opportunities around the globe. Surprisingly, Canada rarely (directly or officially) requests dedicated E-3A training support, nor specifically develops quality training opportunities other than the standard yearly Ex Maple Flag. Outside of Maple Flag, CF members within CC-NAEWF (Geilenkirchen) are usually the catalysts who recognize opportunities for both Canada and the E-3A and who initiate E-3A training within Canada (e.g., 2006 TRIDENT FURY and current 2008 Maritime Forces Atlantic (MARLANT) exercise initiatives. Again, activity originated from the bottom up by CF staff attached to the NATO E-3A Component and not by any CF headquarters (HQ) level coordinated development).

While this is an acceptable practice, this has been Canada's approach for 25 years of E-3A activity and many opportunities are perhaps missed. Generally, the average CF aerospace populace appears relatively unaware and continues to display limited creativity to exploit this robust and available surveillance / command and control (C2) capability. The bottom line is it may be determined that Canada could easily access more quality and needed training opportunities in association with the E-3A and other available aerospace participants regarding anti-highjack, anti-terrorist and other training, with minor staffing and relatively minimal financial cost to our nation.

"Asymmetric Threat" Still a Factor? Has it Disappeared for Canada?

The current asymmetric landscape combined with our significant CF efforts in Afghanistan should, in reality, be indicators steering Canada to continue to maintain vigilance against possible retaliation. Like most others, I feel patriotic and generally believe Canada—in particular the CF—is performing outstanding work helping the Afghan people create a better future. However, the Taliban along with active terrorist cells in the region may not have the same happy sentiment and will obviously distort our efforts in a more negative way. To them we're uninvited guests, perhaps literally "pissing in their backyard." Therefore, should we not rethink our position and consider being ever-vigilant shoring up our security arrangements close to home, and in particular, re-evaluating how we request available NAEWF training?

This implies not just focus on traditional E-3A participation at the yearly Maple Flag composite air operations (large package fighter activity), but also on looking toward more fulsome, mutually beneficial processes linking the North American Aerospace Defence Command (NORAD), civilian air traffic control, military C2, and the Royal Canadian Mounted Police in perhaps an anti highjack or asymmetric support-related exercise. Ideally we should support and attempt better synergy with Canada Command centric "contingency robust/asymmetric" sanctioned Air, Land, Maritime/Arctic exercises that provide tangible aid in direct defence of Canada.

Opponents to this line of thought may say that Canada already accesses suitable AWACS support, citing NORAD and our NATO AWACS participation in yearly Maple Flags. My response to this ideology, and I believe most AWACS expertise within Canada would agree with me, is that NORAD and NATO AWACS training activity in Canada is not robust and regrettably sporadic at best. Moreover, despite NORAD, our US friends may naturally be forced to consider national concerns. This may trump NORAD, and in particular Canada, if future asymmetric activity is prevalent on the US side, regardless of whether it manifests on both sides of the border.

One only has to remember post-9/11 Article 5 / NATO EAGLE ASSIST and the request by the US for seven NATO AWACS to assist that country to realize there may not be enough Airborne Warning and Control systems to go around at the right time. Times are changing dramatically. Of significance, this was the first time in history that NATO had defended North America, specifically the US. It doesn't take much of a stretch to consider Canada's unique needs within this context and in particular, within the framework of possible future terrorist scenarios.

NATO AWACS Forward Operating Base (FOB) in Canada? Why not?

One approach Canada could begin looking at more seriously is developing a better training relationship with NATO, in particular the NATO E-3A Component to better exploit available NATO aerospace resources (AWACS). No doubt, the NATO E-3A Component would greatly benefit from a designated Forward Operating Base (FOB) in Canada. The approach would begin by assigning a location, an actual cost-effective "footprint" on which both Canada and NATO could focus training and pre-position NAEWF equipment to conduct activity within our contiguous aerospace. Canada's relatively clear airspace would be a welcome respite from the confines of European skies, in particular for training NATO AWACS aircrews. The aircraft could be utilized to perform cost-effective surveillance activity in our Northern regions as well, helping to validate our sovereignty, not unlike similar roles this jointly owned and multinational manned NATO AWACS aircraft repeatedly performs in Europe.

This concept may begin by simply offering a FOB designation or perhaps requesting NATO funding for constructing a possible E-3A FOB in one or more key strategic locations such as, but not limited to: North Bay, Trenton, Shearwater, Greenwood, Bagotville and Comox. These are areas that provide access to important alliance players within the traditional maritime (MARLANT / Maratime Forces Pacific (MARPAC)) and aerospace (namely 3 and 4 Wing/ NORAD) domains. Moreover, we'd be actually laying preliminary groundwork with the expressed goal of creating more synergistic training opportunities. This approach would perhaps bode well within the groundbreaking transformational processes consuming the CF, NORAD, Northern Command, and the follow on activities identified by the post-9/11 Canada/United-States Bi-National Planning Group.

NATO Security Investment Program (NSIP)? A White Knight or Red Herring?

Good idea perhaps. However, many will question how we create this NATO transformational opportunity in Canada with a limited defence budget. Good question! To begin, one may look no further than the current NSIP funding program. NSIP funds were initially designated "cold war" funds to be utilized for European infrastructure development protection against the Soviet Union. Interestingly, since the early 90s and the end of the cold war those funds have continued to flow unabated from Canada into NATO's new revamped NSIP transformation coffers. In these two NATO programs alone, Canada contributes $76 million annually (2004 CF figures). Of the millions we invest annually, it's generally a one-way cash flow for Canada.

The vast majority of our investment never makes it back to this side of the ocean in the way of credible E-3A training/operations or tangible NATO security investment. (I postulate that most defenders of this approach would quickly imply the continued NATO dues ideology, "big brother" protection and the "away game" mentality NATO supposedly provides to us and our unquestioning membership).

Currently, the NATO military planning staffs of the Allied Command Operations and the Allied Command Transformation (ACT) provide oversight in NSIP construction and procurement projects based on prioritized and accepted requirements to support the Alliance's war fighting capabilities. To clarify the process, NATO nations develop formal requests, or what are identified as capability packages (CPs) to compete for NSIP funding. NATO nations must remain mindful that effective NSIP CPs should address the following six transformational categories: Deployability/Mobility, Sustainability, Command/Control, Air Defence, Command Structure/Training, and Exercises.

Next, these project categories are bundled within CPs, which NATO military and civilian decision-makers review in detail based on relevance to NATO. Most NATO nations pour significant effort, manpower and thought process into developing "over and above" NSIP CPs within their respective nations that are attractive and garner the requisite approval to guarantee funding success. Examples of recent successful CPs would include, but are not limited to, improvements and upgrades

to NAEWF FOB locations in Trapani, Italy and Preveza, Greece, or NATO Fleet support upgrades to various NATO designated naval facilities in participating NATO countries around the world.

Traditionally, Canada has one of the lowest, if not the lowest rate of NSIP return based on the funds submitted. Why? Simply put, Canada traditionally has refrained from actually submitting credible NSIP CPs to access funds, something our NATO Allies are happy to exploit when we don't. Yes, CPs must address "over and above" national requirements, and yes, they appear somewhat complex to develop. However, we have creative minds throughout the CF that can overcome these relatively simple issues. Moreover, this same passive approach to NSIP resource exploitation appears to manifest itself within our CF approach to the NAEWF and its relationship to overall E-3A activity within the confines of Canada.

