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THE NEED FOR PRECISION-GUIDED STANDOFF WEAPONS FOR CANADA'S TACTICAL AVIATION COMMUNITY

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ABSTRACT

Although the provision of aerial firepower in support of land force operations is one of the three core doctrinal roles for tactical aviation, it has historically been marginalized in the Canadian Forces (CF) tactical aviation community. The operational imperatives that prompted the development of armed aviation globally did not gain sufficient prominence in Canada until 2008, when eight CH146 helicopters were deployed to Afghanistan as a consequence of the Manley Report. While it proved to be a capable gunship in over two and a half years of combat operations, the potency of the Griffon's kinetic effects remained insufficient to counter many of the threats typically encountered in Afghanistan, resulting in the Canadian Army's request for an expanded aviation fire support capability. This paper demonstrates that the tactical aviation community must acquire an organic precision-guided stand-off fire support capability to remain relevant for conducting operations in the contemporary security environment. This study begins by examining the historical aspects of armed aviation, including the circumstances that hindered its development in Canada. An analysis of future security challenges follows in order to substantiate the need for precision guided munitions (PGM). Finally, both weapons and platforms are compared in order to explore what options exist for acquiring a PGM capability for the tactical aviation community. The evaluation indicates that in the short term, the most viable solution is expanding the armament of the CH146, given that attack helicopters will likely continue to remain a politically unacceptable solution for the CF. However, emerging rotary wing UAV technologies must be closely monitored, given the strong likelihood that they will afford greater flexibility across the spectrum of tactical aviation battlefield requirements.

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LIST OF ABREVIATIONS

ABFAC	Airborne Forward Air Controlling
ACE	Airborne Convoy Escort
ACF	Aerospace Capability Framework
AE	Aerial Escort
AH	Attack Helicopter
ALB	Air-Land Battle
ALI	Air-Land Integration
AOP	Aerial Observation Post
AOW	Armed Overwatch
APKWS	Advanced Precision Kill Weapon System
ARH	Armed Reconnaissance Helicopter
CA	Canadian Army
CAS	Close Air Support
CCA	Close Combat Attack
CDS	Chief of the Defence Staff
CFDS	Canada First Defence Strategy
CDR	Capability Development Record
CF	Canadian Forces
CHF(A)	Canadian Helicopter Force (Afghanistan)
COIN	Counter-Insurgency
DAGR	Directional Attack Guided Rocket
F&F	Fire and Forget
FMC	Force Mobile Command
FW	Fixed Wing
GPMG	General Purpose Machine Gun
GoC	Government of Canada
HQ	Headquarters
IED	Improvised Explosive Device
INGRESS	Inter-operable Griffon Reconnaissance and Escort Surveillance System
JTAC	Joint Terminal Attack Controller
LOAL	Lock On After Launch
LOBL	Lock On Before Launch
MANPAD	Man Portable Air Defence Missile
MBT	Main Battle Tank
MHLH	Medium-to-Heavy Lift Helicopter
MUM-T	Manned Unmanned Teaming
NATO	North Atlantic Treaty Organization

O&M	Operations and Maintenance
PGM	Precision Guided Munition
RCAF	Royal Canadian Air Force
RPG	Rocket Propelled Grenade
RW	Rotary Wing
SOCD	Statement of Capability Deficiency
SOI	Statement of Operating Intent
SSV	Soft Skinned Vehicle
TIC	Troops-in-Contact
TOW	Tube-launched, Optically-Tracked, Wire-Guided
UAV	Uninhabited Aerial Vehicle
UCAR	Unmanned Combat Armed Rotorcraft
US	United States
USD	United States Dollars
USAF	United States Air Force
UTTH	Utility Tactical Transport Helicopter

Army aviation's role of providing the indispensable vertical dimension to the modern battlefield has come to be universally recognized.

- Major-General John "Mark" Curran, Former Commander US Army Aviation[1]

INTRODUCTION

The provision of aerial firepower in support of land force operations is one of the three core doctrinal roles for tactical aviation, but unfortunately, it has historically been marginalized in the Canadian Forces (CF) tactical aviation community in favour of mobility operations, and to a lesser extent, reconnaissance support.[2] The use of helicopters as a direct fire support platform initially gained prominence with the United States (US) Army during the Vietnam War. They proved to be a highly effective instrument for furnishing intimate support to ground forces engaged in battle.[3] The development of the attack helicopter quickly followed, spurred by the masses of Soviet armour on the European front during the Cold War.[4] Canada briefly flirted with the acquisition of a dedicated attack helicopter beginning in 1972. However, this project was effectively terminated when control of the CF's tactical aviation community was passed from the army to the air force in 1975.[5]

The operational imperatives that had provided the catalyst for the development of armed aviation did not gain sufficient prominence in Canada until the Government established the

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[1] Wilson, J.R. "Army Aviation: New Roles for Helicopters in Transforming Times." *Armed Forces Journal* 141, no. 8 (March 2004): 44.

[2] Department of National Defence, B-GA-440-000/AF-000, *Tactical Helicopter Operations* (Ottawa: DND Canada, 1998), 1.

[3] James W. Williams, *A History of Army Aviation: From Its Beginnings to the War on Terror* (Lincoln: iUniverse, 2005), 117.

[4] James W. Bradin, *From Hot Air to Hellfire: The History of Army Attack Aviation*, (Novato: Presidio Press, 1994), 92, 122.

[5] Dean C. Black, "Canada's Army Loses its Air Force: The Royal Canadian Air Force and the Origins of 10 Tactical Air Group," in *Sic Itur Ad Astra: Canadian Aerospace Power Studies, Volume 2: Big Sky, Little Air Force*, ed. W.A. March, 97-106 (Trenton: Canadian Aerospace Warfare Centre, 2009), 97, 99.

Independent Panel on Canada's Future Role in Afghanistan. The findings of the panel, in what has become known as "The Manley Report," recommended procuring new medium-lift helicopters in order to "improve the safety and operational effectiveness of the Canadian Forces in Kandahar" by helping keep the soldiers of Canada and its allies off the improvised explosive device (IED)-laden roads whenever feasible.[6] Six CH147 Chinook Helicopters were purchased in short order from the US, and less than a year after the release of the report, Canadian Helicopter Force (Afghanistan) (CHF(A)) was established.[7]

In order to protect the vulnerable CH147, it was necessary to deploy eight CH146 Griffon helicopters as part of CHF(A). While the primary task of the CH146 was aerial escort, the aircrew were also given a mandate to provide aerial fire support to troops-in-contact (TIC) throughout their area of operations.[8] This represented a significant departure from the traditional mobility-based employment of the CH146, as these procedures were previously untried by the Canadian tactical aviation community on expeditionary operations. In order to fulfil these force-protection tasks, new sensors and weapons systems had to be procured and fielded rapidly. In very short order, the provision of fire support had gone from a role that was virtually ignored to one that would be conducted in combat on a routine basis.

While the CH146 proved to be a capable gunship in over two and a half years of combat operations, the potency of its kinetic effects remained insufficient to defeat many of the threats typically encountered in the Afghanistan battlespace. In particular, the CH146 door guns were incapable of breaching the structures that insurgents utilized to provide cover for many of their attacks. The legacy of Afghanistan demonstrates that further developments in aviation fire

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[6] John Manley, et al., *Independent Panel on Canada's Future Role in Afghanistan* (Ottawa: Public Works and Government Services, 2008): 35.

[7] Department of National Defence, BG-09.001, *Canada's Air Force in Afghanistan: Backgrounder*, (Ottawa: National Defence Headquarters, 2009): 4.

[8] *Ibid*.

support for the CF are still needed. However, it is necessary to first conduct a thorough analysis of the future security environment to ensure that any capability expansion will posture the tactical aviation community to confront forthcoming challenges, not just those of the past.

The nature of modern conflict has evolved significantly since the end of the Cold War. Arguably the last true conventional battle in line with Cold War expectations was fought during Operation Desert Storm in 1991. Given that the only current global superpower is the US, there is a credible opinion that high-intensity conventional warfare is not likely to be encountered in the next 30 years, and may in fact never return.[9] Consequently, the recent counter-insurgency (COIN) operations in Iraq and Afghanistan are far more indicative of the most probable missions that Western militaries will undertake for the foreseeable future in an effort to promote global stability.[10]

This shift towards irregular methods of warfare has two major characteristics that are of note for tactical aviation. First, irregular warfare is people-centric. As such, the battlefield has become substantially more urbanized, and the corresponding need to limit collateral damage is paramount. This dictates that lethal effects must be extremely surgical in nature, having both a high degree of precision and restraints on the extent of kinetic effects to minimize the risk of unnecessary suffering in the civilian population, given that their support is ultimately needed to achieve victory. Second, opportunities to engage targets are fleeting. Insurgent forces do not wear recognized uniforms and can blend back into the local population as quickly as they first appeared. The evanescent opportunities to acquire and engage these targets demand a short "sense-to-act" targeting loop. Armed aviation platforms, which are able to exploit the vertical battlefield dimension to acquire and track targets, and then rapidly engage them with organic

[9] Maryann Lawlor, "Leaders Call for Balance in the Force," *Signal* 63, no. 1 (September 2008): 88.
[10] Paul Scharre, "A Balancing Act," *Armed Forces Journal* 147 no. 9 (May 2010): 18.

munitions, are exceptionally well suited to overcome these challenges.[11] Regrettably, Canadian tactical aviation cannot fully capitalize on these opportunities to provide effective fire support for the land forces of the CF and its allies due to the lack of a precision guided munitions (PGM) capability.[12]

Technological innovations in aircraft design must also be considered when determining what further fire support developments should be undertaken for the tactical aviation community. The era of manned flight, which only recently celebrated its centennial birthday, remains a relatively recent development in the broader context of waging war. Despite this fact, there is already a school of belief forming that the current generation of aircraft development, which notably includes the F-22 Raptor and F-35 Lighting II, may well represent the last manned combat air platforms fielded.[13] Uninhabited aerial vehicles (UAVs) are being developed with a far greater range of combat capabilities. This is a natural progression in the evolution of air power, as technology has always sought to find ways of minimizing the risk to aircrew. Therefore, prudence dictates that UAVs be one of the solutions examined as a potential means of satisfying the fire support role for the tactical aviation community.

One of the key undertakings associated with completion of the Afghanistan combat mission in 2011 was formally capturing all the mission's identified lessons. Critical to this initiative was a review and re-issue of the Army's capability development record (CDR) for tactical aviation support. The revised CDR released in the spring of 2012 calls for the "provision

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[11] Paul Darling and Justin Lawlor, "Updating Close-Air Support: New Doctrine and Aircraft are Need for COIN Warfare," *Armed Forces Journal* 148, no. 4 (November 2010): 28.

[12] A statement of capability deficiency (SOCD) regarding the acquisition of a PGM stand-off capability was raised by 1 Wing Headquarters in March 2009. This SOCD remains unsupported by the RCAF as of the time of writing this document.

[13] Carl Doyon, "Replacing the CF-18 Hornet: Unmanned Combat Aerial Vehicle or Joint Strike Fighter," *Canadian Military Journal* 6 no. 1 (Spring 2005): 39; "The Defence Industry: The Last Manned Fighter," *The Economist*, 16 July 2011, 67. http://search.proquest.com/docview/877477407?accountid=9867.

of direct and indirect organic precision fire support as part of the sense-to-act function."[14] This is an unequivocal indication of the importance that the Army has placed on exploiting the potential of aviation-borne fires on future battlefields. This study will demonstrate that the nature of future conflicts, in which irregular methods of warfare will be dominant, necessitates that the tactical aviation community acquire an organic precision-guided stand-off fire support capability to remain relevant for conducting operations in the contemporary security environment.

The first chapter will begin by providing a brief literature review and then examining the historical evolution of armed aviation. Next, an analysis of the requirements that led to the development and fielding of the attack helicopter will be provided. The discussion will then shift to an examination of the tactical employment of aviation, including the advent of Air-Land Battle doctrine and the implications of embodying aviation as a manoeuvre element of the combined arms team. The chapter will conclude with a brief historical overview of aviation-borne fire support within the CF. The second chapter will begin by scrutinizing the operational requirement stipulated in the tactical aviation CDR to determine the full extent of its validity. This will be accomplished by examining Canadian aviation operations in Afghanistan to determine the most likely missions that the tactical aviation community will undertake in future operational theatres. This will then be dovetailed into a broader examination of the conflict environments in which the CF is likely to find itself conducting operations.

With the foundation for fire support as an essential capability firmly established, the third chapter will explore both current and emerging weapons technologies, and offer suggestions on the optimum choice based on a number of broad criteria. The final chapter will then provide a brief overview of the full range options that exist for providing a fire support capability, from the

[14] Department of Defence, *Capability Development Record (Tactical Aviation)* 04002v4 (Kingston: Directorate of Army Doctrine, March 2012), 32.

relatively simplistic option of simply enhancing the CH146 Griffon armament to initiating a program to acquire a completely new platform. Recommendations will be based on the effort to maximize the overall combat effectiveness by striking the optimum balance of a number of operational and strategic factors, including, but not limited to: operational capability, flexibility, cost, and survivability. In the end, it will be clear that the CF will reap significant operational benefits from acquiring a PGM capability for the tactical aviation community.

CHAPTER 1: ARMED AVIATION HISTORICAL PERSPECTIVES

Introduction

If Canada is to acquire a PGM capability for tactical aviation, then it is useful to understand the circumstances that have continued to perpetuate the absence of these weapons. This chapter will begin by providing a quick overview of the existing literature regarding the calls for a Canadian tactical aviation fire support capability. The next section will then briefly examine the development and fielding of the helicopter in the Second World War. The impact of the Korean and Vietnam Wars on the development of armed aviation will then be examined, including the hindrances posed by inter-service rivalries between the US Army and Air Force, which ultimately solidified the requirement for the retention of an organic aviation capability for the army. This will lead into a discussion of the circumstances on the European front that triggered the creation of modern, advanced attack helicopters, and the corresponding adoption of a manoeuvrist war-fighting mentality, expressed through the advent of Air-Land Battle doctrine, to support their tactical employment. With this American and North Atlantic Treaty Organization (NATO) historical context, a specific analysis of the history of tactical aviation in Canada will be undertaken, with a particular emphasis on the impacts of both the unification of the Canadian military services in 1968 and the rise of air-land integration in Afghanistan. Ultimately, it will be clear that the enduring lack of Canadian tactical aviation firepower capabilities directly stems from the failure to accept the community as an integral manoeuvre element of the combined arms team.

Literature Review

To commence this study, it is useful to first provide an overview on what has been published with regards to acquiring a fire power capability for the tactical aviation community.

Surprisingly, despite the emotional response that the ongoing lack of an attack helicopter generates amongst CF tactical helicopter pilots, very little has been formally written on the subject. Lieutenant-Colonel (Retired) Dean Black has provided an excellent overview of a number of historical factors that impeded the development of a tactical aviation fire support capability during the period of the unification of the CF in the series on *Canadian Aerospace Power Studies*.[15] Colonel (Retired) Randall Wakelam presents further historical insights into the era that followed the establishment of Air Command. In particular, he describes the circumstances that led to Canada's loss of reconnaissance and lift helicopters as the new financial realities associated with the end of the Cold War took hold, resulting in a fleet rationalization to a single utility platform, the CH146 Griffon.[16] Concerning the modern fleet of Griffon helicopters, Major Danny Houde first articulated the inherent potential for the arming the CH146 in 2000 as a cost-effective means of providing a meaningful aviation fire support capability.[17] This was reiterated less than two years later by the release of *The Armed Griffon Concept* by 1 Wing Headquarters.[18] Unfortunately, the sensor system upon which these models were contingent was cancelled in 2003, effectively ending any further discussions on acquiring a fire support capability for a number of years.[19]

It was not until the acquisition of CH147 under the medium-to-heavy lift helicopter (MHLH) project was announced that the firepower discussion would be reopened. Defence scientists Thierry Gongora and Slawomir Wesolkowski examined the force structures of ten

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[15] Black, *Canada's Army Loses*…, 97-106.

[16] Randall Wakelam, "A Fine Mess: How are Tactical Helicopter Force Came to be What it Is," *Canadian Air Force Journal* 1, no. 3 (Fall 2008): 50-51.

[17] Danny Houde, "The CH-146: An Armed Helicopter for the Canadian Army," *Army Doctrine and Training Bulletin* 3 no. 4 (Winter 2000/Spring 2001): 40.

[18] Canadian Armed Forces. *Tactical Aviation Aerial Firepower: The Armed Griffon Concept*, (CFB Kingston: 1 Wing Headquarters, 2002), i-ii.

[19] Department of National Defence, *2517 Canadian Forces Utility Tactical Transport Helicopter: Minutes of Senior Review Board of 04 Dec 2003* (Ottawa: DND Canada, 31 Dec 2003): 6-7.

tactical aviation communities in order to determine if Canada was missing any key capabilities. Their analysis determined that Canada's future force structure will continue to remain unbalanced owing to the lack of a dedicated attack or armed reconnaissance helicopter.[20] Concurrently, the Air Force Association Aviation Affairs Committee called for the procurement of a fleet of armed reconnaissance helicopters to escort the new CH147s.[21] Furthermore, a select number of papers regarding the broader subject of tactical aviation support to the land force have been written by students attending the Canadian Forces College, with several recommending the acquisition of an attack helicopter, although the last of these was written in 1997.[22] Of note, these papers did not address the applicability of an attack helicopter in COIN campaigns, but this is not surprising given the time frame that these papers were written. Finally, it must be mentioned that many of the weapons and aircraft options discussed in this paper have only been recently fielded, and as such, rely predominantly on technical references given the current dearth of academic sources. This study will exploit the most recent research available to help fill in the gaps in the existing literature.

A Brief Historical Overview: The Rise of Armed and Attack Helicopters

The precise origin of the armed helicopter is likely to remain in a perpetual state of debate. The Second World War saw the initial, albeit modest, military use of helicopters in limited combat roles, including the first known combat extraction of downed aircrew.

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[20] Thierry Gongora and Slawomir Wesolkowski, "What Does a Balanced Helicopter Force Structure Look Like: An International Comparison," *The Canadian Air Force Journal* 1, no. 2 (Summer 2008): 19.

[21] Air Force Association Aviation Affairs Committee, "Canada's Air Power Voice: Air Force Association Aviation Affairs Committee position on Armed Reconnaissance Helicopter Support for Chinook Operations," *Airforce Magazine* 31 no. 4 (December 2008): 7.

[22] J.R. Lessard, "Attack Helicopters in Canadian Tactical Aviation," Command and Staff Course Bright Light Paper, Canadian Forces College, 1987; G.W. Nordick, "Into the Future: Tactical Aviation," (Command and Staff Course New Horizons Paper, Canadian Forces College, 1989); Jean-Pierre Pichette, "Does the Canadian Army Have Adequate Helicopter Support to Meet All Assigned Tasks," (Command and Staff Course New Horizons Paper, Canadian Forces College, 1997); Robert H. Vincent, "Helicopter Fleet Rationalization and Support to the Land Battle," (Command and Staff Course New Horizons Paper, Canadian Forces College, 1991).

