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CH-146 Griffon Replacement: Bridging the Gap

Major Taylor Hall

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CH146 GRIFFON REPLACEMENT: BRIDGING THE GAP

INTRODUCTION

In 1992, the Canadian Armed Forces (CAF) procured 100 CH146 Griffon utility helicopters to replace four different aircraft: the CH118 Iroquois used for combat support at Canadian airbases, the CH135 Twin Huey used for tactical transport of ground forces, the CH136 Kiowa used for reconnaissance, and the CH147 Chinook used for logistics transport.[1] Based on the Bell 412 EP, the aircraft were delivered between 1995 and 1997. Since then, they have been deployed on numerous operations, including Haiti, Kosovo, Afghanistan, Iraq, and Mali; while also performing continuous domestic search and rescue, and support to an increasing number of provincial disaster responses. Although it has been maligned as simply a "militarized" civilian helicopter,[2] it is in fact an improved version of possibly the most popular American military helicopter ever produced, the UH-1 Huey.[3] Retaining the same configuration of two large side doors, and a rapidly reconfigurable passenger cabin, the CH146 Griffon offered substantially increased range, speed, and endurance over all of its predecessors, with the exception of the CH147 Chinook.[4]

Nevertheless, it has been faulted for providing an insufficient lift capability to ground forces. Notably, in the extreme operating environment of Afghanistan, which unsurprisingly limited such tasks to much more expensive and maintenance heavy

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[1] Michel Legault, "The CH-146 Griffon: Reflecting a New Philosophy of Defence Procurement," *Aviation Quarterly* 1, no. 2 (1994): 19.
[2] Kevin Whale (Maj), "Unlike Camels, the Griffon Has Potential," *Defence Policy Review* VI, no. 18 (19 December 2000): 13.
[3] National Air and Space Museum, "Bell UH-1H Iroquois 'Huey' Smokey III," *Smithsonian* (website), last accessed 4 May 2022, https://www.si.edu/object/nasm_A19960005000
[4] Whale (Maj), *Defence Policy Review*, 15.

helicopters such as the Mi-17 Hip, and CH147D Chinook.[5] Subsequently, the CAF procured CH147F Chinook helicopters to perform tactical transport of ground forces in situations or environments that exceed the capacity of the CH146 Griffon. Together, the two aircraft compose the entirety of the Royal Canadian Air Force (RCAF) tactical aviation capability.

Remarkably, the CH146 Griffon has continued to perform such roles with only minimal updates to its original capabilities; most significantly, the addition of an upgraded electro-optic infrared (EO/IR) sensor and more powerful door guns for its role in Afghanistan. At present, the RCAF is conducting the Griffon Limited Life Extension (GLLE) project to address several obsolescence issues with respect to avionics, in order to ensure its ability to continue to operate until its estimated end of life in 2031.[6] However, there are significant capability gaps that will continue to remain unaddressed since the helicopter was originally procured. Subsequent advancements in aviation technology will only cause these gaps to worsen.

Whichever aircraft, or systems, the RCAF eventually procures to replace the CH146 Griffon will pose a significant challenge to the RCAF. Not only in terms of supporting infrastructure and maintenance, but also training and doctrine. For example, crews that had transitioned to the CH146 Griffon from helicopters that were *only twenty years older* had difficulties initially with the modernized avionics management consoles.[7]

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[5] Joseph Trevithick, "Pentagon Admits Afghanistan's New Black Hawks Can't Match its Older Russian Choppers," *The War Zone* (website), 15 June 2018, https://www.thedrive.com/the-war-zone/21558/pentagon-admits-afghanistans-new-black-hawks-cant-match-its-older-russian-choppers

[6] Department of National Defence, "Government of Canada invests in the modernization of the Royal Canadian Air Force's CH-146 Griffon," News Release (website), last accessed 2 May 2022, https://www.canada.ca/en/department-national-defence/news/2019/01/government-of-canada-invests-in-the-modernization-of-the-royal-canadian-air-forces-ch-146-griffon.html.

[7] Whale, *Defence Policy Review*, 16.

CH146 Griffon crews transitioning to aircraft and systems that are *forty years newer*, will likely face much greater challenges. This paper will argue that a continued investment in the CH146 Griffon post-GLLE will be essential to provide integrated air power to the Canadian Army, and transition effectively to any replacement aircraft and systems. It will first examine the future operating environment and its impact on tactical aviation, identify the most significant CH146 Griffon capability gaps relative to potential future aircraft, and use transition frameworks from other recent RCAF procurements to identify areas where key investments could be made to address them.

FUTURE OPERATING ENVIRONMENT

The CH146 Griffon was procured during the immediate aftermath of the Cold War with a high-priority given to cost savings as a result of the significant change in geo-politics.[8] This legacy created issues for crews deploying for combat in failed-states like Afghanistan and Mali.[9] Nevertheless, Canada's tactical aviation enterprise has so far risen to the challenges presented. However, conflict is ever changing and uncertain. The future operating environment will certainly share some aspects with the late-90s and early first two decades of the 21st century, but it will undoubtedly present new aspects and challenges as well.

