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LESS IS MORE: RETHINKING THE RCAF'S FUTURE ROTARY WING FLEET

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ABSTRACT

Fiscal pressures and budgetary constraints are reoccurring themes in the Department of National Defence that force the Department to find economic efficiencies within its current budget and organizational establishment to remain a relevant fighting force. Given the budgetary constraints and the small size of the RCAF, the number of types of rotary wing platforms in service must be reduced as aircraft reach the end of its useful life. Two options offer the potential for long-term cost savings, organizational structure efficiencies and other benefits: a single fleet of medium lift helicopters and a mixed fleet consisting of a medium lift platform and a tactical utility platform. However, this is true only if capability, acquisition costs, operating costs, and life-cycle costs are considered holistically in conjunction with a structural reorganization of the rotary wing training system and favourable political and economic conditions.

CHAPTER 1: INTRODUCTION

Fiscal pressures and budgetary constraints are reoccurring themes in the Department of National Defence (DND). The *Canada First Defence Strategy* (CFDS) appeared to outline a roadmap for future defence purchases and made a commitment to stable and predicable funding for the DND. A few short years after CFDS implementation, fiscal realities and a lack of political will towards the military have placed the DND in a predicament of shrinking budgets and experiencing lengthy delays in major capital procurement projects. The DND is forced to find economic efficiencies within its current budget and organizational establishment to remain a relevant fighting force. In *Air Force Vectors*, the strategic vision of the Commander of the Royal Canadian Air Force (RCAF), one way the RCAF plans to achieve these efficiencies is through a commitment to "pursue the operational advantages and cost efficiencies afforded by multi-role platforms, crews and weapons."[1] However, the RCAF does not appear to be investigating potential multi-role platforms or commonality efficiencies within the rotary wing fleet. The Griffon Limited Life Extension (GLLE) project appeared at the Defence Capabilities Board in May of 2015. GLLE is required to avoid avionics obsolescence within the Griffon fleet by 2020 and extend the life of the aircraft until 2030. These upgrades come with a rough order of magnitude (ROM) cost of $2 billion.[2] Additionally, the Cormorant Mid-Life Upgrade (CMLU) project includes a plan to upgrade the avionics systems on this 15-year-old airframe and has a ROM cost of $732 million.[3] On conclusion of the GLLE discussion, the Vice Chief of the Defence Staff tasked the Commander of the RCAF to conduct a rotary wing fleet rationalization[4]

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[1] Department of National Defence, *Air Force Vectors*, 1st Edition (Ottawa: 2014): 41.

[2] S.W. Ringer, *Briefing Note for CFD: Evolving the CH149 Cormorant Mid-Life Upgrade (CMLU) Project and Griffon Limited Life Extension (GLLE) Project with a Common Fleet (Including Simulation) In Support of CA, SOF, RCAF (Rotary Wing SAR)* (Ottawa: 27 May 2015): 2.

[3] *Ibid*.

[4] Department of National Defence, *Defence Capability Board: Record of Discussion* (Ottawa: 28 May 2015): 6.

to include investigating the possibility of a common fleet for tactical aviation and rotary wing search and rescue (SAR).[5]

Can the DND and the RCAF benefit from procuring a common platform to replace all existing rotary wing fleets? Should the RCAF look to expand on commonality from within our current fleet, as the United States Navy did with the purchase of the Sea Hawk,[6] or is a helicopter from outside of the RCAF inventory required?

Given the budgetary constraints and the small size of the RCAF, the number of types of rotary wing platforms in service must be reduced as aircraft reach the end of its useful life. Two options offer the potential for long-term cost savings, organizational structure efficiencies and other benefits: a single fleet of medium lift helicopters or a mixed fleet consisting of a medium lift platform and a tactical utility platform.

Chapter 1 of this paper will introduce the topic and provide an outline of the arguments to be covered. Chapter 2 will review the relevant literature relating to the military equipment commonality factors that will be the main topics of this paper: capabilities, costs, organizational structure and political factors.

Any military must determine the missions it would like its rotary wing fleet to fulfill. This should be a strategic determination of high-level requirements, not an overly detailed description of every tactical function the helicopter is expected to perform. In the RCAF context, the missions conducted by the current fleet are: SAR, embarked operations supporting the Royal Canadian Navy (RCN), troop transport and utility operations. Chapter 3 will review the current RCAF rotary wing platforms and will include a capability analysis of the fleet. Current rotary

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[5] Ringer, *Briefing Note for CFD …,* 2.

[6] Federation of American Scientists, Military Analysis Network, "UH-60 Black Hawk," Last Accessed 30 March 2016 http://fas.org/man/dod-101/sys/ac/uh-60.htm

wing missions will be used to determine the suitability of each platform to carry out all missions and highlight the areas of capability overlap.

The costs associated with any major capital procurement project receive a significant amount of scrutiny from the government and the media. These costs can be broken into acquisition, operational and life-cycle costs. Commonality has the potential to affect all three costs in a positive or negative manner. Chapter 4 will complete an acquisition, operational and life cycle cost analysis of the current RCAF rotary wing fleet using historical data and investigate potential savings in employing a common rotary wing platform from within the RCAF inventory.