Unsurprisingly, this war provided the initial efforts to arm helicopters, with both the Germans and Americans experimenting with the installation of guns for the purpose of self-defence; however, the conflict would end before an armed helicopter would be employed on the battlefield. Additionally, the British experimented with the use of helicopters equipped with radar and depth charges from merchant marine ships to provide an anti-submarine warfare capability to convoys crossing the Atlantic Ocean. Further developments in the arming of helicopters, including the first efforts towards the use of helicopters for offensive fires support, continued for a brief time following the end of the Second World War. Most notably, the US Army conducted a test in 1945 which involved firing a 75 mm recoilless rifle mounted to an R-6 helicopter, yielding less than optimal results. However, lacking the developmental imperatives of the war, further efforts to arm battlefield helicopters quickly lost momentum.[23]

Despite the helicopter firmly cementing its reputation on the battlefield during the Korean War, it was still largely restricted to combat support functions such as medical evacuation and emergency resupply.[24] It was not until France deployed helicopters armed with both cannons and rockets to Algeria in 1954 that helicopters would finally be used to directly support land combat operations.[25] Similarly, the experiences of the Korean War solidified the opinion that the Army could not rely on the Air Force for its continual close air support (CAS) needs.[26] This provided the impetus for the US Army to recommence their efforts at arming their own helicopters with weapons such as rocket-propelled grenades. Regrettably, these attempts would be seriously hampered by political in-fighting between the US Army and Air Force with regards to the army

[23] Bradin, *From Hot Air…,* 59-61; Pichette, *Does the Canadian Army*…, 4.
[24] Williams, *A History of Army Aviation…,* 52.
[25] Paul Beaver, *Attack Helicopters*, (Dorset: Arms and Armour Press Ltd, 1987), 5.
[26] Bradin, *From Hot Air*…, 88.

possessing armed aircraft.[27] This stemmed from the Key West agreement of 1948, which clearly delegated the roles of both the newly-created US Air Force and the remaining elements of US Army Aviation. The Air Force was to be the only organization with an attack capability, and naturally, they were loath to relinquish any of their new responsibilities. Compounding the difficulties for the Army was that the Air Force was in charge of the acquisition of all aircraft, including the army's helicopters.[28]

In reality, the problems flowed from the systemic difference in the war-fighting philosophies of the Air Force and Army. The Air Force was focused on the teachings of air theorists such as Colonel Giulio Douhet, who believed in using offensive strategic bombing for the enemy's capitulation, even if that came at the expense of all other missions.[29] One of the most extreme examples of this view is evident in the frustrations that were expressed by Air Force personnel at the re-allocation of fighters from bomber escort to intimate army support techniques during the preparations for the Normandy landings of the Second World War.[30] Predictably, the Army was far more concerned with tactical air support, which is ultimately concerned with the defence of the troops on the ground. [31] The Air Force's unwillingness to provide greater emphasis on this role naturally gave rise to a sense of ill-will between the services.

The decision to enter the Vietnam War would prove to be the watershed for the development of armed aviation. At the outset of the war, the only helicopter armaments in-service were door guns on the army's fleet of transport helicopters, which were intended to

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[27] Beaver, *Attack Helicopters*, 5; Bradin, *From Hot Air*…, 85, 91, 94; Williams, *A History of Army Aviation*…, 117.

[28] Bradin, *From Hot Air*…, 75-78.

[29] *Ibid*., 65-66.

[30] Clare L. Annis, "The Dilemma of Air Power," *Canadian Air Force Journal* 1, no. 3 (Fall 2008): 35.

[31] Bradin, *From Hot Air*…, 65.

suppress threats in the landing zone during take-off and landing; unfortunately, this often proved inadequate due to an insufficient weight of fire from the guns. Compounding the problem was the scarcity of artillery and CAS; when air support was made available, its effectiveness was hindered due to a lack of joint training. The need to provide fire support to troops under enemy contact, coupled with the mounting losses of unescorted lift helicopters, provided an absolute requirement for a purpose-built armed helicopter. As an initial measure, the venerable UH-1 Huey was armed with machine guns and 2.75-inch rockets. However, the addition of these armaments would restrict their speed, and ultimately impede their ability to keep up with the 'slick' troop-carrying Hueys.[32] This provided the genesis for the development of the AH-1 Cobra, which would subsequently become the first attack helicopter to enter production.[33] However, the Cobra lacked a true anti-armour capability due to the absence of a precision-strike weapon; in fact, it was the Huey that would be the first aircraft to be equipped with the tube-launched, optically-tracked, wire-guided (TOW) missile system, and this would only occur at the end of the war.[34]

As America began withdrawing from Vietnam, their attention naturally returned to Europe, and the mass of Warsaw Pact tanks. The importance placed on finding a solution to defeat these tanks would become "NATO and the US Army's primary concern… and would become one of the reasons for today's attack helicopters."[35] It was ultimately the Ansbach trials of 1972 that would irrefutably demonstrate the lethality of a missile-laden anti-tank helicopter;[36] they showed that on average, helicopters could destroy 18 tanks per helicopter lost. The results of this exercise paved the way for the subsequent expansion of the Cobra's armament to include

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[32] Bradin, *From Hot Air*…, 112-114.
[33] Beaver, *Attack Helicopters*, 6.
[34] Bradin, *From Hot Air*…, 127-128.
[35] *Ibid*., 92, 122.
[36] Black, *Canada's Army Loses*…, 100.

the TOW system, and greatly influenced the Advanced Attack Helicopter project, the result of which would be the premier attack helicopter of today's battlefield, the AH-64 Apache.[37] While the helicopter had established itself as an important means by which land forces could improve their anti-tank capabilities, it also brought about the need to adopt a war-fighting strategy which would realize the full potential of its combat effectiveness.[38] With this perspective, it is now possible to examine the doctrinal approaches resulting from the incorporation of the attack helicopter into Western militaries.

US Air-Land Battle Doctrine

The armed helicopter quickly became an essential component, if not the centerpiece of modern armies, due to its unparalleled ability to maximize the application of combat power.[39] During the Cold War, the Soviets held the attack helicopter in such high regard that it considered an aviation brigade as being equivalent to a tank division.[40] Similarly, an AH-64 Apache attack helicopter battalion continues to be considered the most powerful battalion in the US Army.[41] Exploiting the full potential of the attack helicopter required developing a corresponding methodology to war-fighting that would capitalize upon the speed, reach and firepower of these platforms. Given the vast numerical superiority of the Warsaw Pact at the end of the Vietnam War, NATO could not afford to engage in a contest of attrition. As a result, Western nations adopted a manoeuvrist approach to warfare, as it enables smaller forces to defeat larger opponents.[42] Simply put, manoeuvre warfare is a war-fighting philosophy that seeks to defeat an

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[37] Bradin, *From Hot Air*…, 129, 134.
[38] Black, *Canada's Army Loses*…, 99.
[39] Houde, *The CH-146*…, 38.
[40] Patrick J. Bodelson and Kevin B. Smith, "Design for Tempo: Aviation as a Maneuver Arm," *United States Army Aviation Digest* (July/August 1991): 8.
[41] Michael J. Forsyth, "Fires for Attack Helicopter Operations," *Field Artillery* (May-June 1996): 26.
[42] Bodelson and Smith, *Design for Tempo…*, 1.

enemy by shattering his moral and physical cohesion, which is his ability to fight as an effective, coordinate whole, rather than destroying him physically through incremental attrition.[43]

The tactical application of manoeuvre warfare theory in the US was expressed through the creation of the Air-Land Battle (ALB) doctrine in the late 1970s. While not pre-emptive in nature, it nonetheless stressed offensive actions, by air and land, to the full depth of attacking enemy formations in order to fragment their cohesion, thus leading to their defeat. The success of the concept hinged on the ability to achieve close interaction between all air and ground battlefield capabilities.[44] The ALB concept was particularly significant to the tactical employment of helicopters, as it provided the doctrinal foundation to establish aviation as an element of the combined arms team. A high degree of integration and coordination was needed to achieve synergy between all elements of the combined arms team, with armed helicopters becoming vital to the commander's ability to dictate the tempo of operations and establish dominance over the enemy.[45] This was verified in a 1975 study by US Army Major Curtis Ebitz, who noted that "helicopters operating as an integral part of the combined arms team in target detection and attack roles greatly enhanced the overall success of the force engaged in ground combat against an enemy force."[46] Aviation forces, and attack helicopters in particular, were to be henceforth viewed as equal in importance with armour, infantry and artillery forces.

The adoption of ALB doctrine in the US and the promotion of aviation as an integral member of the combined arms team ensured that army aviation would continue to prosper, as it was naturally in the army's own best interests. The fielding of attack helicopters and rise of ALB

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[43] Department of National Defence, B-GL-300-001/FP-001, *Land Operations* (Ottawa: DND Canada, 2008), 5-64.

[44] John L. Romjue, "The Evolution of the AirLand Battle Concept," Air University Review XXXV no. 4 (May-June 1984): 7-8.

[45] Houde, *The CH-146*…, 38.

[46] Pichette, *Does the Canadian Army*…, 13-14.

doctrine would cause nations such as Australia, who had previously placed all aircraft under the control of the Air Force, to transfer full command of battlefield helicopters to the Army in 1987.[47] Ironically, while other nations were recognizing the importance of attack helicopters, and aviation writ-large, to the army's combined arms team, Canada would follow a starkly different path as a result of the efforts to unify the Canadian military in 1968. The ramifications of this decision would "effectively end the CF's ability to participate effectively in all aspects of Air-Land battle."[48] The history of Canada's tactical aviation community, and the circumstances which have prevented it from acquiring a meaningful fire support capability, can now be discussed.

Canadian Tactical Aviation: The Bastard Child

The origins of the Canadian tactical aviation community, under the initial stewardship of the Canadian Army, can be traced back to the Second World War; the transition towards a helicopter force would subsequently follow in 1955. The rise of army aviation was primarily due to the inability of the RCAF to provide adequate air support, a situation similar to what was being experienced in many Western nations. This was due to the RCAF's focus on establishing air superiority during the Cold War, as opposed to providing CAS to the Army.[49]

Despite the unification of the Canadian Armed Forces in 1968, Canadian tactical aviation would endure under the command of the army, re-branded as Force Mobile Command (FMC), and would continue to grow;[50] the CH136 Kiowa, CH135 Twin Huey and CH147 Chinook

[47] Nordick, *Into the Future*…, 1.
[48] Black, *Canada's Army Loses*…, 99.
[49] *Ibid*., 97-98.
[50] Stephen L. James, "The Formation of Air Command: A Struggle for Survival," (master's thesis, Royal Military College, 1989), 31.

helicopters would all be introduced to service between 1971 and 1974.[51] Furthermore, by 1972, the Canadian Army had identified the need to procure an anti-tank helicopter, and an acquisition project was initiated.[52] Unfortunately, during this same time period, there was a growing perception amongst senior air leaders that Canada's air power resources, which had been fractured into six different commands as a result of unification, were being mismanaged.[53] An additional source of discontent with the fighter-based core of the former RCAF was the cancellation of the fighter replacement program while aircraft purchases for the land and sea elements continued. Furthering the disgruntlement was FMC's decision to downgrade the role of the air element to a subordinate command, as opposed to an outright co-equal with the entire army component.[54] These key events would help to provide the genesis for the reestablishment of an independent air element within the CF. Consequently, in 1975, the tactical aviation community and its personnel were transferred from the army to the newly established organization known as Air Command, and the anti-tank project was terminated.[55]

Dean Black, a former Commanding Officer in the tactical aviation community, notes that there are a number of possible reasons why the anti-tank helicopter was not pursued. These range from simple funding constraints, to parochial concerns within the army stemming from the perception that an anti-tank helicopter and its vast combat power might supplant the traditional combat arms, and finally, perhaps a belief on the army's part that the newly formed Air Command would assume the responsibility to procure the necessary helicopter variants needed in

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[51] Royal Canadian Air Force, "Historical Aircraft," last accessed 13 April 2013, http://www.rcaf-arc.forces.gc.ca/v2/equip/archives-eng.asp.

[52] The anti-tank helicopter project would be referred to as an attack helicopter project in modern doctrinal terminology; anti-tank, now referred to as anti-armour, is a capability which can be added to any number of helicopter platforms, including the CH146.

[53] W.K. Carr, "Canadian Forces Air Command: Evolution to Founding," *The Royal Canadian Air Force Journal* 1 no. 1 (Winter 2012): 15; James, *The Formation of Air Command*…, 6-7.

[54] James, *The Formation of Air Command…*, 31-33.

[55] Black, *Canada's Army Loses*…, 97, 99; Carr, *Canadian Forces Air Command*…, 23; Brereton Greenhous and Hugh A. Halliday, *Canada's Air Forces: 1914-1999* (Montreal: Art Global, 1999), 142.

future conflicts. Regardless of the actual reason or reasons that the project was cancelled, it would effectively cast the tactical aviation community into a form of purgatory; Air Command would do little to further the cause of an armed capability for tactical aviation, instead choosing to focus on fixed-wing CAS capabilities, while the army simply re-focused on its traditional roles.[56] Sadly, lacking a true proponent since 1975, Canadian tactical aviation has never achieved its rightful status as a combat arm, and Canadian soldiers have had to endure conducting numerous deployed operations without the benefit of the security that is provided by a properly armed helicopter.

With no attack helicopter forthcoming, the Kiowa, a light observation helicopter by design, was used to maximum extent practical to fulfill the doctrinal roles of aerial firepower and reconnaissance, while the preponderance of Chinook and Twin Huey missions were associated with supporting the mobility requirements of the land force.[57] Understandably, the ability of the Kiowa to provide fire support was limited; instead, it was most effective when used as an observation platform to direct and control the fires of both ground-based artillery and fixed-wing attack aircraft. The Kiowa's organic firepower was limited to unguided rockets which were used for marking targets, as well as a single fixed-forward 7.62mm Gatling gun which was used for self-defence.[58]

The end of the Cold War and the fiscal realities of the 1990s would drive the CF to adopt a single aircraft for the tactical aviation community, despite the doctrinally accepted need for four distinct types of platforms: attack, reconnaissance, medium lift and utility. However, it must be noted that this decision was endorsed by the Commanders of both Air Command and Land

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[56] Black, *Canada's Army Loses*…, 98-99; Dean C. Black, "Ansbach, the Apache, and the Decline of the Canadian Army's Air Force," *Airforce Magazine* 31 no. 4 (December 2008): 39.

[57] Wakelam, *A Fine Mess*…, 50-51.

[58] Vincent, *Helicopter Fleet Rationalization*…, 2; Mike Ortman, former 10 Tactical Air Group CH136 Kiowa pilot, telephone conversation with author 11 April 2013.

Force Command. The result was the introduction of the CH146 Griffon in 1994 under the Utility Tactical Transport Helicopter (UTTH) project. While the direction and control of fires was supposed to be a major task for the CH146, it was accepted that the Griffon would not be able to fulfill any anti-armour or counter-mobility tasks for the army.[59] However, the subsequent retirement of the CF-5 as CAS platform in 1995, and unwillingness to permanently dedicate any of the new squadrons of CF188 to this role, left the army with an ever-growing gap in aerial fire-support.[60] The lack of a sponsor for the tactical aviation community was only continuing to harm the combat power of the army.

In reality, the implementation of the CH146 as the sole tactical aviation platform significantly worsened the problem of providing fire support to the land forces. The CH146 was only equipped with two C6 general purpose machine guns (GPMG), and these were solely envisioned for use in a self-defence role. Compounding the problem was the lack of airworthiness authorizations to conduct Aerial Observation Post (AOP) and Airborne Forward Air Controlling (ABFAC), the tactics which facilitate directing and controlling fires. With no ability to provide either organic or inorganic fire support, the Canadian army was forced to look elsewhere if aviation fire support was needed. Consequently, the army became "enamoured with US army aviation," and resulted in an all-time low point of coordination between the Canadian tactical aviation community and the army it exists to support.[61] However, the deployment of the CF to Afghanistan would serve to change the poor fortunes that the tactical aviation community had experienced following its move to Air Command in 1975.

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[59] Department of National Defence, *The Aviation Master Development Plan,* (Ottawa: Chief Air Doctrine and Operations, 1995) 1, 39, 44.

[60] Vincent, *Helicopter Fleet Rationalization*…, 7-9.

[61] Notes on presentation by Lieutenant-Colonel Jeff Smyth, "Air-Land Integration in Afghanistan from the Perspective of the Commander, Canadian Helicopter Force (Afghanistan)," in Richard Goette, Report on CFAWC Air-Land Integration Workshop, Canadian Forces College, 11 March 2011, 5.

Ironically, the actual impetus for the Canadian tactical aviation community to begin adopting an aviation fire support role did not involve the deployment of Canadian aviation into combat; rather, it stemmed from an army training requirement to force-generate Joint Terminal Air Controllers (JTAC), who control fire support assets on the battlefield. No longer able to secure training support from the US military due to their extreme operational tempo sustaining the wars in both Afghanistan and Iraq, assistance was sought from the RCAF in the spring of 2007.[62] The army needed helicopters to conduct Close Combat Attack (CCA), a task which involves the coordinated attack by armed aviation platforms against targets that are in close proximity to friendly forces.[63] 1 Wing, as the headquarters (HQ) for tactical aviation in the CF, quickly established the necessary tactics and procedures. This initial foray into CCA quickly identified that the C6 GPMG was ill-suited for the provision of offensive fire support. Cognizant of the importance of this training to the army, 1 Wing HQ identified the need to secure a more suitable weapon system for the CH146.[64]

Fortuitously, the training role for the tactical aviation community was quickly overshadowed by the actual deployment of the CH146 and newly purchased CH147 helicopters to Afghanistan in December 2009. As stated at the outset of this study, to ensure that the Griffon was able to fulfill its operational mandate, it was quickly outfitted with improved door guns and a cutting-edge sensor suite. Although it still lacked the firepower or performance of the attack helicopters in theatre, it quickly proved to possess certain qualities as a gunship, largely owing to

[62] This observation is based on the author's personal experience of planning the first CCA camp to support Canadian JTACs in Fort Sill, Oklahoma, when serving as the Deputy Operations Officer at 408 Tactical Helicopter Squadron in 2007.

[63] Department of National Defence, B-GA-442-001/FP-001, *Tactical Aviation Tactics, Techniques and Procedures* (Ottawa: DND Canada, 2010), 15-3.

[64] M. Duval, *Endorsement of Statement of Capability Deficiency: CH146 Weapon System for Close Combat Attack* (1 Canadian Air Division Headquarters: file 3518-1-129 (A3 Tac Avn Sys)), 15 January 2008.

its near-360 degree field of fire.[65] As the community established working relationships with the deployed elements of the Canadian Army, it was only natural that the integration of aviation into the combined arms team, which had been absent for so many years, would begin to be re-established. In the current vernacular, this is referred to as air-land integration (ALI).

The cessation of the combat mission has afforded the army the opportunity to formally document the future requirements of the tactical aviation community through an update to the tactical aviation CDR. The decision to transfer a number of personnel positions to the RCAF to facilitate the establishment of the new CH147 Chinook capability provides further evidence of the growing importance of tactical aviation to the army.[66] While the tactical aviation community still lacks formal recognition as an element of the army's combined arms team, it is evident that the combat relations forged in Afghanistan have caused the army to take an active role in shaping the future of the community.

Summary

This chapter has demonstrated that it is in the best interests of militaries to invest in armed and attack helicopter capabilities in light of their exceptional combat power. Evaluating the historical factors associated with the emergence of armed aviation, it can be unequivocally stated that there is a direct correlation between the operational effectiveness of tactical aviation forces and their embodiment as a manoeuvre element of the integrated combined arms team; sadly, this is not the case in Canada. Unification set in motion events that would lead to the establishment of Air Command and the subsequent transfer of the control of the tactical aviation fleet to this organization. Since this event, Canada's tactical aviation community has been

[65] Smyth, *Air-Land Integration…*, 5.

[66] The Commander of the Canadian Army dissolved one armoured squadron of the Royal Canadian Dragoons in order that the RCAF would have a sufficient number of personnel to establish 450 Squadron in Petawawa.

trapped in the unenviable position of having never been completely accepted by either the army or the air force, becoming a 'bastard child' of sorts.

While the combat mission in Afghanistan has provided an initial impetus for re-establishing positive connections with Canada's Army, it is too early to fully appreciate what lasting impact this will have on the future of Canadian tactical aviation. However, it has been suggested that the continuing importance of ALI will be "critical to the relevance and survival of 1 Wing."[67] If this is true, then armed and attack aviation and its ability to provide fire support to the army must continue to be a required capability in future conflicts, not just the wars of the past. This contention will form the basis of the discussion in the next chapter.