Canada's Perspective

Canada's perspective is described overall by the latest defence policy: *Strong, Secure, Engaged* (SSE). In general, it identifies three trends: "the evolving balance of power, the changing nature of conflict, and the rapid evolution of technology."[10] Within

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[8] Legault, *Aviation Quarterly*, 22.
[9] Elan Head, "Mission in Mali," *Skies Magazine* (online), 7 February 2019, https://skiesmag.com/features/mission-in-mali/.
[10] Department of National Defence, *Strong Secure Engaged: Canada's Defence* Policy (Ottawa: Minister of National Defence, 2017), 49.

the theme of evolving balance of power is the re-emergence of major power competition between the United States, its traditional rival Russia, and the emergence of China.[11] Perhaps most concerning is the impact each of these major powers will have with regards to Canada's arctic sovereignty.[12] Nevertheless, violent extremist organizations such as terrorist elements and transnational criminal groups will continue to affect global security in much of the same ways as they have since the end of the Cold War.[13] Concerning the changing nature of conflict, SSE describes growing complexity due to economic inequality, demographic changes and large-scale population migration, Also, the increasing use of "grey zone" and "hybrid warfare" by state and non-state actors combined with linkages between inter- and intra-state conflict, and global terrorism. And finally, the rapid evolution of technology, and especially the rise of space and cyber as unique domains.[14]

Although they were published prior to SSE, the themes identified above are consistent with both the CAF's *The Future Security Environment 2013-2040*, and the RCAF's subordinate *Future Concepts Directive Part 2: Future Air Operating Concept* (FAOC). The latter document identifies Canada's core air power capabilities as control of the air, attack, surveillance and reconnaissance, air mobility, and support to joint operations and the civil power.[15] Furthermore, the RCAF FAOC identified 11 RCAF functional areas. With respect to tactical aviation, the most relevant are: support to land operations in Canada, support to the civil power, RCAF operations in low-intensity

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[11] *Ibid*., 50.
[12] *Ibid*., 79.
[13] *Ibid*., 53.
[14] *Ibid*., 56.
[15] Royal Canadian Air Force, *Future Concepts Directive Part 2: Future Air Operating Concept* (Ottawa: Director of Air Readiness and Plans, 15 August 2016), 5.

conflicts, RCAF operations in high intensity anti-access / area denial (A2/AD) conflicts, and RCAF support to non-combat military operations other than war (MOOTW).[16] With these in mind, this section will examine the implications of the future operating environment on tactical aviation through the lens of failed-states, Europe, the Indo-Pacific region, and the arctic.

Challenges for RCAF Tactical Aviation

Given the preponderance of operations in failed-states since the introduction of the CH146 Griffon at the end of the Cold War, these will continue to be a likely environment for operations in the future. These types of conflicts are most often characterized by threats from small arms, rocket-propelled grenades, and improvised explosive devices at the lower-end of the threat spectrum in places like Afghanistan and Mali; as well as captured anti-air artillery and shoulder-fired missiles at the higher-end in places like Iraq.[17] Despite being conceptualized as "low-intensity", these threats still pose significant issues to tactical aviation aircraft. Also, the conflicts can easily encompass both high-density underdeveloped urban areas as well as large nearly uninhabited regions. This challenges tactical aviation in terms of limited spaces to insert and extract ground forces and the extreme distances between friendly tactical infrastructure.[18]

Central and Eastern Europe represent another potential future area of operations for tactical aviation based on Canadian Army support to missions in Latvia and Ukraine.

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[16] The complete list of RCAF Functional Areas are: Surveillance of Canadian Territory and Air/Maritime Approaches, Aerospace Defence of Canada, Support to Maritime Operations in Canada, Support to Land Operations in Canada, Search and Rescue, Support to the Civil Power, Aerospace Defence of North America, RCAF Support to Continental Operations, RCAF Operations in Low-Intensity Conflicts, RCAF Operations in High Intensity A2/AD Conflicts, RCAF Support to Non-combat MOOTW.

[17] Sean M. Zeigler *et al*, *Acquisition and Use of MANPADS Against Commercial Aviation* (Santa Monica: RAND Corporation, 2019), 1.

[18] Author experiences deployed to both Afghanistan and Kuwait, with the latter in support of operations in Iraq.

Unlike failed states in the Middle East or Africa, conflicts in Europe are characterized by some of the world's most sophisticated integrated air defence systems (IADS). Shoulder-fired missiles and short-range air defence systems pose significant threats towards low-flying helicopters. Operations need to be carefully coordinated to include suppression of enemy air defences (SEAD), detailed intelligence of threat locations, and modern identification friendly or foe (IFF) systems. Additionally, the ability to defeat heavy armour targets is essential.