There is currently demand within the DND as a result of a number of desired emerging fields and capabilities in excess of 3,000 positions. Since military establishment numbers will not grow in the foreseeable future due to shrinking budgets, any manning requirements for new capabilities must be harvested from within the existing organizational structure. There is potential for harvesting positions from within the current RCAF establishment and a common rotary wing fleet could be the catalyst for significantly improved organizational efficiency. A common platform has the potential to allow the RCAF to deliver an equivalent or improved capability with fewer military personnel. Chapter 5 will investigate the potential establishment savings by converting to a common rotary wing fleet. Three options to restructure the training organization of the RCAF rotary wing community will be considered.

Political factors influence every major capital project undertaken by the DND and have shaped the rotary wing fleet employed by the RCAF today. Politics also influence many of the institutional factors that affect procurement decisions. Chapter 6 will explore the case study of the Sea King helicopter replacement, noting the political influences surrounding the initiation, cancellation, delaying and then restarting of the project. General political and institutional factors will be covered in Chapter 2.

Although focused primarily on the rotary wing fleet, the commonality factors that will be analyzed in this paper are potentially applicable to the greater RCAF and CAF. Chapter 7 will summarize the findings of this paper, recommend areas for further study and provide concluding remarks.

CHAPTER 2: LITERATURE REVIEW

There is a significant amount of literature on the subject of equipment commonality and multi-role platforms, both for the public and private sector. Very few of these research papers are focussed on the rotary wing fleet, but there are themes and findings from other aircraft communities that can be helpful to use in examining the RCAF's rotary wing fleet. This literature review will be structured the same as this paper by looking at four themes: capability, cost, organizational structure and political factors.

Even though these themes are often weighted differently, they are interdependent in evaluating commonality. There is a direct correlation between capabilities and costs, as higher capability equipment usually comes with a higher price tag. According to Thomas Held of the Rand Corporation, "the decision to increase commonality requires case specific analysis of each type of cost" with a need to better understand the potential advantages and disadvantages of commonality.[7] In referring specifically to fighter aircraft, Mark Lorell of the Rand Corporation states the goal of any joint program "is to save overall life cycle costs by eliminating duplicate research, development, test, and evaluation efforts and achieving economies of scale in procurement, operations and support."[8] In "Project Laminar Strike," the authors state "having a mix of light-, medium- and heavy-lift helicopters allows for great flexibility in matching requirement with availability."[9] This certainly offers the best capability option, but is this affordable for the RCAF? In addition to increased costs, sustaining multiple single role platforms requires an organizational structure that is more cumbersome than operating a common platform.

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[7] Thomas Held, Bruce Newsome and Matthew W. Lewis, "Commonality in Military Equipment: A Framework to Improve Acquisition Decisions," *Rand Corporation*. (Santa Monica: 2008): 43.

[8] Mark A. Lorell, Michael Kennedy, Robert S. Leonard, Ken Munson, Shmuel Abramzon, David L. An and Robert A. Guffey, "Do Joint Fighter Programs Save Money?" *Rand Corporation*, (Santa Monica: 2013): xiii.

[9] Canadian Force Aerospace Warfare Center*, Project Laminar Strike: Canada's Air Force Post OP Athena* (Ottawa: DND Publishing, 2011): 29.

As is the case with the RCAF and its mixed fleet, each community is an independent stovepipe with its own distinct culture that works only occasionally with the other communities. The final factor, politics, is the overriding influence contributing to all defence procurement decisions in Canada. Politics can lead the Canadian Armed Forces (CAF) into purchasing equipment that is neither its first choice nor the most capable platform.[10] In some cases it is debatable if this equipment even meets the minimum operational requirements.

Capabilities

According to the Griffon Limited Life Extension Business Case Analysis, the 100 Griffons purchased in 1992 replaced 142 helicopters from the Chinook, Kiowa, Twin Huey and Iroquois classes.[11] The Canadian Army was left with only the Griffon to carry out all tactical aviation missions until the Chinook re-entered service. In an article in *The Canadian Air Force Journal* titled "What Does a Balanced Helicopter Fleet Look Like: An International Comparison," author Thierry Gongora compares the Canadian tactical aviation fleet to the fleets of eight nations.[12] Based on the analysis of the eight nations, Gongora defines a balanced tactical aviation helicopter fleet as one with at least four different platforms. He concludes that the RCAF has an unbalanced tactical aviation fleet and requires attack helicopters.[13] In response to Gongora's article, Colonel Randall Wakelam wrote in *The Canadian Air Force Journal* a piece titled "A Fine Mess: How Our Tactical Helicopter Force Came To Be What It Is." Wakelam agrees that the current tactical aviation fleet is unbalanced, but states Canada is unlikely to

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[10] The selection of the Cyclone helicopter as the replacement for the Sea King is an example of the military not receiving the best equipment. This example will be expanded upon in this paper, particularly in Chapter 6.