[67] Smyth, *Air-Land Integration…*, 5.

CHAPTER 2: THE CONTINUING NEED FOR PRECISION AVIATION FIRES

Introduction

Shortly after taking command of 1 Wing in 2007, Colonel Alain Parent issued the mantra for CH146 aircrew to do "less slinging and more shooting." Stemming from the unwillingness of Chief of Defence Staff (CDS) General Rick Hillier to endorse a deployment of the CH146 to Afghanistan when it was first proposed in 2005, this directive served as an acknowledgement that the tactical aviation community needed to undergo a paradigm shift to increase its operational relevance to Canada's army, which was engaged in its first major combat mission since Korea.[68] Four short years later, 1 Wing's own combat mission in Afghanistan drew to a close, with significant experience gained in the application of firepower to assist troops under enemy contact. However, 1 Wing's involvement also demonstrated that the firepower capability that was developed for the Afghanistan mission is insufficient to support all future operational theatres.[69] This chapter will establish the essential need to acquire a PGM capability as outlined within the capability development record (CDR), and summarized in Table 2.1 below, in order to safeguard the future relevance of Canada's tactical aviation fleet.

Table 2.1: Summary of Tactical Aviation Firepower Requirements

Unassisted precision destruction of armoured vehicles, including main battle tanks (MBT) out to 4000m
Unassisted precision destruction of soft-skinned vehicles (SSV) out to 5000m
Unassisted precision defeat of structures in order to incapacitate or destroy personnel out to 2000m

Source: Capability Development Record (Tactical Aviation) 04002v4, 19-20.

[68] CBC, "Canada to Send Griffon Attack Helicopters to Afghanistan," last modified 26 November 2008, http://www.cbc.ca/news/canada/story/2008/11/26/griffon-chinook-afghanistan.html.

[69] C.J. Coates, *Statement of Capability Deficiency: Precision Stand-Off Weapon* (Canadian Forces Base Kingston: file 35-15-1 (A7 Reqr/Eqpt), 9 March 2010): enclosure 3 of 5.

This chapter will begin with an examination of the nature of the most probable defence challenges that will be faced for the foreseeable future. Next, an examination of supporting policies, doctrine, and operational lessons learned will confirm that an expanded fire support capability is grounded in both theory and practical application. A comparison of tactical aviation force structures with Canada's allies will confirm that the acquisition of a PGM capability is in-line with its allies' interpretation of future battlefield requirements. Finally, the last section of this chapter will refute the notion that the current inventory of CF equipment can suffice to cover the existing firepower capability gap within the tactical aviation community.

The Future Security Environment

Understanding the nature of the future security environment requires an appreciation of the pervasiveness of irregular warfare, which has most commonly manifested itself in the form of an insurgency. History has shown that the coexistence of irregular and conventional forms of warfare is in fact a routine occurrence within most conflicts. Warfare is rooted in politics, and in the end, all that matters is whether the nation's political goals are realized.[70] Political scientist Colin Gray highlights that "many wars are neither purely regular nor purely irregular… the mode is dictated by strategic circumstances."[71] The Chinese refer to this as unrestricted warfare: employ whatever strategy and corresponding tactics that are needed in order to be the victor.[72]

War has been waged with conventional and irregular techniques employed simultaneously throughout the duration of the conflict. A clear example of this was the strategy employed by the North Vietnamese throughout their struggle to reunite Vietnam. The US fought a conventional battle against the Democratic Republic of Vietnam (DRV) regular army while

[70] Scharre, *A Balancing Act*…, 21.
[71] Colin S. Gray, "Irregular Warfare: One Nature, Many Characters," *Strategic Studies Quarterly* 1, no. 2 (Winter 2007): 40-41.
[72] *Ibid*., 40.

simultaneously battling the insurgency waged by the National Liberation Front (NLF), more commonly known as the Viet Cong (VC). Alternatively, nations have evolved their strategy to an insurgent focus following the defeat of their primary military forces. Two classic examples of this can be found in the Second World War: following the fall of the French Third Republic to Nazi Germany in 1940, the French Resistance was established to continue the fight against the Germans.[73] Similarly, Yugoslavia saw the rise of the National Liberation Army, which sought to bring about an end to the Nazi occupation of their country.[74] More recently, following the defeat of the Iraqi military in 2003, the most ideologically committed fighters melted away to form the core of the nascent anti-American insurgency.[75]

Today, failed and failing states, in which the government and social structure become dysfunctional in the face of challenges from within to their legitimacy, represent the breeding ground of future insurgencies.[76] These states have a substantial destabilizing influence, particularly in the realms of global security and economics.[77] For instance, Somalia, ranked as the world's top failed state, is home to numerous pirates that have interfered with international shipping routes in the vicinity of the Horn of Africa for years.[78] General James Mattis, the former Supreme Allied Commander Transformation for NATO, summed up the reality of future insurgent activity when he stated "this enemy is not going to go away any time soon."[79] The Government of Canada recognized this same reality within the Canadian First Defence Strategy

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[73] Peter Davies, *France and the Second World War: Occupation, Collaboration, and Resistance* (New York: Routledge, 2001), 50.

[74] Duncan Wilson, *Tito's Yugoslavia* (Cambridge: Cambridge University Press, 1979), 20-23.

[75] Yochi J. Dreazen, "After Counterinsurgency, Military Goes Back to Basics," *National Journal*, September 3, 2010. http://search.proquest.com/docview/749507085?accountid=9687.

[76] Department of National Defence, *Leadmark: The Navy's Strategy for 2020* (Ottawa: Chief of the Maritime Staff, 2011), 80.

[77] Steven Metz, "New Challenges and Old Concepts: Understanding 21st Century Insurgency," *Parameters* 37, no. 4 (Winter 2007-08): 37.

[78] The Fund for Peace, "2012 Failed States Index," last accessed 9 January 2013, http://www.fundforpeace.org/global/?q=fsi.

[79] Lawlor, *Leaders Call for Balance*…, 88.

(CFDS), stating "the peace dividend that resulted from the end of the Cold War was relatively short-lived. The 1990s saw the emergence of difficult security challenges, including failed and failing states, civil wars and global terrorism."[80]

The current state of global affairs strongly suggests that the number of insurgencies should be anticipated to rise in the coming years. Consequently, for Western nations, it is a near-certainty that future COIN operations will be undertaken in order to safeguard their economic prosperity and to eliminate safe-havens for transnational terrorist organizations such as al-Qaeda. The logic of this philosophy can be found in the maxim "peace is good for business."[81] Strategically, the Government of Canada has noted that defeating threats *at their source* is an important aspect of protecting Canada.[82] This sentiment was validated by former US Secretary of Defense Robert Gates, who noted the US will have to continue to participate in COIN operations abroad.[83]

A complementary factor that must be considered in conjunction with the increase in irregular warfare is the actual landscape on which these battles will be fought. The fundamental goal of both insurgents and COIN forces is to win the popular support or "hearts and minds" of the domestic population.[84] The United Nations (UN) notes that between 2011 and 2050, the growth of the urban population will outstrip the overall expected growth in the world's population; furthermore, virtually all of the world's population growth will occur in the urban

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[80] Department of National Defence, *Canada First Defence Strategy*, 6.

[81] Bruce A. Roth, "Peace is Good for Business," in *No Time to Kill*, last accessed 9 January 2013, http://www.notimetokill.org/ch26.htm.

[82] *Canada First Defence Strategy*, 8.

[83] Frank G. Hoffman, "Striking a Balance," *Armed Forces Journal* 147 no. 1 (July-August 2009): 38.

[84] Nigel R.F. Aylwin-Foster, "Changing the Army for Counterinsurgency Operations," *Military Review*, Special Edition: Counterinsurgency Reader (October 2006): 29. http://search.proquest.com/docview/225304735?accountid=9687.

areas of the world's less developed regions.[85] Additionally, it is important to consider that the preponderance of government institutions, which are the tangible symbol of a regime's power, are located within urban areas; as such, they are prime targets for insurgents to attack as a means of demonstrating the weakness of a ruling government. This has been seen in the insurgencies of Afghanistan, Northern Ireland and even within Canada during the *Front de Libération du Québec* (FLQ) crisis.[86] As a result, it should be anticipated that future COIN operations will require an increasing emphasis on urban operations.

Given that irregular warfare is likely the basis for future CF expeditionary operations, the ramifications of this environment must be examined for the employment of tactical aviation. In the document *Projecting Power: Canada's Air Force 2035*, the RCAF itself recognizes that "given the *likely* future security environment and future operating environment that the Air Force expects to face, it must be able to project power through precision effects."[87] This requirement stems from an absolute need to minimize collateral damage, which hinges upon the ability to distinguish enemy targets from civilians within the COIN environment.[88] Lieutenant-Colonel Andrew Scheidl notes the ramifications of collateral damage as follows:

> Its visible effects can be exploited by a savvy enemy… just as in Vietnam, every tactical action might well result in victory, but the physical collateral damage cumulatively alienates local populations and international support.[89]

Therefore, it is imperative that the proper munitions are available to allow aircrew to engage the enemy when warranted without the risk of inflicting unnecessary collateral damage and its associated degeneration of support for the campaign.

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[85] The United Nations, *World Urbanization Prospects: The 2011 Revision* (New York: United Nations, 2011): 1.

[86] John Gray, "Pierre Elliott Trudeau 1919-2000," *The Globe and Mail*, 30 September 2000. http://web.archive.org/web/20080118071232/http://www.theglobeandmail.com/series/trudeau/jgray2_sep30.html.

[87] Andrew B. Godefroy, *Projecting Power: Canada's Air Force 2035* (Trenton: Canadian Forces Aerospace Warfare Centre, 2009), vii.

[88] Darling and Lawlor, *Updating Close Air Support*…, 28.

[89] Andrew Scheidl, "Islam and the War on Terrorism," *Canadian Forces College Review*, no. 27 (2002): 187.

The additional complications generated by the urban environment are succinctly described by Colonel Bill Gavora, commander of the US Army's Aviation Applied Technology Directorate. He notes that sub-optimal sensor-to-shooter linkages place additional difficulties in the prosecution of time sensitive targets in urban settings.[90] American attack helicopters were one of the key weapons used to overcome this challenge, due to their ability to detect and engage targets immediately before they were able to "shoot and scoot;"[91] this is what is referred to as 'organic lethality.'[92] The need to provide a very high degree of accuracy in the application of fires, whilst operating inside a very short sense-to-act loop, lends substantial support to the CDR's assertion of the need for CF tactical aviation to possess a PGM capability.[93]

The final aspect of irregular warfare that needs to be discussed is the actual threats that the CF will face during COIN operations. In Afghanistan, the primary weapons employed by the insurgent forces consisted of small arms, rocket-propelled grenades (RPG), improvised explosive devices (IED), indirect fire systems such as mortars and rockets, and of particular note to aviation, the occasional heavy machine gun and man-portable air defence (MANPAD) missiles.[94] However, irregular warfare can incorporate weapons systems with significantly greater lethality than was observed in Afghanistan. One need only consider the recent uprisings in Libya and Syria, where the revolutionary forces gained access to front-line military

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[90] Sensor-to-shooter linkages is an alternate expression of the Canadian doctrinal term "sense-to-act." B.C. Kessner, "War Deployments Impacting Army UAV Science and Technology Experiments." *Defense Daily* 220 no. 33 (18 November 2003): 1. http://search.proquest.com/docview/234041239?accountid=9867.

[91] Forsyth, *Fires for Attack*…, 29.

[92] Neil L. Thurgood, "The Armed Reconnaissance Helicopter: Meeting the Challenges of a Transforming Army," *Army Aviation* 54 no. 3 (March 2005): 27.

[93] Department of National Defence, *Capability Development Record*…, 32.

[94] Slawomir Augustyn, "The Decision Process of Combat Helicopters Crew in Afghanistan Hybrid Threats Environment," *Strategic Impact* 42, no. 1 (Spring 2012): 126. http://www.ceeol.com/aspx/issuedetails.aspx?issueid=86216cd5-b5ef-46d2-9e38-6740eca0245c&articleId=40c97cda-d316-440b-83e9-ff6c36c6e071; International Security Assistance Force Headquarters, "Seizing Insurgent Weapons," last accessed 11 March 2013, http://www.isaf.nato.int/article/focus/taking-weapons-off-the-battlefield.html; *Capability Development Record*…, 27.

equipment.[95] Regardless of which side of these conflicts Western nations support, it is apparent that the possibility of having to defeat armoured threats in support of ground forces during an insurgency cannot be discounted. In order that aviation engage these threats without exposing crews to undue levels of risk, the aviation platforms need to be able to engage enemy threats from beyond the range of their weapons systems; this is referred to as stand-off. In preparing for the next conflict, it is essential that the CF not simply be capable of re-fighting Afghanistan. As such, the acquisition of a tactical aviation PGM capability that can exploit stand-off firepower is essential, and is completely in-line with the CDR's requirement shown in Table 2.1 for tactical aviation to defeat armoured vehicles including main battle tanks.[96]

Canadian Doctrinal Foundations

Armed with an understanding of the most probable future operating environment for the CF, it is now possible to explore the specific requirements contained within the CDR, exhibiting how they fit holistically into the milieu of national policies, doctrine, and lessons learned. The CDR asserts the vital importance of continuing to develop tactical aviation capabilities in the realm of firepower in order to meet both current and future Army operational requirements. As previously noted, the CDR seeks this development through the establishment of a direct and indirect organic precision fire support capability for tactical aviation under the umbrella of the sense-to-act function.[97]

The overarching policy for the future of the CF has been laid out by the Government of Canada within the CFDS, which recognizes the need for a fully integrated, flexible, multi-role and combat-capable military, possessing robust and modern equipment, in order to carry out the

[95] CNN, "Syrian Rebels Seize Military Base Outside Aleppo," last accessed 11 March 2013, http://avropa.info/news/?sehife=5&xeber=52.
[96] Department of National Defence, *Capability Development Record*…,19.
[97] *Ibid*., 15, 32.

CF's mandate.[98] While the CFDS addresses many individual capability and equipment deficiencies, tactical aviation firepower is not one of the items specifically covered, likely due to the fact that the requirement had not been sufficiently identified or prioritized by either the RCAF or Army at the time of the publication's development. However, the overall intent of the document is to ensure that the CF is postured for future combat operations, and in this context, it is apparent that the CDR finds its initial measure of justification. A second strategic policy guidance document, the *Aerospace Capability Framework* (ACF), provides an even more concrete basis for tactical aviation firepower evolutions. It highlights that the employment of effective air power requires assets not only be capable of immediate offensive actions, but also the need to limit the potential for collateral damage.[99] These concepts, although initially released in 2003, continue to resonate with sound logic and complete applicability for the future COIN operations which the CF is likely to face. With these two strategic policies providing the initial foundation, it is now possible to investigate doctrine to further substantiate the establishment of a meaningful tactical aviation firepower capability.

The recently revised capstone aerospace doctrine for the CF specifically highlights that operations in support of land forces are conducted to target enemy surface forces and their supporting infrastructure. This is accomplished across seven primary applications for aerospace power: support, observation, presence, delay/denial, diversion, disruption, and finally, destruction. Additionally, this same doctrine also emphasizes precision in the employment of firepower as a characteristic of modern air power, due to the inherent capabilities provided by

[98] Department of National Defence, *Canadian First Defence Strategy*, (Ottawa: Canada Communications Group, 2008): 3, 15.

[99] Department of National Defence, *The Aerospace Capability Framework: A Guide to Transform and Develop Canada's Air Force*, (Ottawa: DND Canada, 2003): 6.

PGMs.[100] It is evident that the ability to achieve meaningful battlefield effects across the final five applications hinges on the ability to project firepower that provides a credible threat to the enemy. Considering the aforementioned breadth of possible threats that can be encountered within the contemporary operating environment, weapons with substantially greater kinetic effects and accuracy than can be achieved solely with door guns are essential to safe and effective operations. Therefore, it is clear that Canada's strategic aerospace doctrine firmly substantiates a much more robust fire support capability for the tactical aviation community in support of the army.

The need for an enhanced tactical aviation firepower capability also finds considerable corroboration in operational level doctrine and supporting documentation. NATO tactical air power doctrine recognizes armed action as one of the principle helicopter roles.[101] The CF's operational level aviation doctrine articulates that the role of tactical aviation is to support land force operations through the provision of aerial firepower, reconnaissance, and mobility. This same publication credits stand-off weapons as being *essential equipment* to the combat effectiveness of tactical aviation forces.[102] This fact was verified quantitatively in 2003 by the Army Experimentation Centre, noting the increase in both survivability and operational effectiveness that are realized through the use of precision stand-off weapons for reconnaissance helicopters such as a sensor-equipped CH146.[103]

Following the announcement of the purchase of the Chinook helicopters, the CH146 Statement of Operating Intent (SOI) directed that the CH146 become more focused towards the

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[100] Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine*, 2nd ed. (Trenton: Canadian Forces Aerospace Warfare Centre, 2010): 25-27, 41.

[101] North Atlantic Treaty Organization, ATP-49, *Use of helicopters in land operations - Doctrine*, Version F Revision 1, (Brussels: NATO Standardization Agency, 15 October 2012): 2-1.

[102] Department of National Defence, *Tactical Helicopter Operations*…, 1, 25.

[103] Coates, *Statement of Capability Deficiency: Precision…*, 1.

provision of aerial firepower and reconnaissance, recognizing that the CH147 would assume the preponderance of the aviation-based mobility requirements of the land forces.[104] This was subsequently expressed more tangibly in the concept of operations for interoperable griffon reconnaissance escort surveillance system (INGRESS), which called upon the Griffon to provide direct fire support in order to provide force protection for air and ground mobility operations.[105] It must be remembered that while these documents were specifically written for the CH146, the actual platform that provides the capability is of far less consequence than the capability itself.

Tactical aviation operations in Afghanistan yielded several valuable lessons and validated the overall concept of operations expressed within the CH146 SOI. In particular, Afghanistan demonstrated that there are four primary tasks that the CH146 and its eventual replacement will be required to perform throughout deployed operations. First is the aerial escort (AE) of other aviation assets; this comprised approximately 70% of the total missions conducted in Afghanistan. Next is the armed overwatch (AOW) of ground operations, which also includes responding to troops-in-contact (TIC) situations; this accounted for approximately 25% of the unit's missions. Third is the airborne convoy escort (ACE) to ground combat logistics convoys; this consumed 5% of the total flying hours expended. Finally, there are a limited number of utility tasks, such as passenger transport; these were done on such an infrequent basis after the Chinook helicopters became operational so as to not be of significant consequence.[106]

Of particular note, the first three tasks are all force-protection centric, and as such, the use of firepower is and will continue to be an essential element for effectively completing these

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[104] 1 Canadian Air Division Headquarters, *CH146 Statement of Operating Intent*, (Canadian Forces Base Winnipeg: DSP file 00002517, 6 May 2008): 4.

[105] *Ibid*., C-2.

[106] Chris Morrison, *Canadian Helicopter Force (Afghanistan) 146 Flight: Op ATHENA Roto 11 Force Employment Lessons Learned Report*, (Canadian Forces Base Edmonton: file 3350-1 (146 Flt OC), 21 June 2012): 2.

tasks. The need for these battlefield effects is echoed by respected aviation author Roy Braybrook, who notes that "what remains is a need for fast rotary-wing aircraft that are both armed and armoured, to perform close air support for ground and amphibious forces, and to escort utility and transport helicopters."[107] The natural question that follows is that if the CF successfully accomplished the Afghanistan mission without the use of PGMs, then why does the CF require more than door guns for the next conflict?

The CH146 quickly became one of the helicopters that the insurgents feared the most in Southern Afghanistan. This was due to a unique aspect of the CH146 door guns, which provided a near-360 degree field of fire, compared to American tactical helicopters, which were largely limited to forward-firing. As a result, the CH146 was given the moniker "Dragon's Breath of Allah" by the Taliban.[108] This reputation played a pivotal role on the psychology of the insurgents, facilitating the ground forces freedom of action when a section of Griffons was in close proximity.