Again, Canadian NSIP funds to NATO are significant, to the tune of approximately $43 million per year. Of significance over the past 50 years, Canada, as well as the US, has received abysmal returns on its overall NSIP investments (2005 estimates: Canada 4-5 per cent, the US 9 per cent), perhaps initially justifiable as a bi-product of the Soviet threat. However, since 9/11 even the US has aggressively reacted and is developing NSIP capability packages and designated units within the continental US as NATO units (e.g., 10th Mountain Division) in an attempt to keep precious NSIP funds firmly within their control. The recent US effort has been successful, as they are nearing 23 per cent return from NSIP. Apparently, an equally justified NSIP funding focus swing to benefit Canada has garnered somewhat tacit interest within National Defence Headquarters (NDHQ) and perhaps the overall CF in general, but a significant Canadian centric capability package development apparently has yet to truly materialize despite our equally robust CF transformation process.

NSIP NATO AWACS FOB – Is there a Possible Relationship?

Again, one solution may be as simplistic as drafting a relevant NATO NSIP capability package for an E-3A FOB utilizing available NSIP funds, thereby creating a more hospitable environment for this sophisticated aircraft to regularly visit and train. The same opportunities are already provided by NATO and regularly exploited by many of our NATO allies. With the required infrastructure in place, Canada, with a little imagination, could rapidly become a centre for excellence for NRF training or Data Link (Link 16) with relatively minor upgrades to facilities such as those at North Bay. This would bode equally well for interoperability with our current CF-18 fleet and MARLANT/MARPAC Fleet Link 16 upgrades and an attractive option for current NATO E-3A training opportunities in just these two very important areas.

I offer up two very simplistic examples to consider, which combine and would perhaps better exploit both NSIP and NAEWF:

Concept: NATO AWACS Forward Operating Base (FOB) 22 WING - NORTH BAY Ontario.

Canada (perhaps as simply as with the stroke of a pen) could designate 22 Wing North Bay as their NATO Forward Operating Base (FOB) of choice for the NAEWF. North Bay may be an ideal location, based on its NORAD connection and location within Canada, to provide surveillance of major urban centres and offer E-3 access to CF resources, namely fighter aircraft in both Bagotville and Cold Lake, as well as training opportunities south of the border. The way ahead would require 1 Canadian Air Division (1 Cdn Air Div) or Canadian NORAD Region staff to submit a NSIP CP to the CAS for furtherance to ACT. The goal would be to receive NSIP funding to upgrade existing runways and hangar space to allow various NATO E-3 resources to operate within an FOB framework. Success would prove mutually beneficial to Canada, NATO and NORAD and allow Canada to better exploit its $33 million yearly AWACS investment.

Moreover, without question, support would translate into significant improvements in current training opportunities for NATO, as well as a measure of proactive training and support for the CF and for various other government agencies in preparation for future NATO Article 5 type support. NATO could benefit greatly, allowing mutual training for future Article 5 support operations and a relatively open airspace to conduct flight crew training. This is an opportunity that is considered by many in Geilenkirchen as an ever-diminishing luxury and certainly in very high demand due to the confines of European airspace.

Concept: NATO AWACS Forward Operating Base (FOB) 12 WING – SHEARWATER, Nova Scotia.

Canada could also designate Shearwater as its NATO FOB of choice for the NAEWF. Although some may consider this pure folly due to current limitations of Runway 16-34, Shearwater upgrades don't appear insurmountable. It could, therefore, be considered an ideal location. It offers some compelling options for NATO: proximity to Europe, access to significant CF Maritime training with MARLANT Naval, MARLANT HQ, Link 16 units, Maritime Patrol Aviation, CF18, and east coast US Naval and Aerospace assets. The way ahead could have MARLANT submit a NSIP CP request to Chief of the Maritime Staff to designate Shearwater (or perhaps Greenwood) as a NATO E-3A FOB to receive NSIP funding to upgrade and improve existing runways and hangar space to allow various NATO E-3 resources to operate. Moreover, NSIP support could be further legitimized (exclusive of the NAEWF) by providing a significant NATO AIRHEAD for CC130 and C17 flights (C17 implies future NATO, US and current CF assets) to exploit Shearwater's facilities and to move troops and resources to and from MARLANT (SEAHEAD). The expressed aim is to access future roll-on/roll-off / amphibious vessels for the navy, as the current Chief of the Defence Staff has identified the need for this capability.

Bottom-line, there are no guarantees in life. It is my contention and the consensus of some familiar within the overall CF NSIP planning structure that the way ahead may cost the CF little more than simply submitting a NSIP CP as a viable option for NSIP funding.

Based on the creativity within the current NSIP funding strata the rewards could be as high as 100 per cent financial support for upgrades to hangar space, runways and other support structures. Certainly, it is within the mandate of a creative CF aerospace planner within the CAS domain at NDHQ to flesh out creating a NATO "over and above" requirement independent of our direct CF needs, but within the mandate of the NSIP rules of funding. This is the exact same opportunity exploited by other NATO nations, namely NAEWF FOB / forward operating location (FOL) locations in Greece, Turkey, Norway, and Italy; opportunities that even today are constantly being exploited by all NATO nations, excluding Canada. Yes, NSIP funding is moving away from infrastructure "bricks and mortar" funding. However, terrorist events during 9/11 have changed the rules significantly. No doubt, the demands for an FOB in Canada in the early 80s wouldn't garner much support. A Canadian specific NSIP CP in this area should be given serious consideration due in no small part to our significant low level of past NSIP investment return.

Putting Canada first, offering up a NATO FOB location and requesting to receive NATO funding is rational and allows for proactive training and initial pre-positioning resources within this country in times of increased tension. Can we afford to sit back and wait? Why take this approach? From a military concept, it seems irresponsible. Critics of this "wait and see" approach highlight that in response to 9/11, the terrorist "horse had already left the barn" by the time Article 5 was implemented and NATO's EAGLE ASSIST support to the US actually came to fruition.

Equally disturbing is the fact that our NATO allies are more than happy to let Canada continue to sit idle while allowing their own European dominance of the NSIP funding program, and more importantly, their utilization of NAEWF resources to continue relatively unabated. One only has to attend an annual NATO AWACS planning meeting and NSIP funding meetings to see how well equipped and how eager our NATO allies pursue the available E-3A capability and overall NATO funding. What is clearly evident is the current NAEWF support directed toward Canada is more a product of creative staff work by zealous CF aerospace control officers from within the NATO E-3A Component. Should it not resonate from within our own aerospace domain, namely 1 CAD or CAS with better focus, foresight and planning?

Certainly, by not reacting soon, the current yearly E-3A training hours allotted could continue to migrate away from Canada with the advent and continued refinement of its role within the NATO Response Force with its voracious appetite for quality training opportunities. Canada needs to rethink its significant NATO investment aside from just the high cost (dues) required for NATO participation. We may be required (or smart!) to keep our hand out like all other NATO nations, including the US and be more vigilant regarding our own internal/collective aerospace training.

In conclusion, submitting a NATO/NSIP CP and a more concerted effort to access available NATO AWACS assets should be simplistic enough to overcome. The concept and context of our Canadian security is changing and everybody in the business of aerospace security has to adapt and become smarter in accessing and leveraging readily available technology, personnel, equipment and resources (more specifically potential funding). All NATO nations are examining ways to improve abilities to protect themselves against the use of weapons of mass destruction, capabilities to more effectively protect populations and to assist civil emergencies. Canada can no longer rely on the geographic protection of the oceans that surround us. Threats are trans-national, complex and far reaching.

Attempting to exploit available NATO NSIP funds and state of the art NAEWF assets in unison makes logical sense and is one process we need to better execute. Consider that based on cost comparison and relative NATO fiscal terms, Canada's AWACS percentage of capital funding is significant, the equivalent of owning almost two NATO AWACS aircraft outright. Let's not forget, these particular aircraft are currently amongst the most capable and up to date AWACS aircraft anywhere in the world. Combined with our NSIP investment, we can ill afford to neglect the fact that we invest a total of almost $80 million yearly into these two NATO programs and should continually be attempting to maximize the return on this significant investment. Every other NATO nation takes this approach; why don't we?