With regards to the Indo-Pacific region, our close connection with other Pacific Rim trading partners, and the increasing influence of China will inevitably draw greater attention. The region also presents significant threats to air and aviation from IADS, but also long-range missile strikes against limited island-based infrastructure. Whereas conflict in Europe will primarily involve ground forces, those in the Indo-Pacific will largely consist of maritime forces. Dispersing forces to counter the A2/AD threat could in fact increase the importance of agile mobility across the archipelagos and deep into island territories away from the coasts. Operating at extended ranges and away from traditional airfields will push maintenance and logistics to their limits.[19]

Finally, the arctic represents probably the most challenging operational environment due to its extreme climate and long distances between support bases. Any conflict in the arctic will be characterized by the most basic requirement to simply survive.[20] A complete lack of any road or rail infrastructure limits transport to aircraft and

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[19] Miranda Priebe *et al*, *Distributed Operations in a Contested Environment: Implications for USAF Force Presentation* (Santa Monica: RAND Corporation, 2019), viii.
[20] Adam Lajeunesse, *The Canadian Armed Forces in the Arctic Purpose, Capabilities, and Requirements,* Canadian Defence and Foreign Affairs Institute, May 2015, 3. https://www.cgai.ca/canadian_armed_forces_in_the_arctic

snowmobiles, with the exception of ice-free periods in the summer, which allows access to a few suitably designed ships and submarines. Rather than conventional military conflict, the most likely deployments to the arctic would be in support of humanitarian disasters or in response to foreign commercial encroachment on Canadian sovereign waters.[21] Like the Indo-Pacific region, arctic operations will involve extreme ranges and lack of support infrastructure, but coupled with extreme weather and low temperatures.

Common to all these future operating environments, is the push to link assets and share data across all domains. Currently, this is defined in the CAF Vice Chief of Defence Staff's (VCDS) document *The CAF C4ISR Strategic Vision, Goals and Objectives*. In summary, the overall vision is "[to] provide the right knowledge to the right people at the right time in a secure, reliable, and integrated manner in support of [CAF] operations."[22] This vision is in close alignment with the developing American concept of Joint All-Domain Command and Control (JADC2).[23] Critical to both concepts is the requirement to seamlessly connect "sensors to shooters" while generating "decision superiority."[24] To do so will require the ability to not just push information and data between platforms, but also to the individual soldier and aviator. Leveraging modern technology such as tactical tablets, small software-defined handheld radios, and mobile ad hoc networks (MANET), this will create a military version of the "Internet of Things" and enable the use of cloud

[21] *Ibid*., 2-3.
[22] Vice Chief of Defence Staff, *The CAF C4ISR Vision, Goals, and Objectives*, Version 1.0. 10 February 2016, iii.
[23] Department of Defense, *Summary of the Joint All-Domain Command & Control (JADC2) Strategy*, March 2022. https://media.defense.gov/2022/Mar/17/2002958406/-1/-1/1/SUMMARY-OF-THE-JOINT-ALL-DOMAIN-COMMAND-AND-CONTROL-STRATEGY.PDF?source=GovDelivery
[24] Terrance O'Shaughnessy (Gen), "Decision Superiority Through Joint All-Domain Command and Control," *Joint Force Quarterly*, vol 99, 75.

processing and artificial intelligence (AI) to support both commanders and operators in their decision making cycles.

CAPABILITY GAPS

Given the future operating environment, it is worth examining what capability gaps currently exist in order to meet these potential future challenges. These not only include the disadvantages inherent to the CH146 Griffon, but are also related to capabilities with respect to mission kit and training.

Griffon Capability Deficiencies

Currently, the inability of the CH146 Griffon to support the Canadian Army with precision guided munitions arguably represents the greatest capability gap of the CH146 Griffon. Such a capability has been discussed at length in several papers.[25] But to summarize, the main issue is that the current weapons systems of the aircraft are limited by their side-firing door guns to engagements at close ranges, placing the crew within the weapons effects zones of most enemy weapons systems other than rifles and rocket-propelled grenades. Precision guided missiles have ranges beyond the heavier weapons systems associated with both tanks and armoured vehicles, but also the various truck-mounted anti-aircraft heavy machine guns used by many violent extremist organizations. This allows armed aircraft to engage targets from standoff distances beyond the range of the target's typical ground-based weapons systems.[26] Such a requirement is self-evident in any near-peer conflict, but is also required against any well-armed violent extremist organization such as Daesh prior to their effective defeat in Iraq and Syria.

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[25] For example see: Danny Houde (Maj), "The CH-146: An Armed Helicopter for the Canadian Army," *The Army Doctrine and Training Bulletin* 3, no. 4 / 4, no. 1 (Winter 2000/Spring 2001), 37-42; C.W. Morrison (LCol), "The Need for Precision-Guided Standoff Weapons for Canada's Tactical Aviation Community," (Joint Command and Staff Program Master of Defence Studies Paper, Canadian Forces College, 2013).
[26] Morrison, "The Need for Precision-Guided Standoff Weapons . . .," 27-28.

Operations in forested, jungle, or urban environments expose another capability gap of the CH146 Griffon. Options to insert ground forces from a high hover is normally limited to rappel from the cabin. Although technically capable of conducting fast-rope inserts and extracts, conventional units are not equipped with Fast Rope Insert Extract System (FRIES) kits.[27] The primary benefit of fast-rope versus rappel is the ability to insert ground forces without the need for them to wear specialized harness. The secondary benefit is that ground forces can then be extracted while connected to the end of the ropes, albeit with harnesses, a short distance to a more suitable landing zone, to then load them in the cabin.[28] The major drawback of the current CH146 Griffon FRIES and rappel configurations is their incompatibility with door guns.[29] This leaves the aircraft effectively defenceless while in the most critical phase of its mission.