Despite the lethality of the door guns, it must be noted that the success of the Canadian tactical aviation mission in Afghanistan was made possible due to the availability of coalition support. In particular, the ability to conduct missions into high-threat landing zones was restricted when solely relying upon the CH146 to provide force protection. To enhance the ability to operate with greater impunity in these locations, additional support would sometimes be sought to 'picket' the landing zone. This necessitated coalition support in the form of attack helicopters such as an Apache or the use of a fixed wing attack aircraft such as the A-10. The presence of these assets provided a level of deterrence that was simply not possible to achieve

[107] Ray Braybrook, "Mean Dedicated Machines," *Armada International* 31, no. 5 (October/November 2007): 64.

[108] Ed Storey, "CH-146 Griffon Nose Art," last modified 11 April 2012, http://www.rcaf-arc.forces.gc.ca/v2/nr-sp/index-eng.asp?id=12780.

with a door gun-equipped CH146. Similarly, the ability to use door guns to attack insurgents who were using structures for protective cover on AOW missions was extremely limited. Frequently, another fire support platform would be required to attack these targets due to the limitations of the CH146 weaponry.[109] This is the basis of the CDR's call for the unassisted precision defeat of structures as shown in Table 2.1.[110]

Despite the fact that future operations will remain coalition-based, it is evident that there is a growing concern within the Canadian Army that the provision of critical battlefield enablers from allies, such as attack helicopters, will no longer be available:

> Recent operations have dramatically demonstrated the value and importance of aerial firepower from tactical aviation. The ability to provide precision firepower beyond that of a crew-served heavy machine gun (HMG) is a critical capability that has been provided by other coalition forces *but may not be as readily available on future operations* [emphasis added]. The provision of precision firepower remains an important operational capability that the Army will continue to require from tactical aviation.[111]

Ultimately, the key take away from the CDR is the importance of having a tactical aviation fleet that is properly equipped to independently satisfy all three tactical aviation roles for future conflicts.

As has been shown, national policies, doctrine, and perhaps most importantly, the lessons learned from Afghanistan, all combine to substantiate the CDRs stated need for a PGM capability to be prepared for future tactical aviation operations. As a further manner of irrefutably verifying the CDR's declared capability requirements, an examination of the aviation fleet structures of other NATO and Western nations will be undertaken in the next section.

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[109] Coates, *Statement of Capability Deficiency: Precision…*, enclosure, page 3 of 5. This observation is also based on the author's numerous personal experiences as the CH146 Flight Commander and Operations Officer with Canadian Helicopter Force (Afghanistan) during the course of 11months of deployed combat operations between 2008 and 2011.

[110] Department of National Defence, *Capability Development Record*…, 20.

[111] *Ibid.,* 17.

The Armed and Attack Aviation Capabilities of Canada's Allies

Canada lacks a balanced force structure in its tactical aviation force; the rapid purchase and fielding of six used Chinook helicopters from the US to sustain the CF's participation in the Afghanistan mission was a clear acknowledgment of the conceptual failure of having a single "jack of all trades" fleet of utility helicopters. Defence scientists Thierry Gongora and Slawomir Wesolkowski define a balanced force structure "as the combination of force elements that is likely to ensure the successful completion of a range of military tasks across a range of operational environments."[112] As has already been shown, Canada's tactical aviation fleet lacked sufficient organic balance to either operate independently throughout the Afghanistan battlespace or to achieve the full range of kinetic effects required by the ground troops that were being supported. Furthermore, it is vital to acknowledge that Afghanistan was not even representative of the worst-case scenario in terms of enemy threats. Therefore, it is worthwhile to examine the approach of other nations in dealing with the realities of the contemporary operating environment to determine the validity in possessing not only a balanced force structure, but one that also incorporates a precision-guided stand-off weapons capability.

Of the 16 NATO countries that comprised the alliance prior to expanding the membership to include former Warsaw-pact countries, a total of 11 have some measure of a stand-off firepower capability.[113] It is worth noting that NATO nations such as Belgium, Denmark, and the Netherlands, despite having militaries that are smaller than Canada's, have all invested in an aviation firepower capability. It would be natural to associate this capability in

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[112] Thierry Gongora and Slawomir Wesolkowski, "What Does a Balanced Helicopter Force Structure Look Like: An International Comparison," *The Canadian Air Force Journal* 1, no. 2 (Summer 2008): 14.

[113] Of note, Iceland does not have a military, and the country of Luxembourg is so small as to make having a substantial military force economically untenable. Therefore, a more accurate analysis is that only two other nations, namely Norway and Portugal, do not possess some form of helicopter attack capability. Lindsay Peacock and Alexander von Rosenbach, *Jane's World Air Forces*, 32nd ed. (Coulsdon: Jane's Information Group, 2012): 61, 112, 188, 475, 497, 540; Alexander von Rosenback, *Jane's World Armies*, 31st ed. (Coulsdon: Jane's Information Group, 2012): 278, 305, 316, 401, 689, 760, 803, 836.

European NATO countries as a legacy hold-over from the Cold War and associated ALB doctrine. However, many countries, including the United Kingdom, France, Germany, Spain, Turkey, Greece and the Netherlands have all made significant expansions to their attack helicopter fleets well after the end of the Cold War. The inclusion of a substantial aviation firepower capability in the majority of NATO nations provides further credibility in the requirements promulgated within the CDR, and is in-line with Gongora and Wesolkowski's assertion that the international standard for balanced aviation fleet structures incorporates an attack capability.[114]

While comparing Canada's military capability to NATO is useful, perhaps the nation that facilitates the most accurate country-to-country comparison is Australia. There are a number of similarities between the security environment realities for both Canada and Australia: both countries have large landmasses, and their nearly identical population density is so low as to make ground defence of their territories difficult, if not untenable.[115] Fortunately, at the present time, neither nation faces any meaningful threat to their territorial integrity; this permits both nations participate in international peace and security operations while maintaining relatively small standing militaries. While Canada's total military personnel strength is slightly larger than that of Australia's, both countries spent nearly the same on their militaries in 2012.[116] Finally, both countries are committed to a strategic reinvestment of their respective military's equipment.[117]

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[114] Gongora and Wesolkowski, *What Does a Balanced*…, 14.

[115] CIA World Factbook, "Country Comparison: Area," last accessed 9 March 2013, https://www.cia.gov/library/publications/the-world-factbook/.

[116] Global Firepower Index, "Country Comparison: Canada and Australia," last accessed 9 March 2013, http://www.globalfirepower.com/countries-comparison-detail.asp?form=form&country1=Canada&country2=Australia&Submit=Compare+Countries.

[117] "Australian 2009 Defence White Paper," *Military Technology* 33, no. 6 (June 2009): 118.

It is therefore prudent to note that the evolving force structure of the Australian Army's aviation fleet is to be comprised of three brand-new fleets of helicopters: 7 CH147F heavy lift helicopters, 30 MRH90 medium lift helicopters, and finally, 22 Tiger armed reconnaissance helicopters.[118] As with many of the NATO countries, Australia is actually increasing its attack helicopter capabilities, despite the decreasing global risk of all-out conventional warfare. The importance that Canada's allies place in armed and attack aviation capabilities is irrefutable, given the significant capability investments that have occurred. Nevertheless, there remains one area that must still be addressed in order to complete the substantiation as to why the CF must further develop its tactical aviation firepower capability: why the existing capability gap cannot be filled by one of the platforms currently within the CF's inventory.

The Inadequacy of the CF's Existing Capabilities

Canada's field artillery assets and fleet of CF188 fighter aircraft represent the most readily available weapons within the CF's inventory that can be deployed to provide augmented fire support to assist ground forces during the conduct of operations. However, these weapons are not particularly well suited to employment in urban environments. This is due to their relatively large kinetic footprints, and the associated collateral damage that ensues. Tangible proof of this reality can be found in the direction provided by General Stanley McChrystal, the former commander of NATO's International Security Assistance Force (ISAF) in Afghanistan, when he severely restricted use of fixed-wing strike assets in support of combat operations.[119] Similar challenges were faced by Canadian artillery units in theatre; their ability to engage

[118] von Rosenback, *Jane's World Armies*, 42.
[119] Darling and Lawlor, *Updating Close Air Support*…, 28.

targets was often denied due to collateral damage concerns.[120] The net result of this is that battlefield commanders are placed in a predicament; they have to choose between risking the lives of civilian bystanders and thus alienating the support of the population that they are to help, or exposing their soldiers to higher levels of risk by not using the weapons at their disposal.[121]

Regardless, the losses of either soldiers or innocent civilians both resonate negatively at home, undermining support for the mission. One of the logical solutions to this problem is the use of aviation-borne precision guided munitions (PGM), given their smaller kinetic yield. Major Harry J. Hewson, an AH-1W Cobra pilot with the United States Marine Corps, notes that urban operations require precision fires that are timely, flexible and potent, and remarks that they have been combat-proven as an effective means of targeting the individual windows of buildings, in neutralizing roof-top threats, and in destroying armour in city streets.[122] In this light, it becomes apparent that the use of fixed wing fighters and artillery will not be a suitable substitute for an aviation PGM capability in future contemporary operating environments.

It has also been suggested that rotary wing assets may be too vulnerable to provide intimate fire support to ground forces.[123] Lieutenant-Colonel Paul Darling and Lieutenant Justin Lawlor note that between 2001 and 2010, the US Army lost 70 helicopters due to enemy action, leading them to suggest that rotary wing aircraft have simply been performing CCA/CAS out of operational necessity, as opposed to being the most suitable platform for the job. [124] Sadly, their research fails to acknowledge that only a small fraction of the helicopter shoot-downs occurred during the actual conduct of CCA/CAS missions. In actual fact, while the occasional helicopter

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[120] This observation is based on the author's personal experiences with Canadian Helicopter Force (Afghanistan) during the course of 11months of deployed combat operations between 2008 and 2011.

[121] Aylwin-Foster, Changing the Army…, 29.

[122] Harry J. Hewson, "Light/Attack Helicopters in the Three Block War," *Marine Corps Gazette* 83, no. 4 (April 1999): 25-26.

[123] Paul J. Doyle, *Canada's Air Force Kinetic Capability for the 21st Century: What is Needed*, Curtis Papers Vol. 1, Book 1: 2009-2010 (Trenton: Canadian Aerospace Warfare Centre, 2013), 162.

[124] Darling and Lawlor, *Updating Close Air Support*…, 40.

has been shot down as the result of a coordinated ambush, the majority of combat loses have been simple "targets of opportunity."[125] Furthermore, reflecting back on AH-6 operations in support of TF Ranger in Somalia, it was demonstrated that with sound tactics helicopters can be extremely effective CAS platforms, even in urban terrain.[126] This same observation would again be noted following NATO air operations over Libya in 2011.[127] As such, there is no reason to believe that the CH146 cannot continue to provide effective CCA – much like the United States Marine Corps has been doing with their fleet of Hueys since the Vietnam War – provided that enemy threats are respected and stand-off is exploited when warranted.

Canada's own experience in Afghanistan, albeit based on a much more limited sample size, also refutes the notion that tactical aviation cannot safely and effectively conduct CCA/CAS missions. Canada did not lose any CH146 aircraft during the provision of CCA support to troops in contact; however, a single CH147 was lost to enemy ground fire while transiting between forward operating bases. Nevertheless, one must be cautious in learning the wrong lessons from Afghanistan, particularly with regards to the sufficiency of door guns. As previously mentioned, the insurgent forces within the Canadian area of operations had an extremely limited anti-aircraft capability. There is the very distinct possibility that this will not be the case in the CF's next deployed theatre of operations. Given that CCA is now a core task for Canadian tactical aviation, the procurement of PGMs, with their inherent stand-off, is essential to minimizing the exposure of aircrew to undue or unnecessary levels of risk whilst retaining the ability to provide the required battlefield effects in support of ground forces.

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[125] A target of opportunity is one in which a helicopter is engaged by virtue of operating in the vicinity of insurgents who feel that they have sufficient cover available to mask their engagement. These attacks are classified as happenstance, as opposed to being deliberately pre-planned. "Taliban go to RPGs when Aiming to Shoot Down Aircraft," *Air Force Times*, 22 August 2011, http://search.proquest.com/docview/887510261?accountid=9687.

[126] Hewson, *Light/Attack Helicopters*…, 26.

[127] Tom Withington, "Future Fires," *Defence Helicopter* 32 no. 1 (January/February 2013): 17.

The sensitivity to environmental conditions and impermanence of air power offer the final considerations that dispel the notion that the CF's existing capabilities can obviate the need to procure a tactical aviation PGM capability.[128] Darling and Lawlor aptly note that when air assets respond to a TIC situation, they need to have sufficient endurance to remain on station until the engagement has ended.[129] Unfortunately, fighter jets such as the CF188 have a very limited station time without the use of air-to-air refuelling, and the need to respond quickly will likely preclude the ability to refuel before proceeding to the engagement zone. Further complicating matters is the time that is needed to develop the level of situational awareness of the firefight to facilitate a safe weapons release, particularly if a JTAC is not co-located with the ground force. However, the ability of a fighter aircraft to arrive rapidly overhead the engagement zone is generally unrivalled. In many circumstances, the presence of a fighter over the battlefield is enough to precipitate the insurgents to initiate their break contact drills.[130] Therefore, the actual fuel and weapons load of the fighter may be of little consequence to achieving the desired effect.

On the other hand, tactical aviation platforms frequently have a substantially greater endurance than fighter aircraft. Furthermore, helicopter pilots, given their much lower vantage point of the battlespace and slower airspeeds, can generally develop a rapid picture of the battle. In Canada, this is exemplified by the stated objective of initiating CCA fires within 60 seconds of receiving a fire mission from the ground commander.[131] Finally, while weather can severely impact both fixed and rotary wing operations, in general, helicopters are more capable of

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[128] Department of National Defence, *Canadian Forces Aerospace Doctrine*, 25.

[129] Darling and Lawlor, *Updating Close Air Support*…, 29.

[130] This observation is based on the author's personal experiences as a CH146 pilot with Canadian Helicopter Force (Afghanistan) during 5 months of combat operations in 2011.

[131] Greg Zweng, Aviation Tactics Flight Projects Officer, telephone conversation with author 14 March 2013. This objective was implemented for Canadian Helicopter Force (Afghanistan) Roto 11 by the author. It is anticipated that this will formally become the standard for all 1 Wing aircrew when the next revision of the B-GA-442 Tactical Aviation Tactics, Techniques and Procedures is promulgated in 2013.

conducting CCA/CAS missions in conditions of low visibility and ceilings than fighter aircraft. Ultimately, it is prudent to view fighter and aviation fire support capabilities as complementary and synergistic. However, when all factors are considered in the context of an insurgency conflict, the probability of achieving an engagement with a rotary wing aviation platform is greater than with a fixed wing fighter, with the notable exception of canalizing terrain in high threat areas, which is well suited to helicopter ambushes.[132] Proof of this reality can be found in the demand for an increased number of aviation fire support platforms as opposed to fixed wing CAS platforms in Afghanistan.[133] Therefore, this mandates arming RW tactical aviation assets with PGMs to ensure that they remain capable of providing effective fire support independently in the event that fixed wing platforms are unable to respond.

Summary

Irregular forms of warfare will continue to dominate the future security environment. As noted by Darling and Lawlor, "COIN is not an aberration that we can hope goes away. COIN has been a fixture of US military history, and may well be the predominant form of warfare for the foreseeable future."[134] The need to safeguard global stability will compel Western nations to intervene in failed and failing states. Operating in this environment, which is undergoing rapid urbanization, requires restraints on the use of lethal force in order to protect local, domestic and international support for the military mission. Excelling in the conduct of COIN missions is essential; failure is a vicious cycle that only serves to sow the seeds of further global insecurity.[135]

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[132] Doyle, *Canada's Air Force*…, 167.

[133] Joris Janssen Lok, "Rotary Imbalance," Aviation Week & Space Technology 167, no. 21 (26 November 2007): 32. http://search.proquest.com/docview/206158026?accountid=9687.

[134] Darling/Lawlor, 40.

[135] Aylwin-Foster, *Changing the Army*…, 27.

Ultimately, these factors strongly support the employment of tactical aviation forces that possess organic lethality; the ability to conduct quick, surgical precision strikes with small kinetic effect weapons from stand-off distances that absolutely minimize the risk of collateral damage and risk to the aircrew. This capability requirement finds extensive support in Canadian and allied doctrine, and continues to factor prominently in the evolving tactical aviation force structures of Canada's allies. Unfortunately, this capability cannot be fulfilled with the existing inventory of CF equipment, and the expectations that allies will provide this capability on Canada's behalf is no longer an acceptable answer to the problem. The only manner of ensuring that the tactical aviation community is postured to meet the challenges of the future battlespace in support of the army is to undertake the necessary capital investment in a PGM capability.

CHAPTER 3: WEAPONS ANALYSIS

Introduction

Having firmly established the absolute need for a tactical aviation PGM capability to remain relevant for supporting the CF's future expeditionary operations, it is now possible to examine what options exist to provide this fire support capability. There are four primary families of stand-off precision guided weapons: rockets, missiles, glide bombs, and the budding concept of kinetic energy munitions. A brief overview of the developmental history of each of the weapons families will be provided, culminating in the provision of a select number of examples of potential solutions for the CF that are either known to be currently fielded or under development. The available weapons options will then be compared against one another to determine their relative merits or weaknesses.

This analysis will be predominately qualitative, due to the unclassified nature of this paper. The criteria selected to form the basis of comparison are as follows: usefulness; aircraft survivability impacts; weaponeering considerations; cost; and finally, commonality. Of note, criteria such as individual weapon reliability, which were not deemed to provide a meaningful level of discrimination between the systems due to their similar performance characteristics, have been specifically omitted. Furthermore, criteria that are dependent upon the firing platform, such as aircraft maintenance life-cycle impacts, are also not addressed in this chapter. Table 3.1 provides an overview of the weapons options and their comparative performance characteristics.

The Weapons Options

The use of air launched rockets in combat can trace its origins back to the First World War, stemming from the need to develop a weapon that was capable of shooting down German

observation balloons.[136] The Second World War served as the catalyst to re-examine the use of rockets as a means of shooting down heavily-armed bomber aircraft while staying outside the range of their machine guns. The modern lineage of rocket design, which commenced in the late 1940s, saw the incorporation of a folding-fin tail assembly to afford increased in-flight stability, thus resulting in improved accuracy.[137] Following the fielding of guided air-to-air missiles, rockets would be effectively used in a ground attack role, and would be the first successful stand-off weapon system employed from US Army helicopters.[138] Current systems, such as the American Hydra and Canadian CRV7, offer an extensive range of battlefield applications due to their numerous warhead configurations, including anti-armour, anti-personnel, smoke and illumination.[139]

Precision guided aerial rockets are a relatively new innovation stemming from the recognition that legacy air-to-ground missile systems, such as the Maverick and Hellfire, are often 'overkill' in COIN operations. A nascent capability, the Advanced Precision Kill Weapon System (APKWS) is the only PG rocket system currently fielded, having been certified for use by the USMC in March, 2012.[140] While the basic body and warhead of the Hydra rocket remain unchanged, a guidance and control kit is added to the front of the weapon to provide the required homing and manoeuvering abilities needed to strike the designated target.[141] The APKWS rockets are limited to lock-on after launch (LOAL) guidance mode due to the fact that the seeker heads are blind to the target until the rocket is in flight. Practically, given the narrow field of

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[136] "A Brief History of Rocketry," last accessed 21 April 2013, http://science.ksc.nasa.gov/history/rocket-history.txt.

[137] Robert Hewson, *Jane's Weapons: Air Launched 2012-2013*, (Coulsdon: Jane's Information Group, 2012), 515.

[138] Bradin, *From Hot Air*…, 107.

[139] Hewson, *Jane's Weapons…,* 485-486, 515-517.