Looking Outside of the Box

If not, couldn't we use NATO funding elsewhere more effectively? We'd be foolhardy to assume asymmetric threats or terrorist cells are going to signal or allow NATO enough time to pre-position and spin-up to support its member nations (Article 5). Furthermore, a strategy that considers the current NATO E-3A Component investment sound or somehow fighting an "away game", or worse, providing an effective barrier against terrorism on behalf of Canada within the confines of European airspace is myopic at best and downright foolish in the worst case. Continuing to remain with the current approach to NATO, in particular supporting "Canada after all others," NATO aerospace doctrine seems flawed and perhaps better situated in the previous cold war mentality.

Finally, many might say that Canada's current fiscal conduct towards NATO–in particular the NAEWF–appears to lack direction and perhaps even borders on being considered irresponsible with regards to supporting our own nation's transformational needs. This body of evidence may help stimulate other, more creative ideas to challenge the status quo.

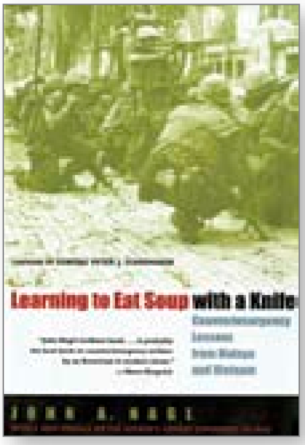
I believe we can ill afford to continue to throw vital defence funds in NATO's direction without receiving a more effective rate of return, as we've taken a back seat long enough with regards to NATO security spending. After 50 years of Canada supporting this North Atlantic security organization, fear not! NATO will still wish to keep us part of the Alliance, and more importantly, perhaps respect us more for not always being the fiscal martyrs we tend to portray ourselves as. ■

Maj Mike Collacutt is an aerospace control officer currently posted to the NATO E-3A Component Geilenkirchen, Germany. He is one of 113 Canadians currently employed within the E-3A Component. Maj Collacutt is currently the Chief of Standards and Evaluations (CSE) for the E-3A Component mission crew. He has approximately 5,000 hours flying aboard numerous CF aircraft with approximately 3,000 hours directly related to NATO E-3A operations. Of significance, from 1993-1997 he had over 230 missions directly supporting UN operations in the former Yugoslavia. He currently holds a B.A in Geography (Saint Mary's University) and M.ED (University of Oklahoma). He is an NRF Qualified Evaluator Tactical Director considered an expert regarding NATO E-3A employment, training and current operational capabilities.

List of Abbreviations

ACT	Allied Command Transformation	HQ	headquarters
AWACS	airborne warning and control system	MARLANT	Maritime Forces Atlantic
C2	command and control	MARPAC	Maritime Forces Pacific
CDS	Chief of the Defence Staff	NAEWF	NATO Airborne Early Warning Force
CF	Canadian Forces	NATO	North Atlantic Treaty Organization
CP	capability packages	NORAD	North American Aerospace Defence Command
FOB	forward operating base	NRF	NATO Response Force
FOL	forward operating location	NSIP	NATO Security Investment Program

BOOK REVIEWS



LEARNING TO EAT SOUP WITH A KNIFE:

COUNTERINSURGENCY LESSONS FROM MALAYA AND VIETNAM

BY JOHN A. NAGL

CHICAGO, ILLINOIS:
UNIVERSITY OF CHICAGO PRESS PAPERBACK, 2005
249 PAGES ISBN 0-226-56770-2

Review by **Major Lisa Taylor**

This book was first published in 2002, with this 2005 edition being published with an updated foreword and preface. In my opinion, it is an excellent study of how counter-insurgency operations need to be waged. It was clear to me by the end of the book that the US approach described within was quite ineffective. As Canada moves into a prospective new phase of operations in Afghanistan focusing more on nation-building, this book is recommended reading for military and diplomatic planners. It provides useful, contemporary insight into the capability requirements to facilitate Afghanistan's continued evolution toward stable and peaceful nationhood.

This book uses British Army experience in Malaya, 1948-1960, and US Army experience in Vietnam, 1950-1972, to expose the differing organizational cultures and resultant learning abilities of the two armies. Because of these differing organizational cultures and learning capabilities, the author, a US Army Lieutenant-Colonel with two tours in Iraq, argues that the British Army has become better suited to counterinsurgency operations than the US Army.

Chapter 1 begins with an examination of organizational culture, learning theories and how armies apply them. He uses concrete examples of how both armies have developed and employed doctrine as well as how institutional learning has evolved or been resisted in some cases.

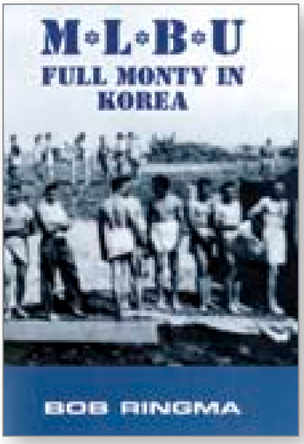
Chapter 2 continues with a detailed analysis of insurgency and its theoretical evolution from Clausewitz and Jomini to Mao Tse Tung, concluding that due to its very nature, insurgency cannot be combated by military might alone. All elements of national power must be integrated – diplomacy, information operations, intelligence, financial and military – to achieve primarily political objectives related to establishing a stable national government capable of thwarting both internal and external threats.

In Chapter 3, a comparison of the two organizations' histories allows the reader to appreciate the organizational cultures that have evolved. He concludes that because of their respective histories, one army was prone to succeed in its next campaign while the other would enjoy less success. With these first three chapters, the stage is set for the author's evaluation of the two counterinsurgency experiences, and from here, he turns his attention to in-depth explanations of the differing experiences of the British Army in Malaya and the US Army in Vietnam.

Chapters 4 and 5 explain the British Army experience beginning in 1948 and culminating with its complete withdrawal in 1960 and a stable, independent Malayan nation. It is clear that the British discovered the requirement for a political-military-economic approach early in the emergency and that this was necessary to win hearts and minds. Chapters 6 and 7 explain the US Army experiences in Vietnam commencing with the advisory staffs deployed in 1950 to help construct military forces in South Vietnam and ending with the US troop withdrawal in 1972. Ultimately, the author provides evidence that while there was a degree of innovative thinking employed by some facets of the US military in Vietnam, the US Army insisted on employing massive firepower, technology and large US troop concentrations to sweep the jungles and destroy the Viet Cong and North Vietnamese Army – in other words, employ an annihilation approach, in spite of documented failures.

Chapter 8 turns the reader's attention to institutional learning theory to explain, in depth, why both armies had very different levels of success in their counterinsurgency operations. The author opines that it is directly attributed to the strength or flexibility of the two institutional cultures. The final chapter provides ideas about how to make military forces adaptable to emerging changes in warfare and how to overcome institutional culture to build learning institutions. Nagl also provides evidence that due to the differing demands of conventional and unconventional warfare, an organization optimized to succeed in one will have great difficulty in fighting the other. The organizational culture that makes it so successful in one arena might actually blind it from seeing deficiencies that make it fail in the other. Thus, he concludes, organizations should focus on achieving one critical mission. Finally, the author concludes that in these "dirty little wars," political and military tasks intertwine, and the objective is more often "nation building" rather than the destruction of an enemy's army. And the ability to quickly learn during these "dirty little wars" and adapt strategies and tactics is key to "learning to eat soup with a knife." ■

Maj Lisa Taylor, a military police officer, has spent the years since 9/11 focusing her training and employment on force protection. She is currently employed with the Concepts & Doctrine Development Branch at CFAWC, responsible for FP, CBRN and military police doctrine for the Air Force.