Most importantly, there is perhaps no greater capability gap in the CH146 Griffon than its almost complete lack of any command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) integration beyond voice transmission through legacy radios and outdated IFF.[30] Fortunately, Canada's tactical aviation has been able to operate in theatres where the probability of an enemy flying a helicopter is nearly non-existent; however, this assumption will no longer hold true in any near-peer type conflict. To avoid being engaged by friendly air defences, the CH146 Griffon requires a more modern IFF system and a Link-16 data transfer capability. Although critical, they are nevertheless not sufficient to meet the aim and objectives of

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[27] Adam Day, "Low Fast Dark: Canada's Special Ops Aviators," *Legion Magazine* (website), 14 November 2009. https://legionmagazine.com/en/2009/11/low-fast-dark-canadas-special-ops-aviators/
[28] "PARAS fast-rope from Wildcat helicopter," *UK Army* (website), 20 July 2018, https://www.army.mod.uk/news-and-events/news/2018/07/paras-fast-rope-from-wildcat-helicopter/
[29] Authors experience as CH146 Griffon pilot.
[30] Jeotey Attariwala, "Helicopter Report," *Canadian Defence Review* (website), 17 December 2020, http://www.canadiandefencereview.com/featured_content?blog/222

the CAF's C4ISR Vision, nor the US JADC2 concept.[31] A more integrated approach is required that will move information across domains seamlessly and securely, even in a contested environment.

Potential Solutions

Given the capability gaps identified above, it is worth considering options that could be available to replace the CH146 Griffon. The next Generation Tactical Aviation System (nTACS) is the program expected to move RCAF tactical aviation beyond the capabilities it currently provides. Overall, the program is not simply a CH146 Griffon replacement, but rather a "system" approach that may involve a combination of multiple platforms. In addition, a complementary Chinook Midlife Block Upgrade is expected to be conducted in parallel to ensure cohesive operations. Importantly, both projects are in the pre-identification phase and have yet to be funded.[32]

Not surprisingly, the timeline for nTACS parallels the development of the US Army's Future Vertical Lift (FVL) program, which aims to deliver two distinct capabilities by the early 2030s.[33] The first project is the Future Long Range Assault Aircraft (FLRAA), which will partially replace the H-60 Black Hawk; the second is the Future Attack and Reconnaissance Aircraft (FARA), which will partially replace the AH-64 Apache. Interestingly, neither system will attempt to perform all the roles that are currently performed by the CH146 Griffon. Since it is unlikely the RCAF would choose to procure two separate types to replace a single fleet of aircraft, nor would it decide to make the CH147F the only tactical helicopter capable of transporting even a small

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[31] Jonathan Gilbert (Maj), "The Neglected Capability: RCAF Tactical Data Links" (Joint Command and Staff Program Service Paper, Canadian Forces College, 2019), 7.
[32] Interview with DAR 9-2 Staff Officer, Director of Air Requirements or Tactical Aviation, 19 April 2022
[33] Jerimiah Gertler, *Army Future Vertical Lift (FVL) Program*, United States Congressional Research Service In Focus IF11367 (online), 13 July 2021, https://crsreports.congress.gov/product/pdf/IF/IF11367

number of passengers, it is much more likely that the FLRAA would be the single type chosen between the two FVL projects. This could be somewhat mitigated if the FLRAA requirements include a weapons delivery capability. Nevertheless, the most likely issue with any of the FVL variants will be cost and reliability. All the potential contenders for the FLRAA are new designs with ambitiously novel configurations. The Bell V-280 Valor is a tilt-rotor design with fixed nacelles,[34] while the Sikorsky-Boeing SB-1 Defiant is a coaxial rotor system with a pusher propeller instead of a tail-rotor.[35] More moving parts will almost certainly result in higher operating costs, and lower availability.[36] While high speed and long range are critical for certain missions, a working aircraft is required for every mission. Given the size of the RCAF's tactical aviation fleet, it likely cannot afford to have only a small fleet of aircraft, many of which would be regularly unavailable due to maintenance issues.[37]

Alternatively, the RCAF could choose to procure a proven mature platform such as the UH-60M Black Hawk or UH-1Y Venom. Both are capable aircraft, with greater performance than the CH146 Griffon in terms of payload, range, and speed, but with almost certainly greater costs to operate. This may be an acceptable trade-off, but the same resources could alternatively be invested in additional capabilities that are aircraft independent, such as more capable attached sensors, defences, and munitions. Dedicated

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[34] The only current operational military tilt-rotor, the V-22 Osprey, has engine nacelles that tilt with the rotors, which likely makes the rotor drive train simpler.
[35] Current military coaxial helicopters such as the Kamov Ka-27 Helix and Ka-52 Hokum-B are all Russian produced and neither has a pusher propeller.
[36] Dan Parsons, "UPDATED: US V-22s Can't Fly Half The Time And That Won't Improve 'Soon Enough'," *Rotor & Wing International* (online), 9 May 2019. https://www.rotorandwing.com/2019/05/09/half-marine-corps-v-22s-cant-fly-wont-improve-soon-enough/
[37] Aircraft costs and availability are affected by many factors, and can be highly dependent on national procurement requirements that include offsets and subsidies. Rigorous analysis for any aircraft is beyond the scope of this paper.

attack helicopters such as the AH-64 Apache and AH-1Z Viper are not likely to be procured for the same reasons as the FARA. Both would be a significant investment in a platform that could only fill a single role, which would find itself underemployed on most CAF deployments.