[140] Defense Industry Daily, "APKWS II: Laser-Guided Hydra Rockets in Production at Last," last accessed 14 March 2013, http://www.defenseindustrydaily.com/apkws-ii-hellfire-jr-hydra-rockets-enter-sdd-phase-02193.

[141] Hewson, *Jane's Weapons*…, 513.

view of the seeker heads and limited manoeuverability of the weapon, these rockets have a restricted envelope from which they can be launched in order to successfully strike the desired target. Furthermore, the APKWS is solely used with a high explosive warhead, which limits the breadth of targets that can be successfully defeated. To increase weaponeering flexibility, the APKWS should be used in conjunction with a smart pod launcher system that incorporates selectable zones, such as the M260 that is utilized by the US Army;[142] this will permit the APKWS to be intermixed with unguided rockets, thus expanding the scope of battlefield effects that can be successfully achieved, while also minimizing the time required to tailor weapons loads to meet individual mission requirements.

An alternate system, the Directional Attack Guided Rocket (DAGR), also known as Hellfire Jr., is currently being developed for the US Army, with initial production and deliveries in early 2013.[143] Of note, it offers the ability to be employed in a lock-on before launch (LOBL) targeting mode, giving pilots greater confidence in the exact location that the weapon will impact, which is vital when providing fire support in urban environments. Compatible with both CRV and Hydra rockets, the DAGR has a significantly greater ability for off-axis hits due to the expanded capabilities of its seeker head and increased manoeuverability. One drawback to the DAGR is the requirement for a completely new launcher, with a corresponding decrease in the number of stored shots available. Like the APKWS, the DAGR is only currently fielded with a basic high-explosive warhead.[144]

The use of missiles on helicopters evolved from the need to overcome the Warsaw Pact's overwhelming numerical advantage in tanks and armoured vehicles on the European front,

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[142] *Ibid*., 518. This is alternatively known as the Rocket Management System (RMS).
[143] Withington, *Future Fires*, 18.
[144] *Ibid*., 513-514; Lockheed Martin. "DAGR Product Card." Last accessed 9 Apr 2013. http://lockheedmartin.com/content/dam/lockheed/data/mfc/pc/dagr/mfc_dagr-pc.pdf.

circumstances that would subsequently provide the impetus to develop a dedicated attack helicopter.[145] Missiles, unlike unguided rockets, afforded helicopters the precision strike capability and necessary warhead energy to defeat Soviet armour. The first use of aviation-borne missiles occurred at the end of the Vietnam War, with the employment of the tube-launched, optically-tracked, wire-guided (TOW) missile system.

Missile technology has continued to evolve, initially using laser guidance systems to obviate the need for the physical umbilical between the helicopter and missile as is needed for the TOW system. Newer missiles, such as the Longbow Hellfire and Rafael Spike multi-purpose missile system, possess a true fire-and-forget (F&F) capability; this affords significantly greater protection to the firing platform, as it no longer has to be exposed to continually designate the target when operating independently.[146] Warhead enhancements have kept pace with the guidance system improvements; dual-stage warheads have been created with an initial precursor element to defeat the advent of reactive armour, which itself was a response to the improved killing capabilities of anti-armour missiles. Similarly, thermobaric warheads have been developed to defeat buildings occupied by insurgents in Afghanistan and Iraq.[147] The latest version of the Hellfire missile incorporates a multi-purpose warhead that is capable of defeating all threats, greatly simplifying target weaponeering and enhancing battlefield flexibility.[148]

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[145] James W. Braden, *From Hot Air to Hellfire: The History of Army Attack Aviation*, (Novato: Presidio Press, 1994), 126-128.

[146] Hewson, *Jane's Weapons…*, 114-115, 153.

[147] Thermobaric weapons are explosives optimized to produce heat and pressure effects instead of armour-penetrating or fragmentation damage effects. Thermobaric warheads use a mixture of fuel-air explosive specifically designed to create a sustained over-pressure far greater than standard high-explosive warheads, and precipitate the collapse of unreinforced structures. Furthermore, the initial overpressure and the subsequent vacuum effect are highly lethal to personnel in confined spaces. For further reading, see Dr. Anna E. Wildegger-Gaissmaier's article entitled "Aspects of Thermobaric Weaponry," available at http://www.defence.gov.au/health/infocentre/journals/ADFHJ_apr03/ADFHealth_4_1_03-06.pdf.

[148] Hewson, *Jane's Weapons…*, 153-157.

An additional precision guided stand-off low kinetic yield weapon system that has recently been developed is the Viper Strike glide bomb, offering a viable alternative to missiles and rockets. The weapon is a GPS and laser-guided derivative of the Brilliant Anti-Tank (BAT) submunition that was designed for the US Army's surface-to-surface Advanced Tactical Missile System.[149] The primary advantage of the Viper Strike over missile systems such as the Hellfire is its exceptionally small collateral damage radius, which makes it ideally suited for use in the urban environment. Despite its small size, the high explosive warhead is effective against personnel to a 10 foot radius as well as mobile armoured targets; it is anticipated that additional warhead and fusing options will be made available to improve the ability to defeat hardened structures.[150] Contrasting the Viper Strike to precision guided rocket systems, a further advantage is its ability to be used in steep angle final attack modes to strike targets from above in tightly congested areas such as alleyways and canyons.[151] The largest drawback of the Viper Strike is that the range of the weapon is completely dependent upon the altitude and velocity of the launching platform; as such, these weapons are optimized for employment from fixed wing aircraft and UAVs, and are poorly suited to use on rotary wing aviation assets operating in the low-level environment. Nonetheless, as the Canadian tactical aviation community has previously employed fixed wing tactical UAVs, and given the Viper Strike's combat success, this weapon deserves further analysis.[152]

An emerging concept in weapons design is kinetic energy weapons, which rely solely upon a projectile's speed to neutralize the desired target. One such proposed weapon is the

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[149] *Ibid*., 323-324.

[150] Sean Hayes and Steve Borden, Small Guided Munitions Project Office, "Small Guided Munitions: Path Ahead," last modified 11 March 2009, http://www.dtic.mil/ndia/2006psa_apr/borden.pdf.

[151] MBDA, "Viper Strike: Stand-off Precision Attack Guided Munition," last accessed 29 March 2013, http://www.mbda-systems.com/mediagallery/files/viper-e_datasheet-1365173839.pdf.

[152] Canada employed both the CU161 Sperwer and CU170 Heron UAV systems in Afghanistan.

Canadian High Energy Missile (HEMi), a hyper-velocity laser-guided projectile with a top speed of Mach 7. While the initial technological investigations undertaken by Defence Research and Development Canada were centred on providing Canada's fleet of Light Armoured Vehicles (LAV) an organic ability to engage and destroy main battle tanks, the research team identified the potential of employing the system from aviation platforms. While the design has yet to be finalized, it appears that the size and weight of the HEMi missile will be comparable to that of Hydra and CRV7 rockets. Given the infancy of this technology, the full range of battlefield effects that the HEMi will be able to achieve is unknown; computer modeling has indicated its effectiveness against armoured vehicles, but further analysis and physical testing will be required to confirm its degree of viability for attacking alternate targets such as personnel and buildings, crucial capabilities needed in the future security environment.[153] While the weapon may not be able to meet the immediate needs of the community, it should nonetheless continue to be monitored closely to determine if it will be suitable for future tactical aviation platforms, as there appears to be significant potential in this system. Sadly, given the vast unknowns that currently exist, it is not possible to conduct a meaningful analysis of this weapons performance against the other previously mentioned systems.

Figure 3.1: Advanced Precision Kill Weapons System (APKWS)

[153] Jacques Dubois, *et al*., *High Energy Missile Project*, Defence Research and Development Canada - Valcartier, 00 December 2004: 1, 2, 7. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA432104.

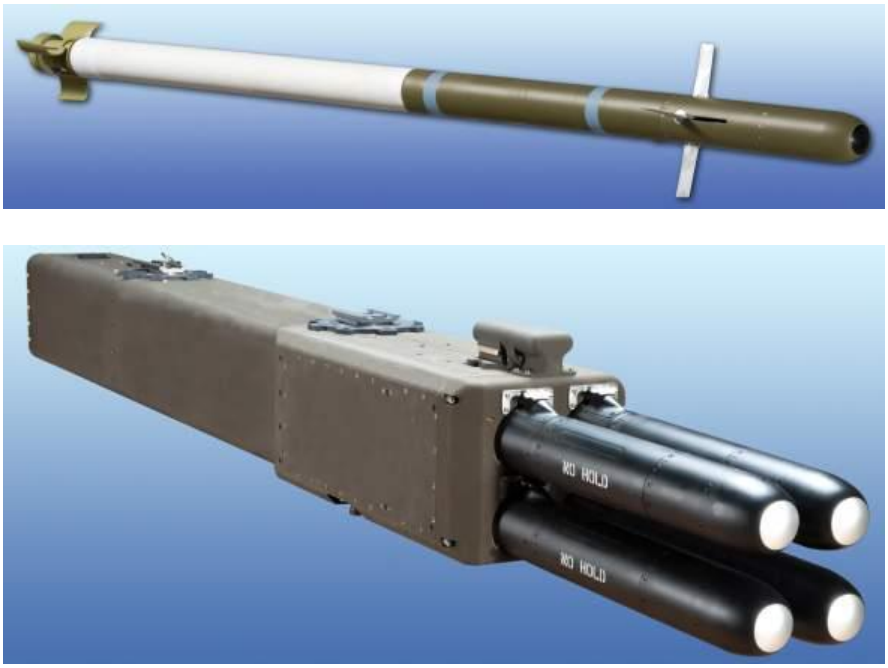

Figure 3.2: Direction Attack Guided Rocket (DAGR)

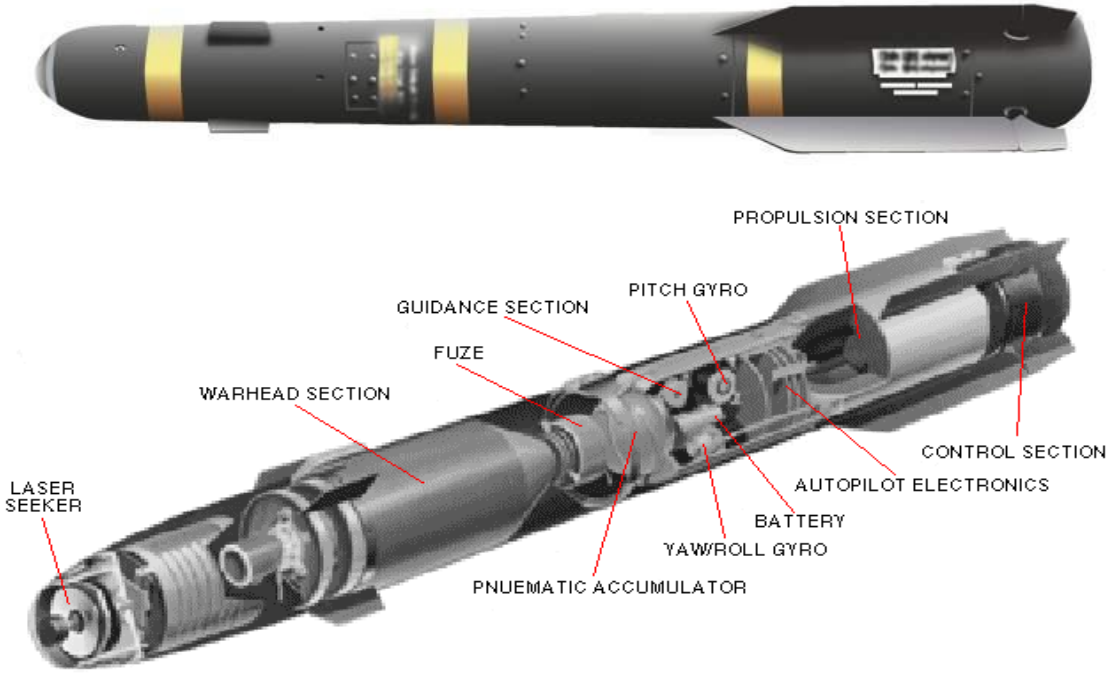

Figure 3.3: Hellfire Missile

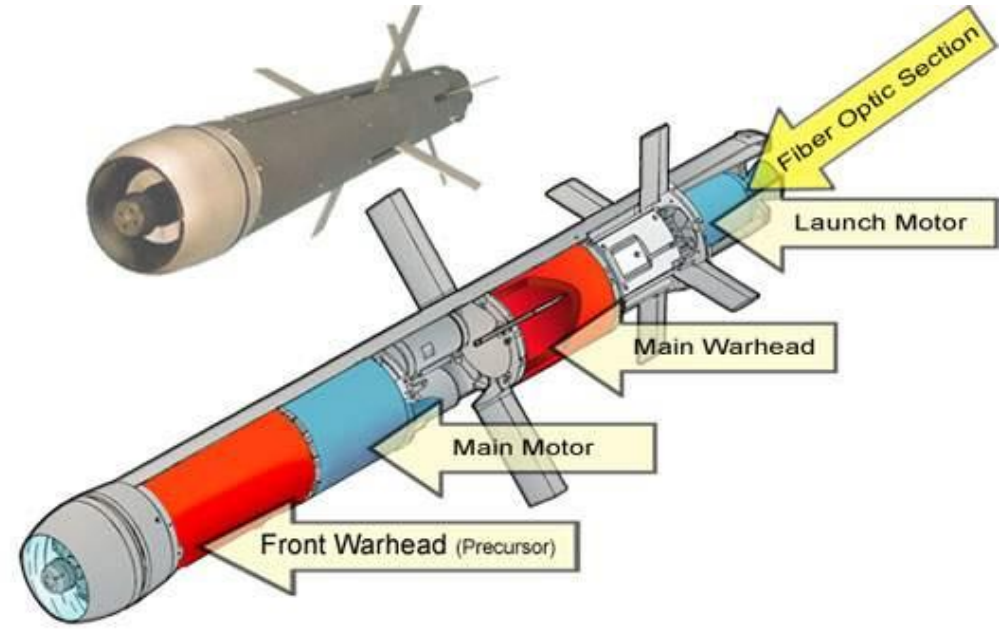

Figure 3.4: Spike Missile

Figure 3.5: GBU-44 Viper Strike

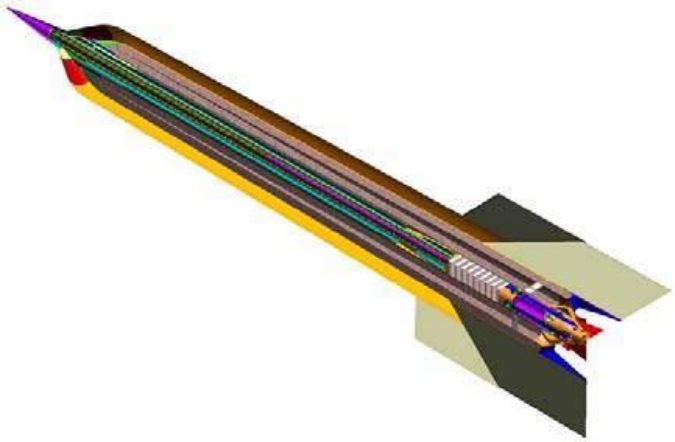

Figure 3.6: Canadian High Energy Missile (HEMi)

Table 3.1: Summary of Weapons Comparative Analysis

		APKWS	**DAGR**	**Hellfire**	**Spike**	**Viper Strike**
Family		LG Rocket	LG Rocket	LG Missile	EO/IR Missile	GPS & LG Glide Bomb
Current Status		In service, USMC only	Final development, US Army	Full multi-national employment	In service, Spain & Romania	In service, US only
Range (m)		5,000	7,000	9,000	8,000	10,000
Guidance Mode		LOAL	LOAL LOBL	LOAL LOBL	F&F	LOAL
Potential Stored Kills (maximum per CFDAS mount)		7	4 + 1 missile	2	2	2
Weight (kg)	Round	15	19	48	34	20
	Launcher	27[1]	44 + 21	44[2]	55[3]	44[2]
	Maximum Load	132	189[4]	140	123	84
Cost (per round, USD)		17,000[5]	10,000-15,000[5]	80,000-120,000	200,000 +[6]	90,000[7]
Usefulness	Platform Interoperability	RW & FW	RW & FW	RW & FW	RW & FW	FW

	Defeat of MBT	No	No	Yes	Yes	Yes
	Defeat of SSV	Yes	Yes	Yes	Yes	Limited[8]
	Defeat of Structures	Limited	Limited	Yes	Yes	Yes
Survivability Implications		Good	Good	Good	Excellent	Good
Logistical Commonality		Poor-Fair	Good[9]	Excellent	Poor	Poor[10]
Weapons Operational Procedures Commonality		Unguided Rockets	With Hellfire	With DAGR	Nil	Nil

Notes:
1. M260 Launcher
2. M310 Launcher
3. Rafael Launcher (actually has capacity to hold 4 missiles)
4. Includes 1 Hellfire
5. Projected high rate of production cost
6. Estimated based on Spain's purchase of 44 launchers and 200 missiles for 64,000,000 USD, using the maximum reported value of $400,000 USD per launcher
7. Low rate of production cost
8. To a maximum speed of 60 km/h
9. Once in production
10. Due to exceptionally low rate of production of 75 rounds/year

Comparative Options Analysis

Usefulness

The leading consideration in selecting a weapon system must be its usefulness, which, first and foremost, is the ability to fulfill its intended spectrum of battlefield effects. While this may seem obvious, the importance of this principle is evidenced in its specific capture, under the title of "results-focused operational capability," as one of only 8 strategic vectors for the Air Force. Even more significantly, this vector notes the expanding importance of continuing to invest in PGM capabilities in order to achieve decisive effects with minimal casualties and collateral damage.[154] The draft of the next version of the *Air Force Vectors* goes one step further,

[154] Ken Pennie, "Transforming Canada's Air Force: Vectors for the Future," *Canadian Military Journal* 5, no. 4 (Winter 2004-2005): 42.

espousing the importance of PGM capabilities for contemporary operations.[155] Of the aforementioned options, the only weapon that is currently able to fulfill each of the criteria stated in the CDR is a missile system, largely due to the non-diverse nature of the warheads that are currently used with the other systems. However, it must be noted that missiles have the largest kinetic yield of the options presented, and as such, pose the greatest risk of inducing collateral damage. As a result, missile systems present a small drawback, in that the ability to fire these weapons is likely to be slightly more restricted within the rules of engagement than the other options, although far less so than conventional bombs and artillery munitions.[156] Accordingly, collateral damage concerns may necessitate the carriage of multiple types of weapons to ensure the ability to engage time-sensitive targets in the urban environment.

Usefulness also incorporates the notion of interoperability, which is the ability to utilize the weapon from a variety of platforms. In this regard, the Hellfire is a proven system that has an extensive history of battlefield success in both rotary and fixed-wing fire support applications.[157] Alternatively, the APKWS has a unique advantage over the other available weapons options; not only can APKWS be used from fixed wing platforms, but the APKWS can be intermixed with unguided rockets.[158] This would allow the CF to capitalize on the full range of battlefield effects that can be achieved with the various warheads that can be mated to the unguided version of the rockets for those applications in which the battlefield geometry obviates the need for precision

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[155] Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors* (Ottawa: Director General Air Force Development, 2012): 44.

[156] Sean Hayes and Steve Borden, Small Guided Munitions Project Office, "Small Guided Munitions: Path Ahead," last modified 11 March 2009, http://www.dtic.mil/ndia/2006psa_apr/borden.pdf.

[157] The Hellfire missile was selected to fire the opening shots of the First Gulf War. A total of eight AH-64 Apaches were tasked with simultaneously destroying two Iraqi air defence nodes in order to establish a corridor for fixed-wing aircraft to begin the offensive bombing campaign. See Chapter 1 of James Bradin's book *From Hot Air to Hellfire: The History of Army Attack Aviation* for a detailed account of this event. Furthermore, the use of Hellfire missiles from Predator UAVs to kill terrorists in countries such as Pakistan and Yemen is well documented.