[11] Department of National Defence, *Business Case: Griffon Limited Life Extension (GLLE) Project* Version 1.5 (Ottawa: 2015): 5.

[12] Australia, France, Greece, Italy, Netherlands, Spain, UK, US Army and US Marines.

[13] Thierry Gongora and Slawomir Wesolkowski, "What Does a Balanced Helicopter Force Look Like: An International Comparison" *The Canadian Air Force Journal* Volume 1, no. 2 (Summer 2008): 15, 19. http://publications.gc.ca/collections/collection_2008/forces/D12-13-1-2E.pdf

purchase attack helicopters because of "cost and politics."[14] Therefore, any armed escort duties are likely to be carried out for the RCAF by an ally or with a modified aircraft from within our fleet, as was the case in Afghanistan.

According to Sean Bourdon of Defence Research and Development Canada (DRDC) "the decision to purchase a single type of aircraft or to own different aircraft will be the function of the aircraft's ability to satisfactorily execute the desired mission set at an acceptable cost."[15] Regarding a mixed fleet with a high-cost, high capability aircraft and a low-cost, low capability aircraft Bourdon concludes in "A Comparative Analysis of Minimum Resource Requirements for Single and Mixed Fleets for the National Fighter Procurement Evaluation of Operations" that "unless the acquisition cost of the lower cost aircraft is half the acquisition cost of the higher cost aircraft or less, then there is strong evidence to suggest that the mixed fleet is expected to result in reduced overall fleet capability."[16] It is also expected that over its lifetime the mixed fleet will cost more compared to a single fleet of the higher capability aircraft.[17] This factor will be considered in Chapter 4 where the costs of the current RCAF fleet are evaluated.

In "Do Joint Fighter Programs Save Money," Mark Lorell and team outline a number of capability risks associated with operating a single fleet of aircraft. One operational risk calculated by the authors is that "any given modern fighter in the inventory has, on average, a 2.2 percent probability of the entire fleet being ordered to stand down at any given point in the

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[14] Randall Wakelam, "A Fine Mess: How Our Tactical Helicopter Force Came To Be What It Is," *The Canadian Air Force Journal* Volume 1, no. 3 (Fall 2008): 50. http://airforceapp.forces.gc.ca/CFAWC/eLibrary/Journal/Vol1-2008/Iss3-Fall/Sections/08-A_Fine_Mess-How_Our_Tactical_Helicopter_Force_Came_To_Be_What_It_Is_e.pdf

[15] Sean Bourdon and Gregory Hunter, "A Comparative Analysis of Minimum Resource Requirements for Single and Mixed Fleets for the National Fighter Procurement Evaluation of Options," Defence Research and Development Canada, Last Accessed 3 February 2016. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2005%20Mixed%20Fleet%20(En)%20-%20final.pdf

[16] *Ibid*.

[17] *Ibid*.

future…. However, if there are two fighter types in the inventory, the probability declines to 0.05 percent."[18] Having a second aircraft in the fleet reduces the operational risk of the entire fleet. Although the percentages will vary by aircraft type, this risk applies to a common rotary wing fleet; therefore it must be considered in evaluating the merits of a common fleet.

Lorell's paper, written from a United States perspective, notes there is a higher level of procurement risk with joint programs and points out that of the eleven major historical joint fighter programs studied, eight were cancelled early in the process due to conflicts over performance requirements and design.[19] One key difference between the organizational structure of the Department of Defense in the United States and in the CAF is that all air assets in the CAF fall under the Commander RCAF. In the Department of Defense, the air assets of the Navy and Air Force fall under different Commanders and are therefore competitors. In the CAF, each rotary wing community has a different customer: the Navy, Army or the Air Force. With strong, balanced, leadership in the RCAF and with commonality as a goal, the tactical differences of the communities should be overcome in working together to develop a common fleet. This procurement failure remains a risk with a common rotary wing fleet, but the risk is much less in the RCAF than in the Department of Defense in the United States.

In "Commonality in Military Equipment, A Framework to Improve Acquisition Decisions," Thomas Held and team propose a model to guide procurement decision makers. The guide includes four separate plans: the Model Plan, the Differentiation Plan, the Commonality Plan and the Base Model Plan. The Model Plan is a systems level approach that defines project requirements, lists the capabilities to meet requirements and leads to the decision on "which

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[18] Lorell, "Do Joint Fighter Programs Save Money?"…, 36.
[19] *Ibid*., 40.

capabilities should be hybridized, modularized, or differentiated."[20] The second step, the Differentiation Plan, is a component level approach to analyze the model's trade-offs and cost effectiveness to determine which components truly need to be unique. Held states, "if the model's differentiating attributes are not found justifiable, the model may be abandoned and its capabilities reconsidered in step one."[21] The third step is the Commonality Plan that looks to identify which components can be shared with other models. This step should include a cost analysis and training impact analysis.[22] The final step is the Base Model Plan that investigates "whether a sufficient number of components can be shared to warrant development of a base model."[23] The decision to develop a base model is an economic decision as well as an operational decision. The authors claim that developing a base model has the potential for improved operational capability and fewer logistical requirements. Ideally a commonality percentage goal should be determined during this phase, although this must be carefully considered and not arbitrarily selected.[24]