MLBU – MOBILE LAUNDRY AND BATH UNIT

– FULL MONTY IN KOREA

BY BOB RINGMA

BURNSTOWN, ONTARIO:
GENREAL STORE PUBLISHING HOUSE, 2004
169 PAGES ISBN 1-894263-85-5

Review by
LT(N) Pierrette LeDrew

History has shown that logistics is crucial to success in warfare. Countless books have been written about the many facets of logistics, with one notable exception. According to Bob Ringma, the author of MLBU (Mobile Laundry and Bath Unit) – Full Monty in Korea, these essential components used in the field in the Second World War and in Korea have been largely neglected by military historians.

Mr. Ringma, who was an officer in charge of such a unit in Korea, explains in the introduction that this lack of attention to a little known but essential aspect of troop support prompted him to write on the subject. Unfortunately, this book, although an enjoyable read, does little to fill the historical void on this topic.

Mr. Ringma's narrative is a personal account of his experience as a new officer in the Canadian Army Special Force that was sent to Korea in 1951. It follows him as he gets exposed to the military experience as a student at the University of British-Columbia, where he meets many veterans of the Second World War; through summer training in Montreal and pre-deployment training in Fort Lewis, Washington; and to his tour of duty in Korea and Japan. In a few short years, he evolves student to enlistment in an army corps he chose based on the location of the training (Ringma states: "My choice of a corps was made for totally unmilitary reasons. I wanted to see Canada, and the school for the Royal Canadian Ordnance Corps was in Montreal."). He then became a veteran of the Korean War who spent months as close to the front lines as anyone in the support services could.

Although Mr. Ringma is clearly proud of the shower and laundry services he and his staff provided for the soldiers, the book is about much more than that. In fact, while the MLBUs are mentioned throughout the book to a varying degree, this is, essentially, another anecdotal account of the broader Korean conflict, interspersed with facts and figures. It includes the author's musing on various issues, ranging from the firing of MacArthur by Truman to the effect of unification on the Canadian Army. The build up to the war and the overall conflict are discussed at length, as are the participation and contribution of the army, navy and air force. Two entire chapters, which could have been combined and summarised in a few pages, are devoted to historical and contemporary armies and support organisations.

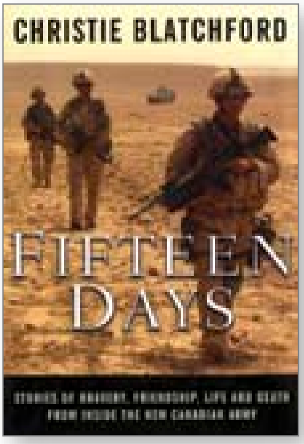
Many of the quotes used by Mr. Ringma are far too long. In chapter 18, The Air War, over two pages are devoted to a direct quote from another book. Others, such as the various Daily Routine Orders used in the Korean theatre, while aiming to provide clarity to the information given, only take up space in the book and do not add much to the story. The epilogue, in line with the foreword, written by Major General Lewis MacKenzie (Retired), has a "preachy" tone, and is not relevant to the expressed topic of the book – the MLBUs.

The book also suffers from editing flaws. There is much repetition of facts throughout; in one instance, the same sentence is repeated twice back to back. Some figures are not numbered, words are omitted, and there are numerous typographical errors.

On a more positive note, the book is written with a good dose of humour, and the author seems to be open about his personal experiences, both positive and negative. His perspective of Korea and its people is informative. The book is an easy read, with short chapters, that can be quickly skimmed over when necessary. The reader can find many references to other works on the Korean War that might be worth pursuing if the topic is of interest.

Although the narrative does not discuss the MLBUs as much as the cover or the introduction suggests, this book is still worth a quick read. If nothing else, it is an opportunity to read a first hand account of one man's war, as there are lessons to be learned in such accounts for all of us. ■

Lt(N) Pierrette LeDrew is a Public Affairs Officer at the Canadian Forces Aerospace Warfare Centre. She holds a bachelor's degree in history from the Royal Military College of Canada.



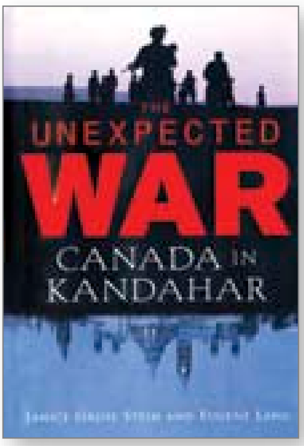
FIFTEEN DAYS:

STORIES OF BRAVERY, FRIENDSHIP, LIFE AND DEATH FROM INSIDE THE NEW CANADIAN ARMY

BY CHRISTIE BLATCHFORD

DOUBLEDAY CANADA, 2007
385 PAGES, HARDCOVER
ISBN 9780385664660

Review by **Major Paul Johnston**



THE UNEXPECTED WAR:

CANADA IN KANDAHAR

BY JANICE GROSS STEIN AND EUGENE LANG

VIKING, 2007
348 PAGES, HARDCOVER
ISBN 9780670067220

Why is Canada in Afghanistan? For such an important, and controversial, question it is perhaps surprising that it has taken so long for Canadian publishers to produce books touching on that issue. Or maybe it is not so surprising. Regardless, 2007 saw something of a flurry of books on the subject. Two that tackle the issue from opposite directions are *Fifteen Days: Stories of Bravery, Friendship, Life and Death from Inside the New Canadian Army* by Christie Blatchford and *The Unexpected War: Canada in Kandahar* by Janice Gross Stein and Eugene Lang.

They are opposite in many ways: *Fifteen Days* is a study of the human face of the Canadian soldiers undertaking the mission; *The Unexpected War* is a piece of policy analysis. *Fifteen Days* tackles it from the bottom-up, *The Unexpected War* from the top-down. One is gripping and at times frankly emotional; the other is abstract and rather dry. Both books have attracted their share of criticisms as well as plaudits. While you might not agree with everything they have to say, both should be read by those interested in following the issue of Canada's commitment to Afghanistan.

Christie Blatchford is a long-time reporter, currently for the Globe and Mail, who is most well known for her crime coverage, in which she tends to focus on the human interest angle—the victims, their families, the impact on communities, and of course the perpetrators themselves. Not surprisingly, this is the approach she brings to *Fifteen Days*, the result of her time in 2006 as an embedded reporter with the Princess Patricia's Canadian Light Infantry battle group in southern Afghanistan.

Fifteen Days is very much a "face of battle" type study. It is also, as the author herself admits in the Author's Note, a highly personal and somewhat selective view; the fifteen days of the title are fifteen days of her time in Afghanistan that stood out in her memory as the most significant. They were indeed significant days—days in which fatal casualties were incurred, and also as the author presumably intended, days that are emblematic of the general nature of our operations there. The lens through which they are reported is highly personal, and the selection is somewhat idiosyncratic—they are not even presented in chronological order. Blatchford recounts in her author's note that she struggled with the writing of this book, eventually just pouring it out as it came to her.

It must be said, the result is a gripping page turner. The human face of the conflict is brought into vivid relief. It should also be mentioned that the focus is not solely on the young soldiers in the field; almost equal attention is paid to the impact on the families and communities back home, who Blatchford clearly spent a great deal of time interviewing. One particularly poignant section describes how the father of one young soldier received notification of his son's death. Errol Cushley was out hiking on a side road near his home of Port Lamberton Ontario when one of his neighbours pulled up behind him and rolled down the window of his vehicle to say "Get in." When Errol asked what was wrong his neighbour tersely replied, "The army's here."[1] One can just imagine the clench in the gut the father must have felt at those words.