[158] Rodger Holliday, United States Marine Corps Cobra pilot responsible for testing the APKWS, conversation with author 20 March 2013.

munitions; this would naturally have a corollary cost-savings benefit. From an interoperability perspective, the Viper Strike system is at a distinct disadvantage, given that its use would be restricted to a fixed-wing UAV platform insofar as the CF is concerned. In summary, of the available choices, the most useful weapon option that is available at this time is a missile system, although pairing this with another system may be required to fully meet the challenges of the urban environment.

Survivability

The provision of equipment with inherently high survivability is an important consideration for all facets of CF operations. Canada's population, like that of most nations, has a limited tolerance for the number of military casualties that it will be willing to accept during a military campaign before the popular support begins to erode. The growing demands for Canada's withdrawal from the combat mission in Afghanistan as the death toll increased attests to this reality.[159]

The majority of the aspects associated with battlefield survivability are directly related to sound tactics, defensive electronic warfare suites and the basic design of the airframe.[160] However, the guidance mode of a PGM also plays a crucial role in aircraft survivability. The *Armed Griffon Concept* development team noted that survivability is directly related to the exposure time needed for an aircraft to engage its intended targets. As such, to minimize the exposure time and the associated risk, it was recommended that weapon procurement be

[159] David Bercuson, "The War Where Public Opinion Marched Out the Door," *Globe and Mail*, last modified 23 August 2012, http://m.theglobeandmail.com/commentary/the-war-where-public-opinion-marched-out-the-door/article1376950/?service=mobile.

[160] Department of National Defence, *Tactical Aviation Tactics*…, 9-1.

prioritized in the order of F&F, LOAL, and finally, LOBL.[161] This approach is completely valid for a conventional conflict, due to the likely presence of a robust anti-aircraft capability. However, as has already been shown, conventional conflicts are no longer the realistic primary threat scenario for Canada and its allies. COIN campaigns, with the associated need to minimize collateral damage to safeguard the support of the local population, must become the priority of focus for the CF.

The effective conduct of fire support in COIN operations has a significant impact for tactical aviation. First, positive control of the weapon should be maintained at all times. Despite the best efforts of all personnel involved in the targeting approval chain to minimize the risk of collateral damage, unforeseen changes to the situation do occur following the release of a weapon, even those with a relatively short time-of-flight; this may necessitate that the weapon be re-directed away from the target. This very situation has in fact accounted for a substantial number of the 'misses' with the APKWS in Afghanistan.[162] It is this COIN battlefield reality that will ultimately see the F&F capability of advanced missile systems under-utilized. Commanders and aircrew alike must be prepared to accept a level of personal risk to maintain control of their weapons in order to meet the greater purpose of the COIN campaign. A similar parallel can be drawn by the need for select ground patrol commanders to remove their personal protective equipment and weapons when they were conducting key leader engagements in Afghanistan. Unfortunately, this cannot always be done without cost, as evidenced by the severe injuries sustained by Captain Trevor Greene when he was attacked by an axe-wielding militant during

[161] Canadian Armed Forces. *Tactical Aviation Aerial Firepower: The Armed Griffon Concept,* (CFB Kingston: 1 Wing Headquarters, 2002), 6-10.

[162] David A. Fulghum, "Report Card on Advanced Precision-Kill Weapon System," *Aerospace Daily & Defence Report*, 16 Oct 2012, http://www.aviationweek.com/Article.aspx?id=/article-xml/asd_10_16_2012_p03-02-507229.xml.

one such meeting.[163] Nevertheless, the benefits to achieving long-term stability and peace outweigh the risk to individual soldiers. The corresponding follow-on impact is that in the long term, if the risk to aircrew is to truly be minimized, then manned aircraft may not always be the best option to provide fire support; however, this aspect is beyond the scope of this section and will be specifically addressed in the next chapter.

Practically, given the requirement of the CDR for aircrew to conduct autonomous operations, a weapon with a LOBL mode offers the surest guarantee that the weapon is locked onto the target prior to launch, and gives aircrew the ability to rapidly adjust the point of impact if needed.[164] Although a LOAL weapon may be released by aircrew with no direct indication that the weapon is properly "locked-on," they nevertheless have the assurance that the person designating the target can adjust the point of impact if needed. Furthermore, F&F capabilities represent an unnecessary expense that the CF should avoid in light of the current security environment.[165] Thus, in striking the appropriate balance between maximum survivability and minimal risk of collateral damage, the Hellfire & DAGR are the preferred weapons of choice, followed by the APKWS, and finally, highly advanced F&F systems such as the Spike multi-purpose missile system.

Stored Kills & Weaponeering Flexibility

Stored kills equates to the number of targets that can be engaged and defeated. The notion of stored kills is critical, as it is directly related to impermanence, one of the vulnerabilities of air

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[163] Noah Richler, "How a Canadian Soldier Escaped Death in Afghanistan," *Vancouver Magazine*, 1 June 2012, http://www.vanmag.com/News_and_Features/Canadian_soldier_tells_of_near_fatal_axe_wound_in_Afghanistan.

[164] Autonomous operations are those that do not rely on another platform, such as ground troops or a UAV, to designate the target. This does not imply self-designation, as aviation assets always operate in pairs for the provision of mutual support.

[165] As shown in Table 3.1, the cost of a single F&F missile can be more than $100,000 USD over LOBL/LOAL missiles such as the Hellfire II.

power.[166] Ideally, an aircraft would have a sufficient number of stored kills to match its fuel endurance in order to maximize its time on station. This fact finds grounding in the feedback from aircrew in Iraq and Afghanistan, who have indicated that they have not always had enough rounds to complete their missions; this has led to demands by US military officials for lighter weapons that will increase the number of stored kills on combat aircraft.[167]

The stored kill capacity of an airframe is highly dependent upon the platform's power and performance characteristics, which in turn are influenced greatly by environmental factors such as density altitude.[168] Consequently, in order to provide a simple basis of comparison, a typical weapons pylon will be used, such as that found on the recently fielded CH146 door gun mount, also known as the Canadian Forces Defensive Armament System. Like many other platforms, this pylon has the capability of holding a dual-rail missile launcher. This would facilitate the carriage of a combination of 2 missiles and/or Viper Strikes, or alternatively, a single missile or glide bomb in conjunction with a 4-pack launcher of DAGR rockets. On the other hand, the dual-rail launcher could be replaced with a 7-shot rocket pod for the APKWS. However, it is worth bearing in mind that most aircraft will have more than one weapons pylon available, leading to an increased ability to mix and match munitions to meet the operational requirement.[169] While the APKWS has the greatest number of rounds per mount, it must be remembered that this does not directly equate to the greatest number of stored kills, as a stored kill implies that the weapon has sufficient kinetic effectiveness to defeat the intended target. It is this reality which leads to the vital aspect of target weaponeering, the art of matching weapons to specific targets

[166] Department of National Defence, *Canadian Forces Aerospace Doctrine*, 25.
[167] Caitlin Harrington, *Unmanned Unbound*, 25.
[168] Canadian Armed Forces, *Tactical Aviation Aerial Firepower*…, 6-8.
[169] For example, most attack helicopters have at least 4 weapons pylons, and the CH146 has the potential for 2 weapons pylons.

during mission planning to ensure the desired outcome of the attack.[170] Regrettably, weaponeering in the truest sense is difficult to achieve in the COIN environment. Insurgents choose when, where, and for how long they will expose themselves to commit their actions; aircrew must be prepared at all times to adapt to exploit opportunities that present themselves.[171] This demands weaponeering flexibility, and is a crucial aspect that must be considered within the context of stored kills. The logical solution is to have a range of options, such as unique warhead choices or distinct weapons systems that are available at all times to defeat the gamut of threats which should reasonably be anticipated to be encountered. Unfortunately, it is unlikely that any one system will provide a sufficient number of stored kills whilst retaining the critical degree of flexibility and responsiveness that the COIN environment demands.[172] As a result, it is likely that two distinct weapons systems will need to be procured to meet the operational requirements of the future security environment.

Cost

The acquisition of new capabilities will prove challenging in the current financial atmosphere. Lieutenant-General Yvan Blondin, the Chief of the Air Force, stated in his 2013 priorities update for the RCAF that the greatest challenge facing the RCAF is to continue delivering the same excellent service that Canadians and Canada's allies have come to expect without "breaking the bank."[173] There are several financial aspects that must be considered in the purchase of any weapons system. The first procurement cost is associated with the integration of

[170] Department of Defense, *Air Force Pamphlet 14-210 Intelligence: USAF Intelligence Targeting Guide*, 1 February 1998: 56, http://www.fas.org/irp/doddir/usaf/afpam14-210/part06.htm.

[171] Jason Kenny, "Targeting in Irregular Warfare: How is it Different," *Royal Canadian Air Force Journal* 2, no. 1 (Winter 2013): 30.

[172] This observation is based on the author's personal experiences during the course of 11 months of deployed combat operations between 2008 and 2011, and is the fundamental reason why attack helicopters flew in Afghanistan with a mix of Hellfire missiles and Hydra rockets.

[173] Yvan Blondin, "Moving forward in Times of Change: RCAF Priorities," *Overflight*, 8 February 2013, http://airforce.mil.ca/dairpa3/vital/docs/overflight-survol/overflightFeb8_13e.pdf.

the weapon onto the airframe;[174] there are a range of options available, from simply 'bolting-on' a mission kit to an existing airframe to purchasing a new platform with the integral weapons capability. All of the suggested weapons options have the ability to be used as a modular mission kit, and are relatively similar in terms of the integration required to successfully detect, designate and engage the target. Consequently, this cost is far more dependent on the platform selected to fire the weapon than the weapon itself; as such, these programmatic costs will be dealt with separately in the next chapter.

The next financial investment concerns the cost of the individual weapons. Missiles represent the most expensive option, with the cost increasing in relation to the complexity of the guidance system and warhead. An individual Hellfire costs between $80,000-$120,000 (US dollars – USD), depending on the variant selected, while the Spike F&F missile costs more than $200,000 USD per round. Alternatively, it is anticipated that the cost of an individual APKWS rocket, once in full production, will be in the order of $17,000 USD. Similarly, the initial cost projections for a DAGR rocket are in the magnitude of $10,000 to $15,000 USD.[175] Finally, the current cost of a Viper Strike glide bomb is $90,000 USD per unit.[176] Peter MacKay, the Canadian Minister of National Defence, notes that financial realities dictate that a balance must be reached in terms of operational capabilities and their associated cost in the post-Afghanistan era of monetary resource constraints.[177] In this regard, the optimum solution is likely a dual

[174] As will be shown in Chapter 4, the cost of integrating a Hellfire capability onto the CH146 is less than $1 million USD per aircraft.

[175] Hewson, *Jane's Weapons*…, 513; Defense Industry Daily, "Spike Missiles for Spain," last accessed 9 April 2013, http://www.defenseindustrydaily.com/spike-missiles-for-spain-04420/. Spike Missile costs estimated based on Spain's purchase of 44 launchers and 200 missiles for 64,000,000 USD, using the maximum reported value of $400,000 USD per launcher.

[176] Doug Denneny, Vice President for Business Development, MBDA, Inc., telephone conversation with author, 9 April 2013.

[177] Maclean's, "Losing Soldiers was a Shock to Everybody's System: An Interview with Defence Minister Peter MacKay," last modified 4 Mar 2013, http://www2.macleans.ca/2013/03/04/on-lessons-from-afghanistan-the-f-35-controversy-and-cutting-military-spending-2/.

stream approach: procure a limited quantity of missiles to defeat heavy armour and infrastructure, while relying upon the less expensive rockets to handle the remaining threats. This will also facilitate a gradual transition towards a greater emphasis on rockets as the technology matures and future warhead capabilities are established.

The final costing that will be discussed is in regards to training. It is essential that crews maintain a satisfactory level of proficiency on these weapons given the catastrophic consequences of missing an intended target in the COIN environment. This was the underlying basis of the analogy "choosing not to shoot won't lose the war, but taking the wrong shot might" that was frequently quoted by CHF(A) leadership in Afghanistan. Studies undertaken by 1 Wing on the training requirements of PGM weapons systems noted that the use of simulation has reached a sufficient level of fidelity that the need for live-fire training is largely eliminated, although it still remains desirable on a periodic basis.[178] In this regard, the DAGR has a distinct advantage over the other weapons systems. The DAGR not only provides an excellent capability itself, but can also serve as a highly effective surrogate training round to the Hellfire missile, given their near-identical operating procedures, which would help to defray the annual training costs of the community.[179]

It must be noted that the previously mentioned costing envelopes is by no means an exhaustive list of all of the financial implications associated with these weapons. For instance, the infrastructure costs associated with storing these natures of ammunition or developing suitable range facilities have not been considered, nor have the costs of modifying the existing simulation facilities to provide aircrew with a synthetic training tool. These have been excluded

[178] Canadian Armed Forces, *Tactical Aviation Aerial Firepower*…, 5-7.
[179] Lockheed Martin, "DAGR Product Card," last accessed 9 Apr 2013, https://mfcbastion.external.lmco.com/missilesandfirecontrol/our_news/factsheets/Product_Card-DAGR.pdf.

from the discussion as they are not believed to vary significantly between the available weapons options, and therefore represent a fixed overhead cost associated with acquiring a PGM capability. As such, they do not provide a meaningful contribution to the basis of comparison.

Commonality

The final criterion for the basis of comparison between the weapons options is system commonality. There are two key aspects to the commonality in the operation of a weapon system, which can simply be grouped under the broad umbrella of external and internal factors. Examining the external factors, the most significant area that needs to be considered is logistical support, particularly when conducting expeditionary operations. While the CDR aptly notes that the CF may no longer have the luxury of relying on other nations to provide aviation-based fire support, this does not imply that military operations will not be coalition-based. To the contrary, multi-national coalition operations will continue to form the basis of Canada's participation on deployed missions.[180] One of the basic premises for forming an alliance such as NATO is the efficiencies that are gained by ensuring commonality of equipment, including munitions and the associated target designating systems. This greatly improves battlefield flexibility, as munitions can be loaned from one country to another in times of stock shortages, and the ability to have shared forward arming and refueling points. In Afghanistan, CHF(A) routinely sought and provided logistical support assistance to other countries in order to sustain the tempo of the combat operations.[181] Consequently, a procurement consideration must be ensuring that the CF does not end up with an orphan weapon system. Of the available options, the only system that is

[180] Department of National Defence, *Canadian First Defence Strategy*, 9.

[181] This observation is based on the author's personal experiences with Canadian Helicopter Force (Afghanistan) during the course of 11 months of deployed combat operations between 2008 and 2011.

currently in wide-spread use is a Hellfire missile, which gives it a clear advantage in terms of external commonality.

The internal aspects of commonality are primarily concerned with the procedures associated with the employment of the weapons. This is particularly important in light of the preceding analysis which has indicated that more than one weapons system may be needed. The field of aviation human factors engineering has shown the merits of having operating procedures that are as identical as possible for a family of similar systems. This leads to simplified crew coordination, reducing the risk of errors and should ultimately facilitate a more responsive attack.[182] This would suggest that if two systems were to be procured, a combination of Hellfire and the DAGR would be the preferred option, given that the DAGR was purpose-built to mimic the Hellfire operating procedures.[183] The one major drawback to this approach is that both weapons systems are likely to be susceptible to the same negative battlefield impacts, such as laser dispersion due to atmospheric conditions.[184] However, it must be noted that the preponderance of armed aviation assets have traditionally been limited to a single PGM option, but nevertheless remained highly effective battlefield enablers. Therefore, it is evident that the potential perils associated with the similarity of the Hellfire and DAGR guidance systems would be well within an acceptable level of operational risk.

Summary

The goal of this chapter was to determine what families of PGMs might best suit the operational needs of the CF, particularly in light of the greater range of possibilities brought

[182] This principle is the foundation upon which Airbus designs its aircraft in order to allow pilots to routinely rotate between the A320, A330 and A340 family of aircraft; E. Tarnowski and J-J. Speyer, "Integrating Human Factors and Automation with Progress in Aircraft Design and Flight Management," in Aviation Safety: Human Factors, System Engineering, Flight Operations, Economics Strategies, and Management, ed. Hans M. Soekkha, 169-187 (The Netherlands: Ridderprint, 1997): 172.

[183] Lockheed Martin, *DAGR Product Card.*

[184] Department of National Defence, *Tactical Aviation Tactics*…, 9-5.

about by recent technological advancements in weapons design. Sadly, many of the innovations, such as kinetic energy weapons, while holding great promise for minimizing the risk of collateral damage on future COIN operations, are far too immature to meet the immediate needs of the CF. Furthermore, capabilities such as fire and forget, while understandably borne out of survivability requirements of the conventional battlefield, are not necessary for the CF to acquire given the low intensity nature of COIN operations. Ultimately, as has been shown, there is not a single system solution that is perfectly suited to the needs of the tactical aviation community.

The one conclusion that can be unequivocally stated is that based on current weapons capabilities, a missile system such as the Hellfire is vital to delivering the full range of battlefield effects specified within the CDR. Unfortunately, this comes with the trade-off of high unit cost and the lowest ability to offset impermanence. In the end, it is apparent that the optimum solution for the CF will involve a mix of both missiles and PG rockets; this will ensure that collateral damage considerations are fully respected whilst safeguarding the ability to exploit the fleeting opportunities of the COIN environment to the maximum extent possible. However, it must be reinforced that a final analysis of classified performance specifications and a full consideration of the specific weapons-platform interface implications remains an area for future research.

CHAPTER 4: DELIVERING A PGM CAPABILITY

Introduction

The quest to safeguard the operational relevance of the CF's tactical aviation community has demonstrated the critical need for obtaining a PGM capability and yielded specific recommendations on the weapons which are best suited to fulfill this requirement. In order to complete the analysis regarding the acquisition of this capability, it is necessary to undertake an examination of the various aircraft that could potentially be employed in an aviation fire support role for the CF. Canadian aviation doctrine explicitly recognizes that a wide variety of platforms, up to and including attack helicopters, are capable of delivering the desired weapons effects.[185] Consequently, this study will examine five distinct types of aircraft: armed utility tactical transport helicopters (UTTH); armed reconnaissance helicopters (ARH); attack helicopters (AH); and finally, both fixed-wing (FW) and rotary-wing (RW) uninhabited aerial vehicles (UAV). The first section will briefly describe the key characteristics of each and provide an example airframe that will be subsequently used to provide a basis of comparison.

It is important to note that the ability to deliver PGMs from stand-off distances does not define the overall operational suitability of a platform. There are numerous factors which must be examined holistically to determine the overall combat effectiveness of any platform. As such, this study will compare the selected aircraft against the following criteria: operational capability; flexibility; survivability; cost; endurance; psychological impact; and lastly, service life. It is acknowledged that the fire support capability gap should be rectified as expeditiously as possible; however, the implementation time has nonetheless been omitted from consideration. As was seen with the rapid acquisition of the CH147D for Afghanistan, it may be faster to procure a

[185] Department of National Defence, *Tactical Helicopter Operations*…, 1.

new capability than to modify an existing one. This is due to the fact that the time to implement a capital project can be substantially influenced by operational imperatives and political will; therefore, any answer provided in this study would be pure conjecture. Finally, criteria that would naturally be a core requirement of any future platform, such as allied interoperability, will not be discussed as they do not provide the variance needed in a comparative analysis. Table 4.1 provides an overall summary on the findings of the aircraft comparative analysis.