In Major L.A. Caux's article, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet for the Canadian Forces," he highlights how the CAF saved money with the Griffon purchase. One way was by adopting "the mandate of minimal customization and [relying] on one baseline configuration supplemented by mission kits."[25] This means each Griffon model was able to carry out many missions, but was not required to have all the mission equipment installed all the time. He points out that "the approach taken to fit all aircraft for but not with … equipment is viewed as a substantial cost avoidance opportunity as it offers

[20] Held, "Commonality in Military Equipment …", 51.
[21] *Ibid*., 56.
[22] *Ibid*.
[23] *Ibid*., 57.
[24] *Ibid*., 57.
[25] L.A. Caux and R.G. Delaney, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet for the Canadian Forces," *Advisory Group for Aerospace Research and Development CP-600* Vol. 1 (April 1997): 106.

employment flexibility and permits a reduction in the number of kits normally purchased,"[26] which would save money and increase flexibility in a future multi-role, common rotary wing fleet.

Held's paper, prepared for the United States Army, concludes that planners need to use objective and informed analysis to determine which components should be common.[27] He recommends adopting "a capability-based commonality decision making aid,"[28] similar to the four step plan outlined above. A briefing note produced by DRDC titled "Optimum Fleet Sizes" suggests the Combined Operational Effectiveness and Investment Appraisal (COEIA) analysis be utilized in the DND force development situations requiring the analysis of multiple criteria. DRDC suggests decision makers use like-with-like comparisons, such as constant cost, constant output or constant capability. DRDC notes it has been working closely with Director General Capability and Structure Integration within the Chief of Force Development to institutionalize the COEIA approach in the Options Analysis phase of project development.[29]

Costs

Of the factors being considered in this paper, acquisition and life cycle costs receive the highest level of scrutiny from the government, the media and the general public and as a result is the focus of much of the research material available.

In analyzing historical acquisition costs for fighter fleets, Lorell concluded that costs increased by of 24 percent for single-service platforms while joint programs experienced a significantly higher cost growth rate of 65 percent.[30] Lorell believes there is an inverse

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[26] *Ibid.*, 107.
[27] Held, "Commonality in Military Equipment…", 59.
[28] *Ibid.*, 59.
[29] B.W. Taylor, *Optimum Fleet Sizes: DRDC Response to Chief of Programme* (Ottawa: 13 November 2015): 1-3.
[30] Lorell, "Do Joint Fighter Programs Save Money?"…, 11.

relationship between the need for maximum commonality and service specific requirements. For example, in the 1970's the United States Congress directed the development of the Joint Air Combat Fighter program that started with a goal of 100 percent commonality but eventually resulted in two distinct platforms with zero commonality.[31] Achieving maximum commonality increases the potential for joint cost savings while service specific requirements tend to reduce commonality due to different operating environments, doctrine, roles and missions.[32] Lorell states "attempts to reconcile different requirements in a common-core airframe increase technical complexity and risk, which can lead to [research and development; test and evaluation] and procurement cost growth."[33] Additionally, increased specialization for different communities decreases commonality, which reduces the likelihood of cost savings. He concludes that "the increased complexity and decreased commonality can lead to greater cost growth than for single service programs, especially when initial baseline cost estimates have assumed optimistic projections of theoretical maximum savings from commonality."[34] The Joint Fighter Program initially aimed for 80 percent commonality,[35] but when the requirements of each of the competing services were combined with the requirements of the foreign nations involved, the result was significantly increased program costs.[36]

Sean Bourdon of DRDC believes that "there is ample evidence that minimizing the number of types of aircraft in a fleet does lead to cost savings,"[37] but to focus only on decreasing the acquisition costs is not enough in considering the whole-life costs of the available options.

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[31] *Ibid*., xvii-xviii.
[32] *Ibid*., 17.
[33] *Ibid*., 18.
[34] *Ibid*., 18.
[35] *Ibid*., 21.
[36] *Ibid*., 22.
[37] Bourdon, "A Comparative Analysis of Minimum Resource Requirements…", Last Accessed 3 February 2016. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2005%20Mixed%20Fleet%20(En)%20-%20final.pdf

He outlines numerous duplicated costs associated with operating a mixed fleet, such as the RCAF's current rotary wing fleet. These duplicated costs include: "infrastructure, aircraft maintenance support equipment, operational and maintenance training, supply lines, project management, engineering support, aircraft certification, storage and management of spare parts."[38]

In determining which life cycle costs to analyze for the purposes of this paper, Thomas Held suggests investigating research and development costs, spare part costs, personnel costs in managing suppliers, personnel costs in ordering spare parts, inventory costs, training costs and maintenance personnel costs.[39] Mark Lorell suggests that operation and support costs often make up the majority of overall life cycle costs but are challenging to estimate before the project is fully developed.[40]