What is certain is that future operations will make greater use of uncrewed aerial vehicles (UAV) and autonomous systems. The FVL program includes the requirement for aircraft to be optionally crewed. However, fully automated rotary-wing aircraft are still in the early stages of development. The USMC fielded two uncrewed Kaman K-Max rotorcraft to Afghanistan between 2011 and 2013.[38] The system required ground based operators to take-off and land, and one of the two aircraft was involved in a 2013 crash,[39] but the trial was generally considered a success and the project continues to be funded in 2020.[40] DARPA, in conjunction with Sikorsky, developed an automated UH-60A Black Hawk helicopter that made its first autonomous flight in 2022.[41] Nevertheless, just like autonomous cars, many obstacles are required to be solved before human-rated autonomous flights can be formally certified for airworthiness. This is especially true for tactical operations in GPS-degraded environments. Even simpler routine civilian routes between prepared landing zones are not anticipated to be certified before the 2030s.[42]

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[38] Kaman Press Release, "Kaman K-Max advances civil and military autonomous flight programs," *Vertical Magazine* (online), 3 February 2020. https://verticalmag.com/press-releases/kaman-k-max-advances-civil-and-military-autonomous-flight-programs/.

[39] "K-Max cargo drone home from Afghanistan, headed to storage," *Marine Corps Times* (online), 2 August 2014, https://www.marinecorpstimes.com/news/your-marine-corps/2014/08/02/k-max-cargo-drone-home-from-afghanistan-headed-to-storage/.

[40] Elan Head, "How Kaman's unmanned K-Max helicopter is getting smarter," *Vertical Magazine* (online), 21 August 2020, https://verticalmag.com/news/kaman-unmanned-k-max-helicopter-autonomy-upgrade/.

[41] Jen Judson, "For the first time, Black Hawk helicopter flies without anyone aboard," *Defense News* (online), 8 February 2022, https://www.defensenews.com/land/2022/02/08/black-hawk-helicopter-flies-unmanned-for-the-first-time/.

[42] Cade Metz, "I'm Not a Pilot, but I just Flew a Helicopter Over California," *New York Times* (online), 25 October 2021,

Consequently, any consideration for an optionally crewed CH146 Griffon replacement should be considered high-risk until the technology becomes significantly more mature.

Interestingly, the Bell 412 family of helicopters continues to be upgraded. In 2015, the Japanese Self Defence Forces (JSDF) initiated a program to develop a replacement for its UH-1J Hueys. In a joint collaboration between Subaru and Bell, the result was the Subaru Bell 412 EPX. The helicopter is effectively a Bell 412 EPI with an enhanced transmission giving it greater capabilities in terms of high-hover performance at moderate temperatures and elevations.[43] Although the aircraft remains less capable than an H-60 Black Hawk or UH-1Y Venom, it would likely be less costly in terms of acquisition and maintenance. Furthermore, it would require very few changes to currently established mission support and maintenance equipment and infrastructure. Given the extensive legacy of UH-1 Huey and Bell 412 operations across the globe, additional improvements to the family of platforms will likely be made before the anticipated CH146 Griffon end of life.

Notwithstanding the variety of potential CH146 Griffon replacements identified above, they all share the ability to incorporate the capabilities demanded by 21st century operations provided they are equipped with appropriate mission kits and avionics. Careful trade-offs between speed, range, manoeuvrability, lift, survivability, and affordability will need to be considered in relation to Canada's critical requirements. Nevertheless, the

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https://www.proquest.com/docview/2585527737?parentSessionId=Md5BKWe0ROMNWf4TWBio3RLctayEov5BvFXRzEGEkPg%3D&pq-origsite=summon&accountid=9867.

[43] Bell Press Release, "Bell and Subaru collaborate on commercial 412 helicopter upgrade," *Vertical Magazine* (online), 16 July 2018, https://verticalmag.com/press-releases/bell-and-subaru-collaborate-on-commercial-412-helicopter-upgrade/.

current capability gaps of the CH146 Griffon will need to be addressed, and a plan to transition between aircraft and systems will need to be considered.

TRANSITION BETWEEN CAPABILITIES

Rectifying the capability gaps identified earlier will not be as simple as procuring another platform. Making a significant leap from the CH146 Griffon to nTACS would represent a challenge to crews that have been operating in effectively the same fashion since Afghanistan. Moreover, the RCAF historically extends its aircraft well beyond their original end of life timeframes. In general, this speaks to the complexity involved with significant and often politically controversial decisions that represent long-term commitments of taxpayer funds. The eventual CH146 Griffon replacement program will almost certainly be no different. Reviewing how the RCAF transitions between other legacy aircraft to more modern ones provides some useful examples for mitigating such challenges.