Errol Cushley was out hiking on a side road near his home of Port Lamberton Ontario when one of his neighbours pulled up behind him and rolled down the window of his vehicle to say "Get in." When Errol asked what was wrong his neighbour tersely replied, "The army's here." One can just imagine the clench in the gut the father must have felt at those words.

A few points do bear mentioning. As outlined above, there is no attempt at history or context, much less analysis. A bit more curiously, there is virtually no mention of the Afghans themselves. Surely an examination of the human impact on them would be illuminating. Finally, while this is not a criticism, readers of a journal such as this should be advised that the book is, as it says on the cover blurb, "stories of bravery, friendship, life and death from inside the new Canadian Army." It is indeed very much an account of the Land Forces' contribution to the mission, with nary a mention of the Air Force. Finally, there are those who will believe that Blatchford is an example of what is wrong with embedded journalism, that she illustrates how "embeds" can lose their objectivity and become simple cheerleaders for the soldiers they live amongst. "The Blatch", as she is known, might not dispute a claim that she is a cheerleader for the troops; she might even revel in the assertion. Most recently, she has been making a speaking tour of the country to promote her book and tell the stories of our soldiers' doings. In a recent newspaper column she describe how she "almost wept with relief" at the robust recommendations of the Manley report.[2]

The Unexpected War is very different. Individuals feature prominently in it too, but not the soldiers at the sharp end—it focuses on the politicians and officials in Ottawa. It is primarily an examination of the political decision making process that led to the commitment of a major Canadian force to the south of Afghanistan. As the authors note, sending troops to war is the "most difficult decision any government makes."[3]

Or at least, it should be, for the main theme of the book is that the government essentially sleepwalked into a significant combat mission in Kandahar. The authors Janice Gross Stein and Eugene Lang argue that the decision to undertake this major commitment was essentially a result of two factors: a desire to curry favour with the Americans, and the driving personality of the new Chief of the Defence Staff, General Rick Hillier.

That analysis is not unreasonable, and the core chapters that present it are the strongest portions of the book. It is based primarily upon interviews with an impressive array of insiders, including Prime Minister Paul Martin, Defence Ministers John McCallum, Bill Graham, and Gordon O'Connor, Generals Ray Henault and Rick Hillier, and various other luminaries, including John Manley, and Colonel Bernd Horn (former Director Canadian Forces Leadership Institute), not to mention the US Ambassador to Canada of the time, Paul Cellucci.

The authors make some interesting assertions. One is that in 2005, Prime Minister Martin wanted to focus foreign military commitments not on Afghanistan—a mission he had inherited from the Chrétien government—but on Darfur primarily, Haiti secondarily and the Middle East (specifically the Arab-Israeli conflict) thirdly.[4] "Afghanistan was a distant fourth at best."[5] Gross Stein and Lang assert that General Hillier, in a 21 March meeting and just a little over a month into his tenure as CDS, personally pitched to the Prime Minister the merits of a major commitment to Kandahar. It was only after Prime Minister Martin demanded, and received, personal assurances from General Hillier that a Kandahar mission would not preclude a major commitment to Darfur, Haiti or the Middle East, that Martin agreed.[6]

The authors' access to key personnel gives the book an aura of insider knowledge that can be fascinating. One of the little tidbits is the assertion (buried deep in the endnotes) that "Had John McCallum been minister of defence at this time [Jan-Feb 2005, when the new CDS was being selected], [then Major General Andrew] Leslie would have become CDS."[7] One of the reasons for this access is one of the problems with this book—Janice Gross Stein is a respected academic at the University of Toronto, Director of the Munk Centre for International Studies no less. But Eugene Lang is a Liberal party insider—in fact, he was the chief of staff for Ministers of National Defence John McCallum and Bill Graham,[8] a partisan position that the book is coy about admitting. While it is a defensible choice of writing style, never once does the text use the first person, even when describing meetings at which Lang was present. An interesting observation is that in the endnotes Lang continues to refer to himself in the third person. Not even the author's blurb on the back of the jacket can bring itself to admit that Lang was a partisan participant in the events the book describes. It does, however, slide in a vague reference to his work for "two ministers of national defence" who go unnamed. There is nothing wrong with someone like Lang making his argument for his interpretation of events, but that does not mean that the world has to accept it as the consensus conclusions of independent academics. Worse, this Liberal bias is clearly evident throughout the work, sometimes comically so. One raises an eyebrow at lines like "Prime Minister Martin's inquiring mind endeared him to officials and advisers—finally, here was a senior politician who didn't think he knew everything and really wanted advice."[9]

The book also meanders a bit. Considerable attention is devoted to ballistic missile defence (BMD). This topic is pertinent in that the book argues that it was to placate perceived American pique over Canadian refusal to join BMD that largely motivated the decision to deploy to Kandahar. But did we need two whole chapters worth of material on the arcane intricacies of the subject? Similarly, we get a chapter that is little more than a potted overview of the theory and history of insurgencies. Finally, there is a chapter on the "vexatious detainees" which is interesting (and once again current), and another chapter on the "3D" or "whole-of-government" concept, and how this is failing to live up to the larger claims made for it. This material is all interesting, but not entirely relevant to the book's core study of the original decision making in Ottawa.

Nevertheless, for its exhumation of the political decision making process, it remains "an important piece of political archaeology," as another former government insider put it in his review of the book.[10] It also closes with a chapter on "Canada in Kandahar: Making Choices" which is cogent, clear-sighted and forceful. As the authors note: "That Canada slid into this war does not make the war either unjust or wrong."[11] The authors believe that "Canada has at least three broad options" in Afghanistan: "extend its commitment in Kandahar and continue its combat."[12] Alternatively, they argue that in 2009 Canada "could legitimately claim that it had done its share" and withdraw (presumably to be replaced by other troop contributors, but who, if anyone, would do that would be a separate issue).[13] And finally, they believe that Canada could "withdraw its combat forces completely … [and shift to] development assistance." The Canadian commitment to Afghanistan "would not end, but change."[14] Clear-sightedly, the authors note that "no matter what Canada chooses to do, there is no guarantee of eventual success."[15]

Gross Stein and Lang do not appear to be cut-and-run advocates themselves. While realistic about the difficulties and prospects for success, the book ends with an account of a plea from some of the Afghans themselves. An Afghani man, meeting then Deputy Prime Minister John Manley in May 2007, is described passionately declaring that "If the international forces leave, the central government will collapse, millions of people will be displaced." [16]

In conclusion, both books are very different, not only in style and tone, but also approach. Both, however, have attracted a fair amount of attention and both can be recommended, for different reasons, to those seeking to learn more about Canada's involvement in Afghanistan. ■

Maj Paul Johnston is employed on the doctrine staff of the Canadian Forces Aerospace Warfare Centre, and has published widely in military journals.

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1 Christie Blatchford, *Fifteen Days: Stories of Bravery, Friendship, Life and Death from inside the New Canadian Army* (Toronto Doubleday Canada, 2007), 241.

2 Christie Blatchford "Government must now Embrace the full, bloody truth of Afghanistan" *The Globe and Mail*, 23 January 2008.

3 Janice Gross Stein and Eugene Lang, *The Unexpected War: Canada in Kandahar* (Toronto: Viking, 2007), 289.

4 Ibid., 189-190.

5 Ibid., 191.

6 Ibid., 192.

7 Ibid., 313.

8 A political appointment in the Minister's own office, not a civilian member of the Public Service or Department of National Defence.