In another Canadian example, the "New Shipborne Aircraft" (NSA) proposal to replace the Sea Kings in the late 1980's aimed to reduce non-recurring engineering costs by making the aircraft more common with the model selected for British and Italian Navy programs.[41] This is also a goal in Australian defence procurement. Its "Defence Procurement and Sustainment Review" states Australia must "explore ways to combine its demand with that of its allies to achieve economies of scale."[42] In selecting the Cyclone as the eventual winner to replace the Sea King, the RCAF missed the mark on reducing commonality costs with other nations, as Canada will be the first military to employ the Cyclone. The Options Analysis of the "New Search and Rescue Helicopter" (NSH) project, which was eventually combined with the NSA project before

[38] *Ibid*.
[39] Held, "Commonality in Military Equipment…", 21.
[40] Lorell, "Do Joint Fighter Programs Save Money?"…, 24.
[41] Aaron Plamondon, *The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter* (Vancouver: UBC Press, 2010): 100.
[42] Australia, Department of Defence, *Going to the Next Level: The Report of the Defence Procurement and Sustainment Review* (Canberra: Defence Publishing Service, 2008): 40. http://www.defence.gov.au/publications/mortimerreview.pdf

both cancelled in 1993, stated "there were additional savings achievable during the capital acquisition stage of the two projects through the economies of scale, which were at least partially dependent on the co-implementation of the projects."[43] The Griffon purchase also provides fleet rationalization example where "annual operations and maintenance costs"[44] were reduced.

Australia's 2013 Defence White Paper states off-the-shelf solutions will continue to be used as the baseline in assessing risks and benefits of developmental projects. It accepts that this will result in a share of its military equipment being purchased from other nations.[45] Major Caux believes there were significant "cost benefits achieved as a result of the selection of a civil certified aircraft fleet customized for military employment."[46] He goes on to state "the use of readily available military and commercial products eliminated development and support costs."[47] Author Aaron Plamondon argues in "The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter" that the Cyclone procurement claimed to be an off-the-shelf purchase, even though the S-92 had never been used by another military in the maritime role. He states that the "procurement occurred even though the importance of buying off-the-shelf and avoiding the risks of using untested equipment had been repeated countless times by analysts and military professionals along the way."[48] The CAF, given its small size, should avoid procuring large-scale developmental projects and should focus on purchasing off-the-shelf options when available, that are already in use in the intended role by other militaries. The Griffon example, as outlined by Caux, is an exception and was deemed a success in part because the civilian role of the Bell 412 is similar in complexity to the military tactical aviation role,

[43] Plamondon, *The Politics of Procurement…,* 101.

[44] Department of National Defence, *Business Case: Griffon Limited Life Extension (GLLE)…,* 5.

[45] Australian Government, Department of Defence, *Defence White Paper 2013* (Canberra: Defence Publishing Service, 2013): 116. http://www.defence.gov.au/whitepaper/2013/docs/WP_2013_web.pdf

[46] Caux, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet…", 103.

[47] *Ibid*., 108.

[48] Plamondon, *The Politics of Procurement…,* 188.

although the threat environment is very different. In terms of equipment requirements, the military maritime role is more complex than the civilian role of the S-92, requiring intricate mission specific equipment and folding rotor blades and tail cone. This indicates that the Cyclone should not have been the choice for the maritime helicopter replacement. Going forward, the RCAF should enact a policy of purchasing off-the-shelf aircraft and equipment when available and practicable, thus avoiding research and development costs.

Held believes the unit cost of spare parts, including those during initial procurement, repair and replacement can be decreased due to production economies of scale. He points to the example of Swedish truck manufacturer Scania, who estimates that for every doubling of production quantities production costs fall by 10 percent.[49] This value will be used throughout Chapter 4 as an economy of scale factor.[50] Held also notes the potential risk of increased parts costs due to "excess functionality,"[51] essentially paying for functions or quality that is not required to complete assigned missions. He refers to the Joint Strike Fighter example where "the United States Congressional Research Service raised concern that the projected Joint Strike Fighters are apt to be more costly than Air Force requirements might dictate, but provide less capability than the Navy might desire."[52]

Regarding logistical support, Caux states, "in the past, the DND policy concerning support to operations was for total self-sufficiency anywhere in the world and mandated use of

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[49] Held, "Commonality in Military Equipment…", 23.

[50] The best way to determine the actual economy of scale factor is through the procurement process. A project management office could ask the manufacturer to quote the per-unit price at different purchase quantities. That is beyond the scope of this paper. Ideally a value associated with helicopter production would be used, but that value could not be located in the literature. Therefore, the Scania value will be used as both truck and helicopters are mass-produced on an assembly line and both should experience a similar economy of scale factor for increased production.

[51] Held, "Commonality in Military Equipment…", 23.