Contemporary RCAF Capability Transitions

One of the most comprehensive modernization and life extension programs has been the CP140M Aurora Incremental Modernization Program (AIMP). Beginning in 1998, the program involved over 23 individual projects to enhance the overall capabilities of the aircraft, including new sensors and communications suites.[44] The program is expected to deliver sufficient capabilities to extend the service life of the fleet to the mid-2030s, and the procurement of the future Canadian Multi-Mission Aircraft.[45] Although the final phase of the program, the Block IV upgrade, is currently estimated to be four

[44] Chris Thatcher, "Upgraded Block IV Aurora undergoing flight testing," *Skies Magazine* (online), 2 March 2020, https://skiesmag.com/news/upgraded-block-iv-aurora-flight-testing/.
[45] Department of National Defence, "Canadian Multi-Mission Aircraft," last accessed 3 May 2022. http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=975.

years behind schedule,[46] the effort overall has delivered a capability that made significant progress adapting to the needs of the RCAF in the early 21st Century. Most notably, providing effects well outside its normal maritime role in overland operations such as Afghanistan and Iraq. Such missions would not have been possible had it not been for the focused effort to make the fleet relevant before its predicted retirement.

Another example is the CF188 Hornet replacement program. The delayed decision to select the F-35 Lightning II was mitigated not only by a two-phase incremental modernization project, but also a Hornet Extension Project (HEP). The federal government announced the latest project in 2020, and is expected to deliver a full operational capability by 2025.[47] The stated goal of the project is to provide a relevant capability in support of NORAD and NATO until 2032.[48] Perhaps just as critically, the project will provide an effective "transition" capability between the fourth generation CF188 Hornet and fifth generation F-35 Lightning II. According to the special advisor to the RCAF Fighter Capability Office, Brigadier-General Balfe:

> [The new systems] will enable us to begin the transition of our people, our mindset, our procedures and our way of thinking for the capabilities that are going to come with the future fighter. We think HEP is a great bridge toward that path.[49]

It should be emphasized that for the fighter force, the transition to the CF188 Hornet from the CF104 Starfighter was also no trivial matter. Changes from an analogue to digital

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[46] David Pugliese, "Modernization of military surveillance aircraft fleet delayed as $52 million more needed for project," *Ottawa Citizen* (online), 10 August 2021, https://ottawacitizen.com/news/national/defence-watch/modernization-of-military-surveillance-aircraft-fleet-delayed-as-52-million-more-needed-for-project.
[47] Department of National Defence, "Hornet Extension Project" last accessed 3 May 2022. https://www.canada.ca/en/department-national-defence/services/procurement/fighter-jets/hornet-extension-project.html.
[48] *Ibid*.
[49] Chris Thatcher, "Major upgrades incoming for Canada's fleet of CF-188 Hornets," *Skies Magazine* (online), 19 June 2020, https://skiesmag.com/news/major-upgrades-canada-fleet-cf-188-hornets/.

cockpit, exasperated by insufficient lead-in training, and doctrine, likely contributed to an elevated crash rate during the first decade of operations.[50]

However, perhaps the best case study with regards to the importance of not just sustaining, but further developing a legacy capability until its very end of life is the CH124 Sea King transition to the CH148 Cyclone maritime helicopter. Because of delays in the Maritime Helicopter Replacement Program, the CH124 Sea King suffered from a lack of investment over almost two decades.[51] Obsolescence issues had rendered it ineffective in its primary purpose, antisubmarine warfare. Furthermore, it was being tasked to conduct operations that were outside of the traditional scope of a maritime helicopter, such as overland support to the Vancouver Olympics and the G8 and G20 summits in 2010. Consequently, it was recognized that there would be a significant gap in terms of proficiency for crews and support trades who would be expected to conduct a multi-generational leap in technology, comparable to "a jump from the [CF104] Starfighter to the F-35 Joint Strike Fighter [Lighting II] – without the benefit of the CF188 Hornet as an intermediary."[52] In response, the 12 Wing commander released an initiating directive in 2008 that would lead to Operation *Bridge*, an operation to:

> . . . maintain (or develop) relevant transitional operational capability and capacity in the CH124 [Sea King], and set the conditions for rapid transition to the CH148 [Cyclone].[53]

One of the key deductions of the planning process, was the importance of the CH124 Sea King as transitional tool between the two platforms. The overall purpose of the operation,

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[50] Richard Shimooka, "Training at the Edge: The Canadian Air Force's Transition to the CF-18, and Lessons Learned for Canada's Next Generation Fighter," *Canadian Military Journal* 15, no. 4 (Autumn 2015): 30-39.
[51] Sam Michaud (Col), "Operation BRIDGE: A Bold Leap Towards the Cyclone," *The Royal Canadian Air Force Journal* 2, no.4 (Fall 2013), 54.
[52] *Ibid*., 45
[53] *Ibid*.