9 Janice Gross Stein and Eugene Lang, *The Unexpected War: Canada in Kandahar* (Toronto: Viking, 2007) pp 110-111.

10 Robert Fowler, "Alice in Afghanistan" *Literary Review of Canada* Volume 16, Number 1, January/February 2008, pp 3-5.

11 Janice Gross Stein and Eugene Lang, *The Unexpected War: Canada in Kandahar* (Toronto: Viking, 2007) p 290.

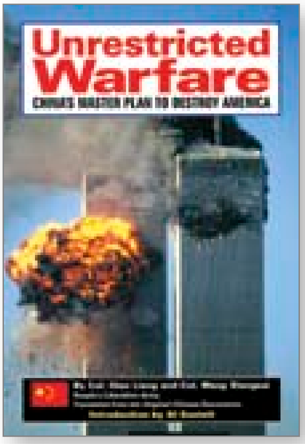
12 Ibid., 296.

13 Ibid., 298.

14 Ibid., 299.

15 Ibid., 299.

16 Ibid., 304.



UNRESTRICTED WARFARE:

CHINA'S MASTER PLAN TO DESTROY AMERICA

BY COL. QIAO LIANG AND COL. WANG XIANGSUI

TRANSLATED FROM THE ORIGINAL CHINESE DOCUMENTS
PANAMA CITY, PANAMA:
PAN AMERICAN PUBLISHING COMPANY, 2002
197 PAGES ISBN 0-9716807-2-8

Review by
Major Darrell Synnott

Unrestricted Warfare: China's Master Plan to Destroy America provides exposure to national strategic thinking at the grandest level. Employing every available means to achieve victory over one's enemy is the focus of this strategy. Building upon Sun Tzu's principles of war, this book looks at how technologically superior, conventionally structured forces can be crippled and beaten by numerically and/or technologically inferior military powers through the use of unconventional military and non-military attacks. Trade War, Financial War, "New Terror War in Contrast to Traditional Terror War", and even Ecological War are concepts now being recognized as viable tools capable of bringing about an enemy's defeat.

Chinese military strategists watched the American-led coalition destroy the fighting effectiveness of Iraq's military forces through the employment of high technology weapon systems during the 1991 Gulf War. The goal of this surveillance was to identify American strengths and pinpoint potential weaknesses within the American military system. In this book Colonels Qiao Liang and Wang Xiangsui present non-military methods of warfare by which China could negate America's overwhelming military/technological advantage, should they ever face off in a major conflict.

Western military forces are currently adapting to training, tactics and force re-structuring to conduct Military Operations Other Than War (MOOTW). Unrestricted Warfare describes how non-military activities can complement military operations in the achievement of strategic objectives. The authors introduce concepts such as: Smuggling Warfare (sabotaging an enemy's economy by flooding its markets with illegal goods), Cultural Warfare (influencing a targeted country's cultural biases by imposing your own cultural viewpoints), Drug Warfare (supplying illicit drugs to a targeted nation's population with the intent of breaking down the fabric of its society), Media and Fabrication Warfare (manipulating journalists, through intimidation or other means, in order to gain access to another country's media for the purposes of imposing your own national perspectives), Environmental Warfare (weakening or conquering another nation by despoiling its natural environment), and Resources Warfare (gaining control of an enemy nation's scarce or essential resources and then being able to control or deny their access and market value).

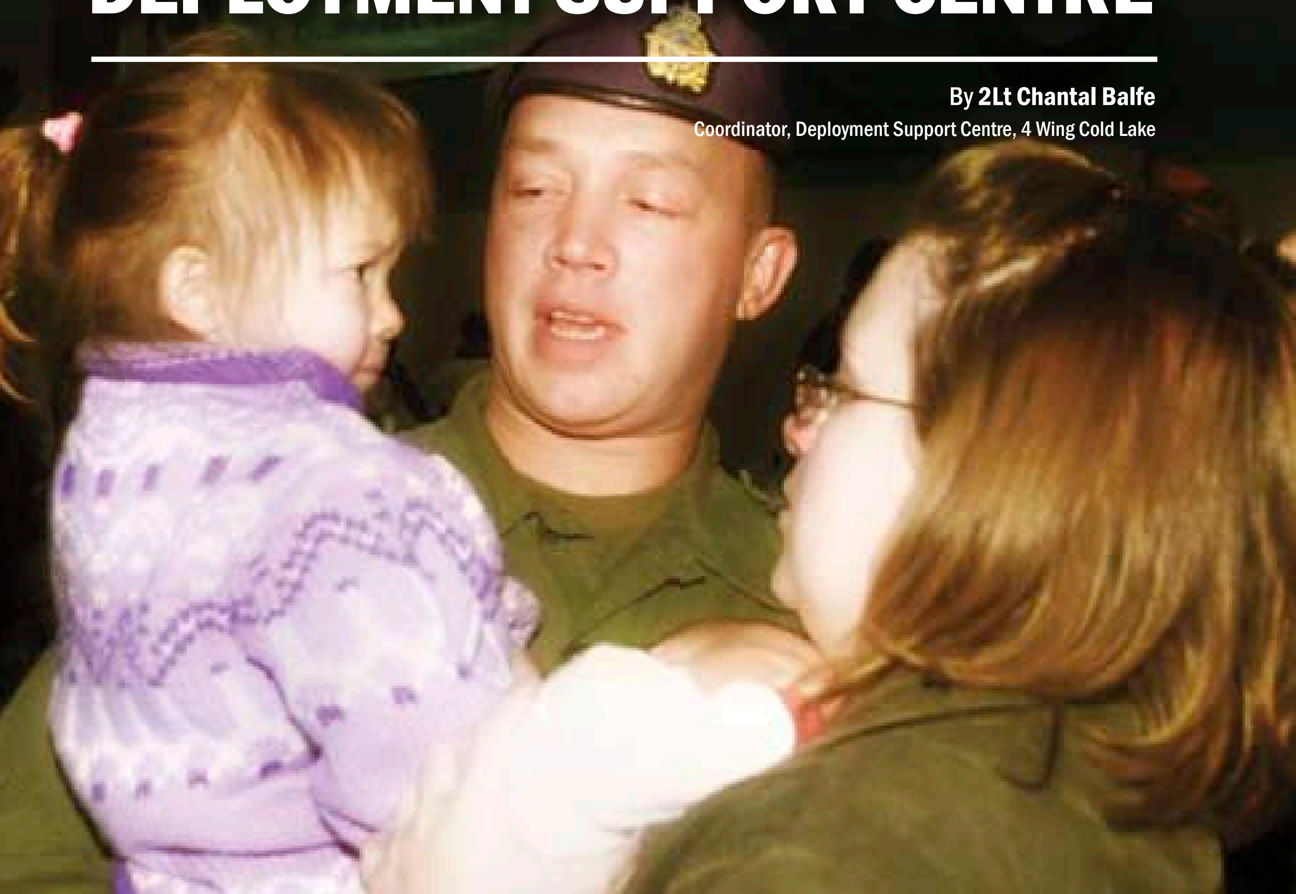
This book questions why a nation's grand strategy is confined to traditional military thinking, when long-term, non-military actions can be much more productive for achieving the desired results. The authors present not only possible targets to be exploited in war, but have identified potential vulnerabilities within Western society that must be protected from targeting by an adversary. *Unrestricted Warfare: China's Master Plan to Destroy America* challenges conventional models of war and the traditional actions of states and non-state actors. Qiao and Wang provide insight into what may become the future combat arena. ■

Major Darrell Synnott is a reservist working within the Concepts and Doctrine Development section of the Canadian Forces Aerospace Warfare Centre.