[52] *Ibid*., 3.

its pre-established support structure and organization."[53] The Griffon purchase changed this philosophy as "the Bell worldwide after-sale product support network"[54] was utilized for replacement parts. The results were: a reduction in the quantity of Griffon spare parts held in inventory by the military and a reduction in administrative overhead as no personnel were required for inventory management, cataloguing, inspection or shipment of parts.[55] This trend has continued with recent in-service support contracts and will likely continue into the future.

According to the Military Analysis Network of the Federation of American Scientists, when the United States Navy was looking for a new maritime helicopter, it decided its best option was to modify the Army's Black Hawk helicopter that was already in the military's inventory. The Seahawk was chosen to take advantage of the existing support infrastructure and to reduce the number of helicopter types in the fleet.[56] In "Reorganizing the Navy Helo Force," author Frederick Latrash notes the Navy's plan to reduce the number of platforms from eight to two. The two remaining helicopters will have 60 per cent commonality and have identical cockpits. The United States Navy estimates this decision will save $20 billion in life cycle costs over 22 years.[57] For this reason, this paper will consider options within the current RCAF rotary wing fleet as a future common platform.

Major McManus argues in his 1997 paper "Rationalisation of Rotary Wing Aircraft in the ADF" that "general consensus in the Canadian Forces and United States Navy is that a fleet needs to have more than 30 helicopters in operation so that the engineering, supply and training

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[53] Caux, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet…", 108.

[54] *Ibid*., 109.

[55] *Ibid*., 109.

[56] Federation of American Scientists, Military Analysis Network, "UH-60 Black Hawk," Last Accessed 3 February 2016 http://fas.org/man/dod-101/sys/ac/uh-60.htm

[57] Frederick Latrash, "Reorganizing the Navy Helo Force," *U.S. Naval Institute Proceedings* vol. 127, issue 1 (2001): 47.

costs can be fully amortized."[58] This number would indicate that all current RCAF rotary wing fleets are not fully amortizing these costs, except the Griffon fleet with 85 aircraft. Although it would be ideal if there were an accepted number that could be used for planning, this information appears to be unsubstantiated and there is no literature on the subject to back up Major McManus' claim.

Lorell concludes that "contrary to expectations, historical joint aircraft programs have not saved money compared with single-service aircraft programs."[59] This is because the increase in acquisition costs has grown at a rate that outweighs any savings from operations and life cycle costs. There is one key difference between a common rotary wing fleet for the RCAF and a joint fighter program for the United States Navy and Air Force. There is a different command structure for military air assets in the United States and Canada. With all air assets falling under the Commander of the RCAF, a common rotary wing fleet technically would not be a joint program.

Lorell's final recommendation is "that unless the participating services have identical, stable requirements, DoD avoid future joint fighter and other complex joint aircraft programs."[60] One admitted shortfall of his research paper is the lack of data derived from completed projects, as the majority of the programs analyzed in the study did not progress beyond the proposal stage.[61] Although Lorell's findings will be considered in this paper, due to the differences mentioned above they merely highlight a risk in developing a common rotary wing fleet, not reason to cease all consideration.

Organizational Structure

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[58] J.J. McManus, "Rationalisation of Rotary Wing Aircraft in the ADF," Royal Australian Air Force Staff Course, Royal Australian Air Force Staff College (1997): 2.

[59] Lorell, "Do Joint Fighter Programs Save Money?"…, 39.

[60] *Ibid.*,40.

[61] *Ibid.*, 9.

As organizations are social institutions they are often influenced by inherent cultures and sub-cultures, which can sometimes run contrary to logic. Dr. Eric Ouellet, professor at the Canadian Forces College, believes that "institutions will spend more energy to protect their legitimacy than accomplish their actual function."[62] Major Devin Conley elaborates on this concept in his article "The Canadian Forces and Military Transformation: The Elusive Quest for Efficiency" in *The Canadian Army Journal*. He believes that loyalty to the individual services is stronger than loyalty to the institution. This can lead to resistance to change initiatives if they are not considered fair in the eyes of the individual service.[63] This institutional rigidity makes the top-down implementation of organizational restructure difficult and makes it questionable if implemented changes will endure.

Thomas Held describes organization or personnel savings as an opportunity cost, an example being "a reduction in procurement management effort that is only realized if the number of procurement personnel is reduced" and used for other purposes or laid-off.[64] In the context of the CAF, there is an extant demand for establishment positions to be reallocated to emerging capabilities. Even though there would be no cost savings in reducing personnel due to commonality efficiencies because personnel would not be laid-off, there is a huge potential benefit to the organization, as these positions would be reallocated to higher priority missions. The result is comparable capabilities delivered by fewer people within the rotary wing fleet and increased capability in the RCAF or CAF as a whole.

Southwest Airlines flies a single aircraft fleet, the Boeing 737, to simplify pilot, maintainer and flight attendant training. This training advantage is so important to Southwest that

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[62] Eric Ouellet, "Institutional Constraints on Command" (lecture, Canadian Forces College, Toronto, ON, 9 December 2015), with permission.