would be to focus on developing "low-cost, high-demand, high-impact capabilities"[54] that represented the modern operating environment. The most tangible result of the operation was the development of the Augmented Surface Picture (ASP), an ISR suite that was developed to provide a more relevant capability that would be similar to the type of capabilities provided by the CH148 Cyclone.[55]

All of the projects above speak to the essential requirement to continue to invest in RCAF capabilities until their transition is completed. The importance of creating a transitional bridge between aircraft in terms of aircrew and maintenance mindset is a critical consideration. Otherwise, new capabilities risk being poorly implemented, underutilized, and potentially wasted. On the other hand, it could be argued that given the scarce resources within the Department of National Defence (DND), efforts should be focused on solving capability gaps through the procurement of future aircraft alone, and that it would create a wasteful duplication of effort to divert resources towards a parallel "transitional" capability. However, this ignores the necessity to fix capability gaps in the near term, and underestimates the risk of prolonging them with the delays common to the complex procurement projects. By attempting to procure both new capabilities and platforms concurrently, the risk to both is compounded. Alternatively, procuring transitional capabilities before a new platform generates valuable lessons learned and potentially avoids stating requirements that could be discovered to be either unsuitable in terms of performance, or infeasible in terms of supportability much earlier. Accordingly, the best course of action is to address capability gaps as soon as possible using the current aircraft, then leverage the lessons learned to transition towards future systems.

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[54] *Ibid*., 48
[55] *Ibid*., 50.

CH146 Griffon Way Forward

By design, GLLE provides no new significant capabilities for the CH146 Griffon. Its sole purpose is to address obsolescence issues that would otherwise prohibit the aircraft to continue operations.[56] These are items such as the replacement of older unsupported avionics, updated civilian regulatory requirements for navigation and position reporting, and the minimum IFF requirements to operate in a modern battlespace. However, some incidental capability improvements will result since the baseline of most modern systems are more advanced than the original components to be replaced.[57] Nevertheless, the updates will not provide any new capabilities per se, just modernized equipment for capabilities that have existed since Afghanistan.

Given previous experiences with RCAF capability development, timelines for nTACS will likely be difficult to achieve. It would be reasonable to consider that any CH146 Griffon replacement could be delayed into the late-2030s or even 2040s. Such a delay would potentially see tactical aviation continuing to operate the CH146 Griffon in effectively the same roles and capabilities as which it was procured in the mid-1990s. In other words, another 50-year old platform, with 50-year old capabilities, effectively placing tactical aviation in the same situation as the CP140M Aurora, CF188 Hornet, and CH126 Sea King.

Building off the lessons learned with the projects above, tactical aviation should consider pursuing equivalent "low-cost, high-demand, high-impact capabilities"[58] to bridge the transition between GLLE and nTACS. Fortunately, for the Griffon, several

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[56] Department of National Defence, "Government of Canada invests in . . . CH-146 Griffon"
[57] Chris Thatcher, "The life extension of the CH-146 Griffon and a plan for what comes next," *Vertical Magazine* (online), 27 May 2021, https://verticalmag.com/news/ch-146-griffon-helicopter-life-extension-what-comes-next/.
[58] Michaud (Col), *RCAF Jounral*, 48.

investments could meet these criteria. Most significantly, would be the delivery of a precision guided missile capability, options to conduct out-of-ground effect insert and extract from contested objective areas, and increased network capabilities identified above.

Despite concerns within both the RCAF and Canadian Army as to whether the CH146 Griffon could carry a meaningful payload of weapons and sensors, most air-to-ground missiles weigh less than half of a typical soldier for an AGM-114 Hellfire, and even less for a smaller AGR-20 Advanced Precision Kill Weapons System (APKWS).[59] The CH146 Griffon would have no issues carrying at least as many missiles as it currently does passengers. Paired with a cable EO/IR turret equipped with a laser designator, the ability to "shoot what you see" is relatively straightforward, and requires little input from the aircrew other than to point the aircraft in the direction of the target and keep the sensor fixed while the missile guides itself to impact. Furthermore, relative to long-range air-to-air missiles and torpedoes, such munitions are low-cost and can be easily integrated using weapons mounts used by other UH-1 Huey derivatives and minor aircraft modifications.[60] Such a combination of forward-firing precision guided missiles and side-firing crew-served door guns should not be underestimated. Unlike a typical attack helicopter, which is limited to engaging targets towards its front, a well-armed utility helicopter provides an almost 360-degree field of fire. This forces enemy combatants to assume they can be engaged even when the aircraft is traveling parallel or

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[59] The weight of an AGM-114 Hellfire and AGR-20 APKWS missile are 99.8-107 lbs. and 35 lbs. respectively. US Army, "Hellfire family of missiles," *US Army Acquisition Support Center* (website), last accessed 3 May 2022, https://asc.army.mil/web/portfolio-item/hellfire-family-of-missiles/.; BAE Systems, "APKWS Laser-Guidance Kit," Factsheet (online), last accessed 3 May 2022 https://www.baesystems.com/en-media/uploadFile/20211026165047/1434608478635.pdf.