STAYING STRONG TOGETHER

- 4 WING ESTABLISHES THE AIR FORCE'S FIRST DEPLOYMENT SUPPORT CENTRE

By **2Lt Chantal Balfe**
Coordinator, Deployment Support Centre, 4 Wing Cold Lake



> **"My mission is, and I give you my word, that we will be taking care of your families and dependants."**
>
> **- Colonel J.J.P St-Amand, Commander, 4 Wing Cold Lake**

From Camp Mirage to Kandahar, Alert to Inuvik, the reality of today's Air Force is that our airmen and airwomen are called upon to upgrade, maintain, and exercise their warrior spirit more often than ever.

An effective network linking families, professionals and the chain of command can reduce the long-term impact of prolonged absences. To that end, 4 Wing has established a full-time Deployment Support Centre (DSC) to help families deal with the impact of repeated deployments and absences from home.

In comparison with the Army and Navy, Air Force deployments are generally smaller, more frequent and on shorter notice. The 24/7 operational tempo does not cease when a unit deploys, and the holes left by deployed members are not normally filled. Thus, there is no large body of personnel left behind to provide full-time family assistance.

Staffed by military members, the 4 Wing DSC was modelled after the Army's existing concept, but changed significantly to reflect 4 Wing's 24/7 operational nature. "Most deployments in the Air Force have very little lead-time and leave significant shortfalls in our operational capability," says Major Mark Schneider, Officer Commanding the 4 Wing DSC. "In the Army, personnel that don't deploy become the rear party (RP) to support the families left behind, but in the Air Force, our ability to provide family support in addition to filling the operational shortfalls is challenging."

The biggest challenge is to develop a sustainable rear party. Fortunately, the Air Force has much of its support infrastructure already in place.

"We maintain 24/7 operations centres, duty officers and chaplains on call, and the local Military Family Resource Centre has a dedicated deployment support coordinator," adds Maj. Schneider.

The DSC acts as a central coordinating and referral agency. Clients are briefed to contact the DSC for deployment information and support services. It is staffed by two military members and one civilian administrative assistant and is comprised of five components: the DSC core staff, the deployed members, the families, the chain of command and the sponsors. The RP consists of the unit Chief Warrant Officers and assigned military sponsors.

"The creation of the DSC has provided a centralized service agency for the deploying members, their families and the sponsors. The reduction in red tape to obtain deployment services has realized a positive impact all our clients," says Maj. Schneider.

During a deployment, a military sponsor is assigned to look after the needs of the member, the immediate family or extended family if the deploying member is single.

Sponsors are key component of the Air Force RP – which fluctuates in size depending on the numbers of members away. They are a continuous human resource that can be tasked to assist families when required.

Sponsors receive an assignment letter that details the duties and assistance expected of them. "Selection of the sponsor is critical as the sponsor, the deploying member and the family must all be agreeable to the assignment," says Maj. Schneider. "The sponsor works closely with the family and advocates for the deployed member for the duration of the deployment."

The sponsor programme is unique to the Air Force; it provides ongoing, continuous family care while maintaining the current operational tempo at the Wing.

"The sponsors are the key to our success," says Maj. Schneider.

Under the authority of the commanding officer or wing commander the sponsors can be excused from duty to assist the families during a crisis such as extreme weather. Additionally, the sponsors are an important link to keeping the families informed of events, unit family days and deployment related activities. "Essentially," he adds, "they are the families' connection to the chain of command and to the deployed member." ■

The 4 Wing DSC is the first official full-time facility of its kind for the Air Force.

Commissioned from the ranks, 2Lt Chantal Balfe is the Deployment Support Coordinator at 4 Wing Cold Lake.

VIRTUAL REALITY KICKS EXERCISE WINGED WARRIOR INTO OVERDRIVE

By **Captain Rae Joseph**
1 Wing Public Affairs Officer

Last year students on Exercise Winged Warrior were fully immersed in a virtual reality (VR) training environment. This year's exercise kicked the VR experience into overdrive with a new program, a new CF simulated air asset and a new location.

In 2006, the pilot VR exercise – the final phase of the 10-week Advanced Tactical Aviation Course (ATAC) – was conducted using the off-the-shelf Steal Beast Professional (SB Pro) program by eSims Games. This year's Winged Warrior used the Virtual Battle Space 2 program (VBS2) by Bohemia Industries from Australia.

"Steal Beast met all the aims," said Captain Jim Knutsson, the adjutant at 403 Helicopter Operational Training Squadron who was responsible for running the exercise. "So this year we wanted to continue with the flow and provide an even better virtual training experience."

ATAC is designed to train future aviation mission commanders to plan and execute missions in a complex and dynamic battle space against an asymmetrical threat and Winged Warrior is the course's validation exercise. The change to VBS2 for the exercise was due to the program's "real time editor" function (which allows control and changes to the scenario during the exercise) and improved visual qualities.

"When you're running a virtual exercise you can't script everything," said Capt Knutsson. "Sometimes the students will go off on a tangent, which is actually good because they create new problems and you can–while on the fly–make changes to the program as it's going, so you can start moving the enemy around.

"You can't always write a scenario that you dictate to an individual at a certain place, a certain direction, a certain time. So that is one of the huge aspects that [VBS2] gives you; to actually create and move things and effects in real time while the mission is being executed."

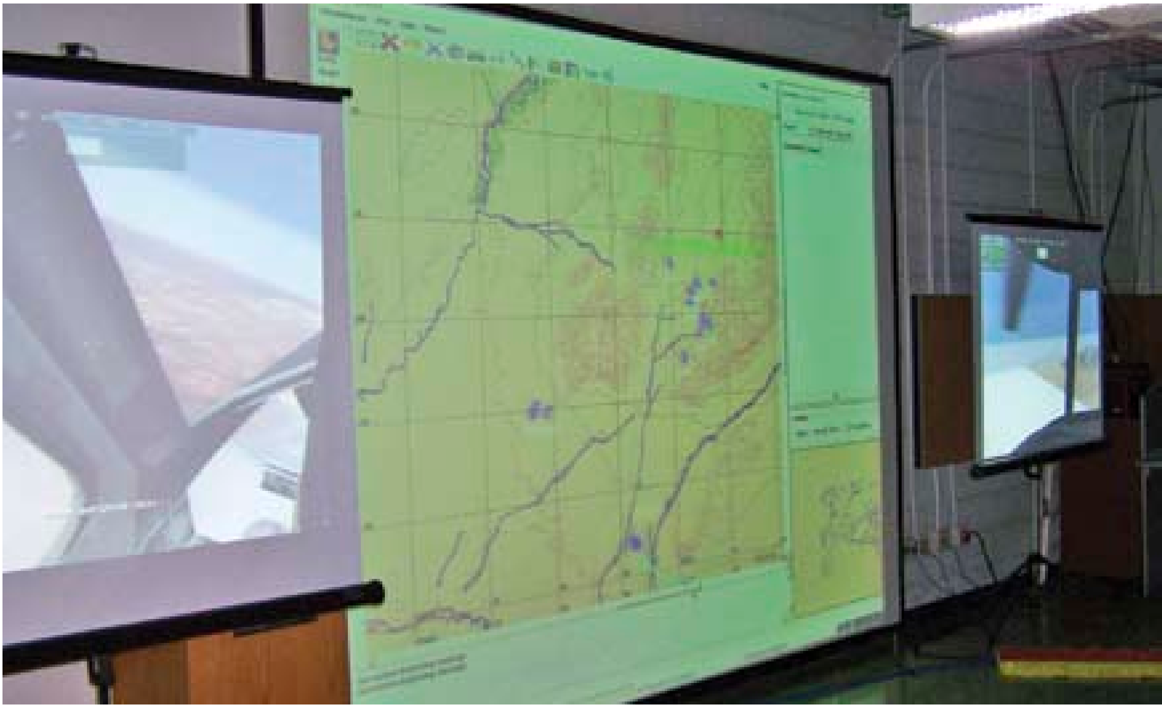
VBS2's graphics have improved visibility that allows the users to view ballistic projection.