[63] Devin Conley and Eric Ouellet, "The Canadian Forces and Military Transformation: An Elusive Quest for Efficiency", *The Canadian Army Journal* Volume 14, no. 1 (2012): 80.

[64] Held, "Commonality in Military Equipment…", 22.

it has rejected changes that threaten to reduce this commonality. When Boeing changed the cockpit design and introduced a glass cockpit on the 737, Southwest demanded Boeing program the cockpit to look like the legacy dials and indicators to that Southwest pilots were accustomed.[65] In looking at another example, the Airbus A-320, A-330 and A-340 airliners have common cockpit controls and displays that are believed to save 20 to 25 percent in annual pilot training costs.[66]

As part of the United States Navy reducing the number of rotary wing platforms to two, Frederick Latrash recommends implementing organizational changes. He believes all of the United States Navy rotary wing communities, regardless of its individual operational missions, should be placed into a single community. The author sees the key benefit to this approach being a single, multi-mission vision for rotary wing aviation.[67] The varying roles of the United States Navy rotary wing platforms have more similarities than the differing roles of the RCAF rotary wing fleet; therefore this type of complete consolidation of operational communities would be difficult within the RCAF. Operationally, this could mean placing all rotary wing squadrons under a single Wing Commander. Currently 1 Wing is structured this way, with the Wing headquarters in Kingston and the Squadrons dispersed throughout the country. The trouble for the RCAF is the different cultures within each community and inexperience working together. Allan English and Colonel (Retired) John Westrop highlight this phenomenon in "Canadian Air Force Leadership and Command: The Human Dimension of Expeditionary Air Force Operations." They identify "stovepipes," or sub-cultures within the RCAF and the resulting problem of one person potentially "working in one community throughout a career" who will

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[65] *Ibid.*, 30-31.
[66] *Ibid*.
[67] Latrash, "Reorganizing the Navy Helo Force"…, 50.

likely “not be exposed to other communities’ roles and challenges.”[68] This can lead to a military that fights “more a function of their culture than their doctrine, or their technology for that matter.”[69] This would need to be overcome, if it is even possible given the theories on institutional rigidity, before attempting a consolidation of the rotary wing operational structure. A common platform and a consolidated community also introduce an opportunity to eliminate a number of headquarters’ positions, as there would no longer be a requirement to have representation from each community.

Held recommends senior leadership determine what organizational changes are necessary to be made and how this can be used to quantify the success of any commonality initiative.[70] One metric could be delivering the same level of capability with fewer people, whether the personnel reductions come from the training system or headquarters’ positions. Currently in the RCAF, each individual rotary wing fleet is responsible for planning its own next generation of aircraft, an example of community “stove piping,” which indicates the RCAF may not actually be practicing Capability Based Planning. Held believes commonality could foster a consolidation of project management offices to a single (or at least fewer) project management office, thus reducing the staff assigned to project management duties.[71] The Griffon project realized savings in this regard, as the project management office had only 37 staff members compared to traditional staffs of 150 to 200 staff members for up to seven years.[72]

Political Factors

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[68] Allan English and John Westrop, *Canadian Air Force Leadership and Command: The Human Dimension of Expeditionary Air Force Operations* (Ottawa: DND Publishing, 2007): 156.

[69] *Ibid*., 158.

[70] Held, “Commonality in Military Equipment…”, 59.

[71] Held, “Commonality in Military Equipment…”, 59.

[72] Caux, “Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet…, 104-105.

Canadian defence procurement decisions have always been heavily influenced by politics. Desmond Morton summarizes this nicely in "Understanding Canadian Defence": "Canadian equipment purchases had always involved politics, right back to the 1880's decision to dress the militia in high cost, low quality Canadian made uniforms in deference to Sir John A. MacDonald's National Policy."[73] Today, the topic of defence is rarely a political priority in Ottawa. Journalist Matthew Fisher, a staunch supporter of the military, believes Australia's approach to defence is more balanced than Canada's. In a recent *National Post* article he states "it would be mighty helpful if Canada's political parties understood, as Australians do, why there is a compelling need for continuity in defence policy and could forge a consensus about what the country's strategic interests and values are."[74] Given Australia's geography, its threat environment is much different than Canada's. Canada's security as a result of its geography has allowed for the politicization of defence processes and procurement.

Canada's Defence Procurement Strategy (DPS) has three objectives: "delivering the right equipment to the Canadian Armed Forces and the Canadian Coast Guard in a timely manner, leveraging our purchases of defence equipment to create jobs and economic growth in Canada, and streamlining Defence procurement processes."[75] Dr. Jean-Christophe Boucher, a professor at MacEwan University, wrote in *Embassy News* that the DPS priorities are "fundamentally contradictory" and he believes "the Canadian government must look abroad to purchase these [military] platforms at competitive price points and with guarantees on deliverability,

[73] Desmond Morton, *Understanding Canadian Defence*. (Toronto: Penguin Books, 2003): 82.