Manned and Unmanned Aircraft Options

The first option that bears examination is an armed UTTH, as studies have previously concluded that the CH146 has the potential to satisfy the tactical aviation firepower capability deficiency.[186] Moreover, recommendations that the army give its "unstinting support for the development of an armed Griffon" have existed since 1999.[187] Possible solutions for arming the CH146 range from a simple and relatively inexpensive bolt-on weapons package with some minor associated avionics modifications, to a major overhaul of the airframe to upgrade it to the UH-1Y Venom Huey, arguably one of the most capable armed UTTHs currently fielded.[188]

The next categories of platforms that must be considered are armed reconnaissance helicopters (ARH), alternatively known as scout helicopters, and attack helicopters. Canadian defence scientists Thierry Gongora and Slawomir Wesolkowski, in examining the force structure of the CF tactical aviation community, concluded that the CF should acquire a purpose-built attack helicopter or ARH.[189] Conventionally, ARH helicopters are the smaller cousins of armed UTTH helicopters, retaining a cabin, albeit reduced in size, which affords them the ability to

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[186] Canadian Armed Forces, *Tactical Aviation Aerial Firepower*…, ii.

[187] Mike Cessford, "Some Thoughts on an Army for the 21st Century," *Army Doctrine and Training Bulletin* 2 no. 1 (February 1999): 50. http://www.army.forces.gc.ca/caj/documents/vol_02/iss_1/CAJ_vol2.1_full_e.pdf

[188] Houde, *The CH-146*…, 37; Royal Canadian Air Force, Directorate of Air Requirements, *CH146 Griffon ELE Extension/Replacement Issues and Options: Vector Brief to Chief of the Air Force*, 8 June 2012.

[189] Gongora and Wesolkowski, *What Does a Balanced*…, 19.

perform some auxiliary utility transport tasks. These platforms have highly specialized and integrated sensors which optimize their ability to conduct reconnaissance tasks while minimizing their probability of being detected. The most recent effort to develop an ARH, the Bell ARH-70 Arapaho, a commercial derivative of the Bell 407, was cancelled due to program cost overruns.[190] Nevertheless, it will be used to provide a sample basis of comparison, as its characteristics are likely to be comparable with whatever platform is eventually selected to replace aging fleets such as the OH-58D Kiowa Warrior.[191]

As previously shown, attack helicopters evolved from the need to provide an additional manner for Western nations to destroy the overwhelming numerical superiority of Soviet armour during the Cold War. These platforms are highly specialized killing machines, and represent the pinnacle of current helicopter design. Major Danny Houde correctly surmised in 2000 that the CF would not acquire a high performance attack helicopter due to financial and political realities for the foreseeable future;[192] his conclusion continues to prove accurate to this day, despite having participated in ten years of combat in Afghanistan. Unsurprisingly, the combat experiences of Iraq and Afghanistan have actually called into question the future of the dedicated attack helicopters, given that the requirement to defeat massed armour may not reappear.[193] Nonetheless, given that attack helicopters continue to form a key element of most aviation force structures, they must be evaluated to determine whether they would provide a suitable means of

[190] Army-Technology.com, "ARH-70A Arapaho Armed Reconnaissance Helicopter," last accessed 18 April 2013, http://www.army-technology.com/projects/arh-70a/; Military Factory, "Bell ARH-70 Arapaho Light Armed Reconnaissance Helicopter," last accessed 18 April 2013, http://www.militaryfactory.com/aircraft/detail.asp?aircraft_id=601.

[191] It is worth noting that Australia has recently fielded a light attack helicopter, the Eurocopter Tiger, to fulfill its ARH role. While a similar movement was previously considered in the US with the development of the RAH-66 Comanche, these helicopters' battlefield characteristics are more representative of an attack helicopter, as opposed to representing their own class of helicopter, and as such are not included in the ARH category for the purposes of this study.

[192] Houde, *The CH-146*…, 40.

[193] Braybrook, *Mean Dedicated Machines*, 64.

addressing the CF's tactical aviation fire support needs. Two options will be examined within this study: the AH-64D Apache, widely considered to be the most effective attack helicopter on the battlefield, and the AH-1Z Viper Cobra, given that it has significant commonality with the UH-1Y and may provide an opportunity for operations and maintenance (O&M) savings costs in the event that a two-platform solution is required.[194] Of note, while there has been a growing movement towards operationally relevant light attack helicopters such as the Eurocopter Tiger, the operational characteristics of these platforms remain sufficiently similar to their heavy attack cousins that they need not be addressed separately for the purposes of this study.[195]

No discussion on fire support platforms would be complete without examining the potential applicability of UAVs, both fixed-wing (FW) and rotary-wing (RW). Jane's defence writer Caitlin Harrington notes that hunter-killer UAVs are an increasingly important aspect of US military operations, having proven to be well-suited to supporting low-intensity conflicts where the airspace is uncontested. This has resulted in the US Army undertaking efforts to greatly expand their UAV capabilities over the next 25 years.[196] The Canadian Army has expressed a similar interest in acquiring such UAVs, as they provide a quantum leap in the ability to find, fix and neutralize the enemy.[197] UAVs are the logical evolution of air power, as they allow for the application of decisive effects on the battlefield without putting the aircrews' lives in jeopardy, an important consideration when trying to maintain popular support for war efforts in the casualty-adverse political environment that is found in Western nations.[198]

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[194] Paul Jackson, *Jane's All the World's Aircraft: Development and Production 2012-2013*, (Coulsdon: Jane's Information Group, 2012): 708.
[195] Braybrook, *Mean Dedicated Machines*, 64.
[196] Harrington, *Unmanned Unbound*, 22-23.
[197] Department of National Defence, *Capability Development Review*…, 27.
[198] Harrington, *Unmanned Unbound*, 22.

An additional consideration that supports investing in UAV technology is the rise in manned-unmanned teaming (MUM-T), which improves manned helicopter effectiveness by enhancing their survivability by identifying threats, identifying targets beyond the range of the helicopters organic sensors, or alternatively, conducting independent attacks.[199] US Major-General William Crosby, the Army's Executive Program Officer - Aviation, observed that one of the most important lessons learned in the decade-long conflict in Afghanistan was that MUM-T is a "game-changing capability in aviation support operations."[200] Canadian Helicopter Force (Afghanistan) also exploited MUM-T during the conduct of deliberate operations, relying on the CU170 Heron UAV to assist in confirming patterns of life and identifying threats within the landing zones and objective areas.[201] While FW UAVs such as the MQ-9 Reaper are now well-established, RW UAVs remain a relatively nascent capability. The US Navy's MQ-8 Fire Scout is the most mature RW UAV platform currently employed by the US military, and is completing the final trials of its fire support and resupply capabilities to augment the traditional reconnaissance and surveillance role.[202] As such, the MQ-8 and MQ-9, representing the most widely fielded RW and FW platforms currently available, will be used to provide the basis of comparison against traditional manned aviation assets.

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[199] Glenn W. Goodman, Jr., "Manned-Unmanned Synergy: US Army's UAV-Related Efforts Gain Momentum," *Armed Forces Journal International* 139, no. 12 (July 2002): 60.

[200] Scott R. Gourley, "Flight Delays," *Defence Helicopter* 32, no. 2 (March/April 2012): 8.

[201] This observation is based on the author's numerous personal experiences as an Aviation Mission Commander and Operations Officer with Canadian Helicopter Force (Afghanistan) during the course of 11 months of deployed combat operations between 2008 and 2011.

[202] Kris Osborn, "Navy Loads Laser-Guided Rockets to Fire Scout," last modified 12 April 2013, http://defensetech.org/2013/04/12/navy-loads-laser-guided-rockets-to-fire-scout/; Northrop Grumman, "MQ-8C Fire Scout Brochure," last accessed 17 April 2013, http://www.northropgrumman.com/Capabilities/FireScout/Documents/pageDocuments/MQ-8C_Fire_Scout_Data_Sheet.pdf.

Figure 4.1: Bell CH146 Afghanistan Combat Configuration

Figure 4.2: Armed Griffon Concept, circa 2000

Figure 4.3: Bell AH-1Z Viper Cobra and UH-1Y Venom Huey

Figure 4.4: Bell ARH-70A Arapaho Armed Reconnaissance Helicopter

Figure 4.5: Boeing AH-64 Apache

Figure 4.6: Eurocopter Tiger Light Attack Helicopter

Figure 4.7: General Atomics MQ-9 Reaper

Figure 4.8: Bell/Northrup Grumman MQ-8C Fire Scout

Table 4.1: Summary of Aircraft Comparative Analysis

Family		Armed UTTH		ARH	Attack Helicopter		FW UAV	RW UAV
Military Designation		CH146 Griffon	UH-1Y Venom	ARH-70 Arapaho	AH-1Z Viper	AH-64D Apache	MQ-9 Reaper	MQ-8C Fire Scout
Current Status		In service CF	In service USMC	Cancelled, comparison purposes only	In service, USMC	In service, multi-national	In service, multi-national	In service, USN
Unit Cost (US Dollars, 2013)		<1 million [1]	26.5[2]	15.7[3,4]	33.7[2]	23.5[3]	23.1[5]	13.6 [6]
Crew Members		4	4	2	2	2	0	0
Combat Effectiveness	AE[7]	Fair-Good[8,9]	Good[9]	Fair[9,10]	Good[11]	Good[11]	None	Fair[9,12,13]
	AOW/ACE	Good[9]	Good[9]	Fair-Good [9,10]	Excellent	Excellent	Good[12]	Fair[9,12,13]
Flexibility		Excellent	Excellent	Good	Poor	Poor	Poor	Fair
Survivability		Fair	Good	Fair	Excellent	Excellent	Fair	Poor
Risk to Aircrew		Fair	Good	Fair	Excellent	Excellent	None	None
Endurance		Fair	Fair	Fair	Fair	Fair	Excellent	Good
Psychological Impact		Good	Good	Good	Excellent	Excellent	Fair	Excellent

Notes:

1. Addition of armament capability only.
2. As reported in United States Department of the Navy, Fiscal Year 2011 Aircraft Procurement Budget Estimates, February 2010, UH-1Y/AH-1Z procurement, page 2 of 13. Note inflation factor already factored in over life of program.
3. As reported in United States Congressional Budget Office, *Modernizing the Army's Rotary-Wing Aviation Fleet*, November 2007, Table 1-2. ARH 8.9 million, AH-64D 16.5 million

(airframe) plus 4.4 million (sensor), for a total of 20.9 million. US inflation factor of 12.3% from 2007-2013 added.
4. As reported by August Cole in *The Wall Street Journal*, the projected cost of ARH had increased from 8.9 to 14.5 million by 2008, resulting in project termination. US inflation factor of 8.1% from 2008-2013 added.
5. As reported in United States Department of Defense, Fiscal Year 2013 President's Budget Submission: Aircraft Procurement - Air Force, February 2012, Volume 1-221. Note inflation factor already factored in over life of program.
6. As reported in United States Department of Defense, Fiscal Year 2013 President's Budget Submission: Aircraft Procurement - Navy, February 2012, Volume 1-169. Note inflation factor already factored in over life of program.
7. Attached aerial escort only. Detached aerial escort can be considered as an overwatch task.
8. Maximum speed limitations.
9. High threat limitations.
10. Fixed forward gun arcs.
11. Restricted gun arcs.
12. Limited to single field of observation
13. Lack of suppressive weapon system (APKWS only)

A Comparative Analysis

Operational Capability

The most important criteria for determining the combat effectiveness of an airframe for the CF is its operational capability, or in other words, the delivery of relevant air power.[203] For the tactical aviation community, any armed platform must be able to fulfill three core force-protection missions: aerial escort (AE), armed overwatch (AOW), and airborne convoy escort (ACE); however, for the purposes of this study, the requirements of AOW and ACE are sufficiently similar that they can be considered as being the same.[204]

Armed UTTH are well suited to meet the operational needs of the tactical aviation community. Their near-360 degree fields of observation and fire, stemming from the use of crew-served door guns, allows the crew to maintain a very high level of battlefield situational awareness. This is particularly useful in deterring rear-aspect small arms fire, the preferred tactic

[203] Department of National Defence, *Air Force Vectors*, 44.

[204] This observation is based on the author's numerous personal experiences piloting the CH146 during the course of 5months of deployed combat operations in 2011.

of insurgents for engaging helicopters, when performing attached aerial escort.[205] Unfortunately, armed UTTHs also have the drawback of exposing the greatest number of lives of any of the platform options. It must be noted that in Afghanistan, armed UTTH and ARH were only capable of independent operations up to a medium threat environment, owing to their limited ballistic protection and susceptibility to battle damage.[206] When threat levels were deemed high, it was a near certainty that an attack helicopter would be present to provide additional fire support.[207] This implies that an armed UTTH will not meet the full range of operational capabilities needed by the CF without the support of another platform.

An additional limitation specific to the CH146 and its ability to conduct attached aerial escort was its maximum speed, which restrained the faster lift platforms they were protecting. Speed directly contributes to force protection, by minimizing threat exposure time. Newer armed UTTH platforms such as the UH-1Y have greater maximum speed limit and eliminate this problem; this must be a consideration for a CH146 upgrade or replacement project.[208]

The largest detractor of armed reconnaissance helicopters is the limitations of their gun arcs. Platforms such as the OH-58D Kiowa Warrior are restricted to fixed-forward gun arcs, which hamper their ability to quickly suppress threats, a particular concern during the conduct of attached aerial escort. Alternatively, attack helicopters such as the UH-1Z and AH-64 have steerable nose cannons, making them an excellent choice for the conduct of AOW tasks, particularly in circumstances of elevated threats.[209] While attack helicopters are capable of

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[205] In Afghanistan, when threat levels were assessed to be medium or above, CHF(A) defaulted to the use of attached AE to provide deterrence.

[206] The CH146 only possesses armoured pilots seats and add-in ballistic floor plates; none of the aircraft components are damage tolerant. This will be expanded in the survivability section.

[207] This observation is based on the author's personal experiences observing US Army operations in Afghanistan, where OH-58s were partnered with AH-64s in areas with elevated threats.

[208] Department of National Defence, *Tactical Aviation Tactics…*, 9-10; Morrison, *Canadian Helicopter Force*…, 19-20.

[209] Jackson, *Jane's All the World's Aircraft*…, 711, 737; Army-Technology.com, *ARH-70A Arapaho...*

performing attached AE, they must do it at a greater distance to offset the limitation of their gun arcs, which is feasible since the range of the cannon is greater than that of the weapons which insurgents are likely to employ.[210] However, despite the lower weight of fire of armed UTTH, it can nonetheless be concluded that they are still better suited to the conduct of AE than attack helicopters in all but the highest of COIN threat scenarios. This is due to its superior responsiveness in the application of suppressive fires, which stems from the simple fact that there are twice as many crew members available to detect the threat.

Fixed-wing UAVs, in spite of their many positive contributions to the battlefield, are simply not yet capable of conducting aerial escort. This stems from the lack of weapons suitable for the application of instantaneous suppressive fires. However, with sufficient coordination, they can contribute to aerial escort by covertly conducting reconnaissance of pre-determined flight paths. A further limitation of FW UAVs is their lack of ability to provide deterrence, an additional consideration that will be subsequently discussed in greater detail under the topic of psychological impact. At this time, there is no evidence to indicate that RW UAVs have conducted AE or ACE missions; however, based on their projected capabilities, there is no reason to suspect that RW UAVs cannot contribute to all of the missions required of an armed tactical aviation platform. Unfortunately, their field of observation will be limited to that of their sensor. As such, their overall combat effectiveness in force protection roles is unlikely to be as effective as a manned helicopter.

Flexibility

[210] The AK-47, the most common personnel weapon in third-world countries, has an effective range of 400m and a maximum range of 800m. Alternatively, the M230 cannon used on the AH-64 has an effective range of 1500m, and a maximum range of 4500m. Shelford Bidwell, *The Encyclopedia of Land Warfare in the 20th Century*, (London: Spring Books, 1977), 199; Gary Wright, "Comparison of 30 mm Automatic Cannons," last accessed 22 April 2013, http://digitality.comyr.com/milnet/heli/30mmAutoCannons.htm.

The newest edition of *Air Force Vectors* states that Canada's armed forces must be sufficiently flexible and adaptable in order to provide the Canadian government with a range of options to meet national ends. This in turn "suggests the importance of multi-role platforms that are able to meet a variety of contingencies."[211] This is already having a direct impact on the current priorities for the RCAF, one of which is to look at "new and innovative ways of employing current and future platforms."[212] Practically, flexibility for tactical aviation implies the ability to be able to contribute to each of the doctrinal roles of fire support, reconnaissance, and mobility, in both an expeditionary and domestic context. In this light, an armed UTTH is clearly the front runner of the available options. An armed UTTH can fulfill a number of roles in the contemporary operating environment, from fire support to casualty evacuation *during the course of a single mission*.[213] Armed reconnaissance helicopters also possess a degree of flexibility, although more limited.[214] Their ability to carry out medical evacuation missions and emergency resupply missions is constrained due to cabin space and weight limitations.

Unfortunately, attack helicopters simply cannot duplicate this degree of battlefield flexibility, stemming from their inability to carry passengers.[215] Furthermore, an attack helicopter would be of little use in current domestic operations, save the occasional Canadian special security event such as a G8 summit, where its advanced sensors would be useful in a surveillance role. However, given the political sensitivities of these events, there is a risk that an attack helicopter would be viewed as being an excessive response, and would diminish police agencies from being rightfully viewed, both domestically and internationally, as the face of Canada's

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[211] Department of National Defence, *Air Force Vectors*, 43.
[212] Blondin, *Moving Forward*….
[213] Hewson, *Light/Attack Helicopters*…, 25.
[214] Some variants of armed reconnaissance helicopters do not have a cabin, limiting their flexibility to that of an attack helicopter.
[215] Houde, *The CH-146*…, 40.

internal security.[216] As such, another platform would likely be a preferred option to meet the surveillance requirements of these events.

Like attack helicopters, the flexibility of fixed-wing UAVs is also quite restricted. By their very nature, fixed-wing munitions-carrying UAVs are constrained to operating from a runway. Moreover, their effects are restricted to the domains of reconnaissance and fire support; they cannot currently provide any contribution to the tactical aviation mobility role. Alternatively, the Fire Scout has already demonstrated the ability to act to contribute to each of the tactical aviation doctrinal roles, and the use of RW UAVs is being considered for the provision of casualty evacuation.[217] While the development of a purpose-built battlefield RW UAV, known as an unmanned combat armed rotorcraft (UCAR), has been temporarily halted, the continuing advancement of RW UAV technology will likely see this platform meeting many of the desired traits of battlefield flexibility in the near future.[218]

Survivability

As previously discussed, the survivability of a military aircraft on the battlefield must be a prime consideration. Systems selected for military operations need to be able to successfully complete their mission in a typical threat environment without the likelihood of being destroyed. The survivability of a platform is greatly increased through the use of sound planning and

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[216] The guiding principle for the use of the CF domestically is that it will always operate in a supporting role acting under the direction and authority of the civil authority, with the notable exceptions of its defence of Canada role and search and rescue. See Department of National Defence, B-GG-005-004/AF-023, *Civil-Military Cooperation in Peace, Emergencies, Crisis and War* (Ottawa: Chief of the Defence Staff, 1999): 4-1; Department of National Defence, B-GJ-005-302/FP-001, *CFJP 3-2: Domestic Operations* (Ottawa: Commander of Canada Command, 2011-12), 3-1.

[217] Huw Williams, "Spinning Around: UAV Revolutions Open Up Battlefield Opportunities," *Jane's International Defence Review* 42 no. 5 (May 2009): 47; Glenn W. Goodman Jr., "Pilots Need Not Apply: Unmanned Attack Helicopters Will be Highly Autonomous, Flexible," *C4ISR* (1 January, 2005): 28. http://search.proquest.com/docview/867017790?accountid=9867.