"When a guy is firing the door gun off the Griffon he can see the tracers [visible bullets], he can lead it on to the target and it's actually going to affect the target as if a real weapon had been fired onto the target," explained Capt Knutsson. "So it is a fully reactive, fully capable program."

The artificial intelligence has significantly improved, according to Capt Knutsson. For example, if the mission was a convoy escort and the convoy ran into enemy forces, the program would stop the vehicles, deploy the ramps, and soldiers would get out and carry out military tactics like an all around defence.

The exercise's realism was added to by the presence of not only more than 50 staff from 1 Wing, a Chinook pilot and a loadmaster from the Netherlands and civilian support staff playing various roles, but also the close air support of CF18s.

The close air support, also dubbed "Raptor Squadron," didn't come from 3 Wing Bagotville or 4 Wing Cold Lake when scrambled, but from Shirley's Bay in Ottawa. This new virtual air asset to Winged Warrior was made possible by



Jon Wade and Murray Gamble from Virtualization and Simulation (VSIM) Centre at Carleton University.

"When the call to 'scramble the jets' was made, the CF18s would be sent via a crew monitoring the exercise from a network site at Shirley's Bay," said Jon Wade, who added the CF wanted a reusable system that could be reconfigured to incorporate any aircraft design, from CH146 Griffon to CF18.

"We created such a system and the CF18 (at Winged Warrior) is the first of the implementation of this technology," he said.

Winged Warrior also changed location this year. Last year Winged Warrior was held in Kingston, but this year it was held at Valcartier, Quebec, at the Centre d'entraînement en environnement synthétique (CEES).

"[CEES] has a great set up and ample room," said Capt Knutsson. "Plus it worked out well in Valcartier because 430e Escadron tactique d'hélicoptères (ETAH) supported Winged Warrior this year by providing pilots and an operations command post."

With 430 ETAH gearing up for high readiness posture next summer, Winged Warrior was also a valuable opportunity in the squadron's preparations for possible deployment anywhere in the world they may be required. ■

Captain Rae Joseph is the 1 Wing Public Affairs Officer working at the Headquarters in Kingston, Ontario.

SUPERMARINE SPITFIRE

THE FAMOUS ELLIPTICAL WING FIGHTER

By **MCpl Rene Paquet**
430 ETAH Valcartier

The Mk V was the first to see extensive service over the desert of North Africa, the waters of the Mediterranean and the vast Indian Ocean off the North coast of Australia. The Mk V was built using an Mk I and/or Mk II fuselage and the new Merlin 45 engine. Outclassed by later models, the Mk V still proved to be a worthy opponent when flown by pilots like Malan, Tuck, Johnson, Caldwell, Duke and Beurling.

The Spitfire was R.J. Mitchell's project and the first British all-metal low wing monoplane semi-monocoque aircraft. This construction was demanding to build. Structurally and aerodynamically very efficient, it carried more military equipment and bigger engines than designed for.

The fuselage was built as one unit, however the tail-section, which included the vertical stabilizer, was detachable from the rest of the fuselage. Only the rudder and elevators were covered with fabric. Protective armor was fitted behind the pilot's seat. The windshield had an armour glass outside, but later models had their armour moved inside.

The elliptical wings were no coincidence. They were designed based on knowledge of aerodynamics. The wings' main spares were mounted to the forward frame and fuselage. The wings were designed with detachable tips, which provided the advantage of reduced drag, especially around the wing tips. This provided very good for high-altitude performance.

The split-flaps were pneumatically operated and retracted by the use of a spring and airflow. When taking off from an aircraft carrier, wooden wedges were placed between the flaps and the wings. Once airborne the pilot cycled the flaps to drop the wedges.

George "Screwball" Beurling

A hand pump hydraulically operated the undercarriage, but later an engine-driven pump was used. If the hydraulic system failed, a carbon dioxide bottle provided pressure to operate the main landing gears one time. A warning horn sounded if the main landing gears were not locked down. The tail wheel used a large shock absorber to handle hard landings.

The Rolls-Royce Merlin 45 was a V-12 liquid cooled float-type carburetor engine with a single-speed supercharger. It was fitted to the airframe with tubular mounts. An electric starter or a Coffman cartridge-starter normally cranked the engine, but for emergencies it could be done by hand. The Spitfire two-bladed propeller was later replaced by a variable pitch three-bladed DeHavilland propeller with two settings.

The early armaments were eight Browning 7.7 mm machine guns, manufactured by Colt in the USA. Later the Mk V used four Browning 7.7 mm machine guns with 350 rounds each and two Hispano-Suiza 20 mm cannons with 120 rounds each.

The battle for Malta

For those who fought and died on the island of Malta between 1940 and 1943, it is a story of death and destruction, of courage and determination. It is a story which is well known and cannot be explained in such limited space.

According to historian Alan Moorehead, it was a siege of annihilation. One after another, all the other great sieges were eclipsed, England and Odessa, Sebastopol and Tobruk. Malta became the most bombed place on earth.

Malta was not a place for beginners, all pilots were carefully chosen, and among their ranks was George "Screwball" Beurling who became Malta's highest scoring ace with 23 and one-third victories.

Born in Montreal, QC in 1921, George Beurling went to Great Britain and joined the RAF in September 1940. After his training he became sergeant and flew the Spitfire Mk V. Beurling claimed his first two victories off the French coast in May 1942.

The following month Beurling went to Malta. In July he shot down 15 aircraft including three Bf 109s in one sortie. He was commissioned a month later. On October 14 Beurling downed a Ju 88 and two Bf 109s, but was wounded by shrapnel in the heels. Later he was awarded the Distinguished Service Order and sent to England for treatment and rehabilitation.

Beurling dedicated himself to improving his skills, especially in deflection shooting, which proved to be vital to survival in the deadly skies of Malta. Beurling was a complex maverick character. He didn't smoke or drink and was not given to swearing. In fact, his prime expletive to anything or anyone unusual was "screwball"; hence the nickname.

He was a talented fighter pilot, but his refusal to accept authority made him many enemies among his superiors and only his distinguished combat record saved him from a court martial. In April 1944, he returned to Canada, but more disciplinary problems forced him to resign his commission and he retired that same year. Beurling had difficulties with the demands of civilian life and for three years he went from job to job.

In 1948 he accepted an offer to fly with the air force formed by the new state of Israel. He was to ferry light transport, but on May 20, after taking off from Rome, his aircraft blew up and crashed, killing him and his co-pilot. Sabotage was suspected, but never proven.

At the end of the war Beurling's victories stood at 31 with one shared destroyed and nine damaged, all but two of which were scored while flying the Spitfire Mk V. This made him by far the most successful pilot on this type of aircraft.

The Spitfire was one of the most elegant and beautiful aircraft that ever flew. Remembering these legendary aircraft, we honour the thousands of men who paid the ultimate price one can pay. ■

MCpl Rene Paquet was born in Havre St-Pierre P.Q. and currently works at 430 SQN ETAH Valcartier. His hobbies as an aircraft modeller (all vintages) and figure maker/modeller (Ancient and Medieval eras) have given him the opportunity to study and become a military history buff.

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CALL FOR PAPERS

CANADIAN FORCES AEROSPACE WARFARE CENTRE

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

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 of its facets. Topics may deal with an individual, command relationships, civil-military interaction, leadership in a coalition, peacetime / wartime leadership requirements, leadership training, etc. Topics need not be limited to flying operations. Individuals interested in presenting a paper should forward a short one or two paragraph proposal to Major Bill March prior to 21 June 2008. Notification of selection will be provided by 30 June 2008.

Maj Bill March
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