[60] Houde (Maj), "The CH-146: An Armed Helicopter . . .," 38.

even away from their location. In fact, it is arguably the combination of attack and utility helicopters that presents the most powerful air support to ground forces, as represented by United States Marine Corps composite formations of AH-1Z Vipers and UH-1Y Venoms.[61] Moreover, although there are obvious concerns with regards to the CH146 Griffons survivability with respect to enemy weapons compared to a traditional attack helicopter, Canada would not be alone in arming utility-type helicopters with precision guided missiles. In addition to the US Marines and their UH-1Y Venoms, the UK, France, and Russia also operate armed utility helicopters in terms of the AW159 Wildcat, SA 342M Gazelle, and Mi-8/17 Hip, respectively.[62] Interestingly, another significant benefit of adding pilot-operated forward-firing missiles to the CH146 Griffon is the potential increase in combat radius and endurance. The ability to provide an offensive capability without the requirement for crew in the rear cabin gives room for auxiliary fuel tanks and additional payload for more fuel. This is not to say that the loss of two crew members does not come at a cost to overall situational awareness, suppressive weapons effects, and other utility roles such as secondary casualty extract. But it would give mission planners the ability to support ground and maritime forces that might not otherwise be possible due to time and distance restrictions.

The procurement of door-gun compatible hoists and FRIES kits would also greatly benefit tactical aviation, again without significant costs. Systems that are compatible with

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[61] "A Poisonous Pair – AH1Z & UH1Y," *Heliops Frontline* (online), 16 December 2018, https://www.heliopsfrontline.com/a-poisonous-pair-ah1z-uh1y.

[62] "Wildcat: Maritime Attack Helicopter," *Royal Navy* (website), last accessed 3 May 2022, https://www.royalnavy.mod.uk/the-equipment/aircraft/helicopters/wildcat; "SA 342 GAZELLE," *Armée de Terre* (website), last accessed 3 May 2022, https://www.defense.gouv.fr/terre/nos-equipements-terre/nos-vehicules/sa-342-gazelle Alex Mladenov, "Armed to the Teeth – Heavy-Duty Workhorses," *Heliops Frontline* (online) 23 August 2020, https://www.heliopsfrontline.com/armed-to-the-teeth-heavy-duty-workhorses.

door guns do exist, and many of them do not require any engineering modifications to the aircraft cabin and can be simply installed in the same fashion as any other cabin reconfiguration. The best option with regards to extracting ground forces from a high-hover is a hoist. Although the CH146 Griffon has a hoist capability, it was procured primarily for search and rescue purposes and is also incompatible with door guns. Furthermore, the systems are also not normally available for conventional units and proficiency for aircrew and ground forces is almost non-existent.[63]

Finally, the use of tactical hand-held tablets connected to crew-worn hand-held radios, to integrate with similarly equipped ground forces through MANET tactical links, could significantly increase the ability of the CH146 Griffon to operate in a modern networked environment. Such a capability would require no integration with the aircraft itself, and such devices are already being procured through the Canadian Army Integrated Soldier System Suite (ISS-S).[64] Furthermore, such systems are already capable of such future critical capabilities such as receiving ISR video from other platforms and controlling UAVs.[65]

Each of these potential capability upgrades are effectively "mission kits" as opposed to permanently installed equipment. As a result, the number of actual modifications to the aircraft would be significantly less than those already being conducted as part of GLLE, and they could likely be implemented independently of one another at much lower costs. Nevertheless, they would finally fulfill capability gaps that

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[63] Authors experience as a CH146 pilot and squadron operations officer.
[64] "Trellisware provides advanced networking waveform to Integrated Soldier System Suite," *Canadian Army Today* (online), 14 September 2021, https://canadianarmytoday.com/trellisware-provides-advanced-networking-waveform-to-integrated-soldier-system-suite/.
[65] Daniel Rettedal (Capt), "Digital Interoperability in the Objective Area: The benefits of COTS technology," *Marine Corps Gazette* 100, no. 4 (April 2016), 50-55.

were identified at the very beginning of the CH146 Griffon project, and would significantly help the RCAF towards operationalizing future capabilities with nTACS.

CONCLUSION

The CH146 Griffon helicopter has served Canada well, delivering key tactical aviation operational effects in support of land forces almost continually since its introduction. GLLE represents a critical update to the aircraft, which will keep it flying until nTACS delivers a replacement. However, GLLE does not address the current capability gaps that have continued to exist since operations in Afghanistan, nor those of future operating environments. Future operations will demand precision guided weapons, increased ability to conduct out-of-ground effect insert and extracts, and networked multi-domain connectivity, in addition to other capabilities. The RCAF should consider addressing these capability gaps before nTACS is delivered. Using CP140M modernization, CF188 Hornet extension, and CH124 Sea King ASP as examples, the delivery of "low-cost, high-demand, high-impact capabilities"[66] would generate valuable lessons learned while bridging the transition for both aircrew and support trades. The result would be a tactical aviation enterprise better able to support ground forces in the future.

[66] Michaud (Col), *RCAF* Journal, 48.

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