[218] Greg Goebel, "Unmanned Aerial Vehicles," last accessed 22 April 2013, http://www.vectorsite.net/twuav_12.html#m2.

techniques such as threat-band avoidance and terrain masking.[219] However, it is important to note that no amount of planning can successfully predict every threat, given that an adversary will inevitably attempt to exploit the element of surprise. Therefore, in addition to a defensive electronic warfare system (DEWS), it is critical that an aircraft incorporate a damage-tolerant components and system redundancy in order to minimize the effects of a successful engagement by an enemy, with the ultimate goal of protecting the lives of the aircrew. Of significance, this level of damage tolerance is only found in purpose-built military platforms.[220] Aircraft such as the CH146, which are commercially-designed aircraft adapted for military use, do not possess this inherent level of survivability. Ultimately, the risk posed to aircrew is inversely related to the survivability characteristics of the aircraft.

Of the available choices, the attack helicopter possesses the greatest survivability and hence the lowest relative level of risk for aircrew operating in a hostile environment. This is evidenced in the failed AH-64 attack at Najaf, Iraq on March 24th, 2003. Of the 32 Apache helicopters employed on the mission, 31 were damaged as a result of an impenetrable wall of well-coordinated ground fire, and yet all but one was able to return to their operating base for repairs. Furthermore, the crew of the downed aircraft was able to survive their crash-landing due to the robust design of the airframe.[221] While other purpose-built aircraft such as the UH-1Y also incorporate damage tolerant components, they do not provide the same level of ballistic protection to the crew as an attack helicopter.[222] Finally, commercially-adapted platforms that incorporate DEWS gear and add-on ballistic plating, such as the CH146, can offer a moderate

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[219] Department of National Defence, *Tactical Aviation Tactics…*, 9-1.

[220] Jang-Wook Hur, "A Study on the Ballistic Damage Tolerance Design of Aircraft Structure from Armor Piercing Bullet Hits," *International Journal of Precision Engineering and Manufacturing* 12 no. 1 (February 2011): 85.

[221] A discussion on the circumstances that led to the success of the Iraqi ambush is beyond the scope of this paper. See Richard J. Newman's article "Ambush at Najaf" in the October 2003 edition of *Air Force Magazine*.

[222] Jackson, *Jane's All the World's Aircraft*…, 709.

level of survivability to the crew. Interestingly, without the need to protect aircrew, neither the Reaper nor Fire Scout currently incorporates any ballistic protection or DEWS equipment. This makes them more vulnerable to attack, although this is mitigated to some extent for fixed-wing UAVs through their use of high-altitude techniques.[223] In particular, the survivability of RW UAVs may have to be enhanced if they are desired to be an operationally viable alternative to supplant the use of attack helicopters on COIN operations.

Cost

Having previously established the contextual importance of financial stewardship in the preceding chapter, it is now possible to address the unit costs of the available options and qualitatively examine some of the factors associated with sustaining the capability. The most economical manner to provide a PGM capability for the CF would be to modify the existing fleet of CH146. The majority of the costs would be associated with modifying the existing MX-15 sensors to incorporate a laser designator, at a cost of approximately $300,000 USD per unit.[224] There would also be some costs associated with purchasing the launchers and establishing the necessary connections between the existing firing controls and the weapons launchers; these costs are projected to be in the vicinity of $375,000 USD per aircraft.[225] Therefore, it can be confidently stated that for less than one million dollars, a single CH146 can be modified to fire PGMs.[226] All other options represent new capital acquisition projects, and as such, are substantially more expensive. In order to provide a common baseline, all unit costs in Table 4.1

[223] Harrington, *Unmanned Unbound*, 23; Northrop Grumman, *MQ-8C Fire Scout*…, 2; US Air Force, "Fact Sheet: MQ-9 Reaper," last accessed 18 April 2013, http://www.af.mil/information/factsheets/factsheet.asp?id=6405.

[224] Gabriel Dore, former INGRESS project manager, E-mail to author, 22 April 2013.

[225] Houde, *The CH-146*…, 40. Costs of the Hellfire mount, launchers, and software ensemble; originally quoted by Danny Houde at $450,000, less the $175,000 floor plank, which is no longer required due to the prior acquisition of the CF defensive armament system weapons mount. Factoring in 35.2% inflation of the US dollar between 2000 and 2013, the revised cost is estimated to be $US 372,000

[226] This nominally accounts for the additional funding needed for initial engineering integration research, test and evaluation, and the procurement of training aids.

are provided in 2013 US dollars.[227] One item that is worth addressing is that even if a UH-1Y upgrade were to be pursued, it is unlikely that a corresponding acquisition of a limited number of AH-1Z attack helicopters would be contemplated. In conjunction to the previously identified flexibility concerns, the AH-1Z has an initial acquisition cost of $US 10 million more than an AH-64D. It is unlikely that the Canadian public would accept paying more for a less capable aircraft, despite the potential savings in maintenance costs gained by the commonality between the UH-1Y and AH-1Z airframes.

The second economic consideration in the purchase of a new capability is the associated O&M costs. While a detailed analysis of O&M considerations is not feasible within the constraints of this research project, the provision of some qualitative observations is nonetheless important.[228] First, arming the CH146 would represent the lowest overall increase in O&M costs, as the majority of the O&M costs would not be affected by the addition of a PGM capability. Second, the O&M cost projections for both FW and RW UAVs is 10% to 50% of the equivalent capability-based manned platform, representing a substantial opportunity for cost-savings over the service life of the aircraft.[229] Finally, purchasing a purpose-built aircraft such as an attack helicopter will have higher O&M costs than options that exploit commercial off-the-shelf technologies, due to the scales of economy.[230]

Battlefield Endurance

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[227] Inflation adjustment factors were taken from the website http://www.usinflationcalculator.com/

[228] O&M costs are very dependent upon the concept of operational employment, as this determines the quantity of items such as operational support equipment and maintenance sparring that must be procured. Unfortunately, developing a concept of operations requires the participation of all stakeholders, and as such, is not feasible within the constraints of this project.

[229] Doyon, *Replacing the CF-18 Hornet*…, 38; Goodman, *Pilots need not*…, 28.

[230] Jacques S. Gansler, "Commercial Off the Shelf (COTS): Doing it Right," last accessed 22 April 2013, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA494033

Battlefield endurance is a crucial consideration, as it contributes to impermanence, one of the doctrinal limitations of air power. Practically, aircraft loitering capabilities are critical to the successful conduct of COIN operations. Paul Darling and Justin Lawlor note that too often the justified engagements of insurgents have been transformed into strategic failures; if battle damage assessments cannot be properly conducted, then the dead insurgents' weapons can be removed and replaced with farming implements, which in turn leads to enemy information operations victories.[231] This is particularly true of 'target of opportunity' engagements, where the documented evidence string leading up to the attack is absent. A platform with sufficient endurance to observe the scene post-attack is needed in order to deter nefarious insurgent post-strike activities, and either gather sufficient evidence or secure the scene until a ground force can arrive. Fixed-wing UAVs have a clear-cut advantage in this area, with station loiter times that can exceed 24 hours, while Rotary-wing UAVs may have up to half of this endurance. Manned helicopter platforms all have a limited endurance of approximately 2½ hours, although some platforms may be able to extend this through the use of an auxiliary fuel tank.[232]

Psychological Impact

The success of COIN operations hinges on the ability to influence the psychological dimension of warfare to a far greater extent than the physical dimension.[233] While it is likely evident that weapons are the instrument of influence on the physical plane, it is less obvious that the firing platform itself is apt to have the greatest influence on the moral dimension of COIN

[231] Darling and Lawlor, *Updating Close Air Support*…, 29-30.
[232] Jackson, *Jane's All the World's Aircraft*…, 709, 711, 738; Army-Technology.com, *ARH-70A Arapaho*…
[233] Gray, *Irregular Warfare*…, 50; Department of National Defence, *Designing Canada's Army of Tomorrow* (Kingston: Directorate of Land Concepts and Design, 2011), 41

operations through the use of deterrence. Deterrence is a form of coercion that involves the threatened use of force, and is aimed at an adversary's will to conduct a hostile act.[234]

In Afghanistan, the close proximity of armed helicopters provided a very strong disincentive to insurgent activity; the fact that not a single Canadian logistics convoy was attacked while escorted by aviation is a testament to the deterrence provided by armed helicopters.[235] It must be noted that while the Afghan insurgents had a high level of respect for the Griffon, there should be no illusions as to its true capability; its battlefield reputation was carefully guarded through deliberate risk management, which often made use of coalition assets such as attack helicopters to mitigate the possibility of exposing the Griffon to situations where it would have been unduly vulnerable.[236] In the final analysis, the psychological impact of attack helicopters employing sound tactics cannot be matched by an armed UTTH.

Alternatively, fixed-wing UAVs are covert in their operation, and therefore do not yield an equivalent level of deterrence. While it is probable that the insurgents are always concerned that they are being observed, they are still inclined to accept the risk of carrying out activities such as IED emplacement, gambling that the UAVs will be focused elsewhere.[237] As such, a combination of overt deterrence and covert observation are actually quite complimentary, and can be employed in an effort to shape insurgent activity into pre-determined kill boxes.[238]

As a final consideration, it is not unreasonable to postulate that UCARs, when fielded, will yield an even greater psychological advantage over insurgents that can be achieved with an

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[234] Brian L. Murray, "Air Power's Contribution to Coercion," *The Royal Canadian Air Force Journal* 1 no. 2 (Spring 2012): 40.

[235] This observation is based on the author's personal experiences with Canadian Helicopter Force (Afghanistan) during the course of 11 months of deployed combat operations between 2008 and 2011.

[236] Morrison, *Canadian Helicopter Force*…, 20-23.

[237] Andrew Drwiega, "Military Insider: Manned-Unmanned 'Cat and Mouse'," *Rotor & Wing* 44 no. 6 (June 2010): 54.

[238] This observation is based on the author's personal experiences with Canadian Helicopter Force (Afghanistan) conducting Op SANGA FIST in 2009.

attack helicopter. Insurgents will quickly learn that shooting down a UCAR is a temporary and hollow victory at best; another will take its place in a matter of hours. The risk-reward balance that the most determined insurgents have followed in highly defended enclaves in an effort to secure an information operations publicity windfall in shooting down an armed helicopter will simply no longer exist.[239]

Service Life

The final factor to consider is the service life of the available options. The CH146 current end of life expectancy (ELE) is scheduled for 2021,[240] and the addition of armaments alone will not extend this date. As such, any decision to invest in an armed Griffon capability should be undertaken within the broader context of a mid-life upgrade to ensure an adequate return of investment. All of the other options would be new purchases, and would therefore have significantly longer service lives. However, there are two primary factors which suggest that the service life of a UAV would be shorter than that of a manned helicopter. First, UAVs have less stringent manufacturing standards, resulting in a lower number of useable airframe hours.[241] Second, UAVs have a significantly higher accident rate than manned aircraft. The CF manned aircraft accident rate per 10,000 hours flying time between 2006 and 2010 was 0.66, whereas it was 48.21 for the UAV fleets.[242] Similarly in the USAF, UAVs have the highest overall accident rate, approximately three times the average rate of manned aircraft.[243]

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[239] Metz, *New Challenges*…, 26.

[240] Royal Canadian Air Force, *CH146 Griffon ELE Extension/Replacement*….

[241] Doyon, *Replacing the CF-18*…, 37.

[242] Department of National Defense, *2011 Annual Report on Flight Safety*, (Ottawa: Directorate of Flight Safety, 2012): 17.

[243] Brendan McGarry, "Drones Most Accident-Prone US Air Force Craft: BGOV Barometer," last accessed 17 April 2013, http://www.bloomberg.com/news/2012-06-18/drones-most-accident-prone-u-s-air-force-craft-bgov-barometer.html.

Recommendations

In light of the factors used to distinguish the variances in the combat effectiveness of the aircraft that could meet the entire operational mandate for the CF's tactical aviation community, including a PGM fire support capability, it is possible to establish some very clear recommendations. It is evident that the decreasing availability of financial resources, coupled with a lack of political desire to deviate from the procurement projects identified in the *Canada First Defence Strategy*, may render an armed CH146 as the only feasible option. Nonetheless, the added combat effectiveness that could be obtained by upgrading the CH146 to the UH-1Y standard suggests that this should be examined further, both as a means of enhancing the ability to provide force protection for the CH147 Chinooks whilst extending the useful life of the Griffon. Unfortunately, even a UH-1Y would still be limited in its ability to operate independently in high threat scenarios. This leads to the final conclusion concerning armed UTTH: on the basis of their operational capability and flexibility, they should continue to form the backbone of the CF's tactical aviation community. However, they will require the support of a second platform to enable operations in the localized high-threat areas that can still be found in low-intensity insurgency conflicts.

Considering the remaining manned options, it is evident that an ARH would be a less capable platform than an existing CH146 employing a bolt-on weapons package; as such, this platform should be discounted from any future acquisition deliberations, either as a complement or replacement for the CH146. Alternatively, attack helicopters have many excellent battlefield characteristics, and are the only platform of the available choices which will enable the freedom to conduct operations in high-threat pockets. Unfortunately, their high cost and lack of flexibility is a severe impediment to garnering the required political support to endorse the acquisition of

even a limited number of aircraft to complement a predominately UTTH-based fleet. Consequently, for the foreseeable future, the freedom of movement of Canadian troops will be inextricably linked to the availability of coalition attack helicopter support, which as previously shown, may not be as readily available on future deployments.

While a full analysis of the implications of manned-unmanned teaming for the CF tactical aviation community remains an area for future research, the increasing battlefield synergies resulting from MUM-T lend considerable weight to the acquisition of UAV platforms. While no UAV is capable of independently providing the operational capabilities needed for the tactical aviation community, there is no doubt they can serve to complement the capabilities of an armed UTTH. Based on their growing use, it is anticipated that FW UAVs will continue to be a vital instrument in the conduct of future COIN operations, and their procurement should be undertaken without delay. However, it must still be recognized that they cannot provide the level of force protection required by friendly forces in a high-threat environment. On the other hand, RW UAV technology remains too immature to be pursued at this stage. Nevertheless, given the potential to afford greater flexibility and coercion than FW UAVs, the development of these platforms should be closely monitored as a means of further exploiting the possibilities of MUM-T in the future security environment.

Summary

The objective of this chapter was to analyze the combat effectiveness of the available families of manned and unmanned aviation platforms and determine what aircraft will best meet the needs of the CF in the contemporary security environment. In the short term, the most viable solution appears to be the arming of the CH146, while an attack helicopter will likely continue to remain a politically unacceptable solution for the CF. Regrettably, an armed CH146 will only

reduce, vice eliminate, Canada's reliance upon coalition aviation fire support. The capabilities of UAVs continue to evolve at a remarkable pace, and can offer a complementary solution to the overall robustness of an aviation fire support capability. While FW UAV capabilities are sufficiently mature to warrant acquisition, RW UAVs abilities are inadequate in their current state. Nonetheless, emerging RW UAV technologies must be closely monitored, given the strong likelihood that they will afford a greater flexibility across the spectrum of tactical aviation battlefield requirements.

CONCLUSION

The recent calls by the Canadian Army for a meaningful tactical aviation firepower capability resonate as accurately today as the first suggestions for arming the CH146 did when they were proposed some 14 years ago. The Griffon, despite its solid performance in Afghanistan, simply did not have the organic lethality to adequately handle the full spectrum of threats in the battlespace. Nonetheless, nations have too often been guilty of equipping their military forces based on the requirements of a previous conflict. As such, a detailed examination of the proposals contained in the Canadian Army's capability development record (CDR) for tactical aviation was warranted in order to confirm their validity. Ultimately, this study has sought to irrevocably demonstrate that the acquisition of an organic precision-guided stand-off fire support capability is essential for the CF tactical aviation community's future relevance in supporting expeditionary operations.

The requirement for armed aviation was forged in the war experiences of Western nations during the Second World War and Korea. Air forces were unwilling to provide adequate fire support to their land force brethren, and even when they did, it was not sufficiently effective. Still, the actual development of armed aviation was hampered by inter-service political fighting, and as a result, the widespread fielding of the armed helicopter would not emerge until after the start of the Vietnam War. However, the most significant evolutions of armed aviation would flow from the Cold War. Not only did it provide the impetus for the development of the attack helicopter, but equally important, it generated Air-Land Battle doctrine. This was central to the embodiment of aviation as an integral element of the combined arms team, and thus optimized the operational effectiveness of these forces.

Regrettably for Canada's tactical aviation capabilities, unification and the lingering parochial interests that would follow set in motion events that would lead to the establishment of Air Command. Canada's tactical aviation fleet was snatched from the army and quickly brought into the air force fold in what has been described as a "window of opportunity."[244] Since this event, Canada's tactical aviation community has been trapped in the unenviable position of having never been completely accepted by either the army or the air force. Unfortunately, this lack of meaningful ownership has precipitated the failure to invest the resources that are needed to acquire a proper fire support capability. Nonetheless, the combat mission in Afghanistan has provided an initial stimulus for the Canadian Army to take the substantial step of formally requesting a more robust tactical aviation fire support capability; only time will tell if this momentum will endure.

There is no doubt that armed aviation will continue to have an important role in the irregular forms warfare that will continue to dominate the security environment for the foreseeable future. Western nations will be obliged to intervene in failed and failing states out of the need to safeguard global stability and their economic prosperity. Operating in this environment, which is undergoing rapid urbanization, requires restraints on the use of lethal force in order to protect local, domestic and international support for the military mission. Of particular concern, there is the distinct possibility that the threats encountered by Canadian aviation in future conflicts will be greater in both variety and lethality than was seen in Afghanistan. Ultimately, this strongly supports the employment of tactical aviation forces that possess organic lethality; the ability to conduct quick, surgical precision strikes with small kinetic effect weapons from stand-off distances that absolutely minimize the risk of collateral

[244] Allan English and John Westrop, *Canadian Air Force Leadership and Command: The Human Dimension of Expeditionary Air Force Operations* (Trenton: Canadian Forces Aerospace Warfare Centre, 2007), 49.

damage and risk to the aircrew. This mandates that Canada invest in a precision guided munitions (PGM) capability so that the tactical aviation community is postured to support the Army on future expeditionary operations.

There are a number of families of precision weaponry that needed to be considered in order to determine which ones would best match the operational needs of the CF. Unfortunately, there is not a single solution that perfectly meets all the needs of the tactical aviation community. Based on the battlefield effects specified by the Army within the CDR, the only weapon that can currently fulfill all the requirements is a missile system such as the Hellfire. Unfortunately, this comes with the drawbacks of high unit cost and the lowest number of stored shots. As such, it is apparent that the optimum solution for the CF will involve a mix of both missiles and PG rockets; this will ensure that collateral damage considerations are fully respected whilst safeguarding the ability to exploit the fleeting opportunities of the COIN environment to the maximum extent possible.

The culmination of this study was a consideration of the combat effectiveness of various manned and unmanned aviation platforms to determine which aircraft would best meet the needs of the CF on the future deployed operations. In the short term, the most viable solution will be increasing the armaments of the CH146. Unfortunately, an armed CH146 is the bare-minimum capability increase that can be contemplated, and will only reduce, vice eliminate, Canada's reliance upon coalition aviation fire support. Regrettably, an attack helicopter, even in limited quantities, will likely continue to remain a politically unacceptable solution for the CF. Canada's future aviation fire support capability is likely to incorporate an uninhabited aerial vehicle (UAV). Although still too immature, emerging rotary wing UAV technologies must be closely

monitored, given the strong likelihood that they will afford a better overall complement to manned aviation than their fixed wing cousins.

This study has identified a number of areas for future research. Do to the unclassified nature of this document, a detailed examination of the classified performance data of the most probable weapons options for the tactical aviation community, namely the Hellfire, DAGR and APKWS, must be undertaken. Furthermore, weapons-platform interactions, such as aerodynamic loading, must be examined to confirm that any airframe or maintenance implications are acceptable to the CF for long-term sustainability. Finally, the brief research that was undertaken in the domain of manned-unmanned teaming would indicate that this is an area in which the CF as a whole is under-developed and could exploit to a greater degree. It is suggested that this be investigated further to determine if UAVs can be better integrated into the CF as a means of improving the overall combat effectiveness of Canada's military.

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