[74] Matthew Fisher, "Lessons on national defence from Down Under," *National Post,* 17 February 2016. http://www.nationalpost.com/m/wp/blog.html?b=news.nationalpost.com/full-comment/matthew-fisher-lessons-on-national-defence-from-down-under

[75] Public Works and Government Services Canada, "Defence Procurement Strategy," Last accessed 27 February 2016. http://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html

irrespective of the domestic economic downfalls."[76] However, Tim Page, President of the Canadian Association of Defence and Security Industries disagrees with Boucher and believes the DPS will benefit both the CAF and the Canadian military industry.[77] Of note, the DPS does not mention value for money. As a result, the CAF could potentially pay more for its equipment by using defence spending to create jobs in Canada, instead of receiving value for money in defence purchases. By comparison, the Australian defence procurement stresses value for money in defence acquisitions.[78] Australia's 2009 Defence White Paper states "defence should not pay a premium for local industry work, unless the costs and risks of doing so are clearly defined and justifiable in terms of strategic benefits."[79] Canada could learn from this ideal and has significant room for improvement within the DPS. Lieutenant-Commander Iain Findlater recommends five DPS improvements in his Canadian Forces College Masters of Defence Studies paper. These recommendations include: ensuring adequate and stable funding for the CAF, increasing the number of Assistant Deputy Minister (Materiel) project staff, improving the training for Assistant Deputy Minister (Materiel) project staff, quantifying the DND's engagement with industry, and implementing a single point of accountability for defence procurement.[80]

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[76] Jean- Christophe Boucher, "Canada's contradictory defence procurement strategy," *Embassy News*, 14 August 2014. http://www.embassynews.ca/opinion/2014/08/14/canadas-contradictory-defence-procurement-strategy/45921

[77] Tim Page, "Is defence procurement on the right track? YES," *Ottawa Citizen* 6 February 2014. http://ottawacitizen.com/opinion/columnists/is-defence-procurement-on-the-right-track-yes

[78] Australian Government, Department of Defence, "Procurement in Defence," Last accessed 19 April 2016. http://www.defence.gov.au/dmo/DoingBusiness/ProcurementDefence/

[79] Australian Government, Department of Defence, *Defending Australia In the Asia Pacific Century: Force 2030 (Defence White Paper 2009)* (Canberra: Defence Publishing Service, 2009): 128. http://www.defence.gov.au/CDG/Documents/defence_white_paper_2009.pdf

[80] Iain Findlater, "Department of National Defence Equipment Procurement and Capital Acquisition in the 21st Century. A Study of the Defence Procurement Process and New Defence Procurement Strategy: A True Reformation or Merely Tentative Steps Forward" (Master of Defence Studies Paper, Canadian Forces College, 2015) 93-94.

Industrial regional benefits (IRBs) have always been an important factor in Canada's defence procurement and became official policy in 1986.[81] The goal of the IRB policy is to use major federal government procurements to create sustained industrial and regional development.[82] The IRB policy was changed with the introduction of the DPS and replaced by the Industrial Technological Benefits program, which includes weighted Value Propositions.[83] Value Propositions are either direct or indirect contributions to equipment or services being procured in Canada and are mandated to equal 100% of the awarded contract value.[84] Charles Davies of the Conference of Defence Associations Institute, believes there is risk in adding weighted industrial benefits to the bid evaluation process, as there is "potential for shifting procurement decisions further away from obtaining the most appropriate operational solution and minimizing whole-life costs of ownership, and towards desired industrial outcomes."[85] Additionally, any added costs "would be at the direct expense of the military capability being acquired within an already resource constrained environment."[86]

Vice-Admiral (retired) Bruce Donaldson, former Vice Chief of the Defence Staff, had experience with the military procurement process during his career. His recent letter to the Minister of National Defence outlines the shortfalls he sees in the current process. He states "our government has no effective system in place … for creating a real strategic partnership with key

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[81] Government of Canada, Innovation, Science and Economic Development Canada, "Industrial and Technological Benefits Policy: Value Propositions", Last accessed 8 May 2016. https://www.ic.gc.ca/eic/site/086.nsf/eng/00017.html

[82] Plamondon, *The Politics of Procurement…,* 9.

[83] Government of Canada, Innovation, Science and Economic Development Canada, "Industrial and Technological Benefits", Last accessed 6 May 2016. https://www.ic.gc.ca/eic/site/086.nsf/eng/h_00005.html

[84] Government of Canada, Innovation, Science and Economic Development Canada, "Industrial and Technological Benefits", Last accessed 16 April 2016. https://www.ic.gc.ca/eic/site/086.nsf/eng/00006.html#vp

[85] Charles Davies, "Canada's Defence Procurement Strategy: An End or a Beginning?" *Conference of Defence Associations Institute*, Vimy Paper 20 (September 2014): 7.

[86] *Ibid*.

national industries,"[87] indicating the DPS has not lived up to its promises. He then blasts the culture of the public service and elected officials:

> I suggest that there is a culture of risk intolerance that has infected the federal level – financial in the case of Public Servants, and political in the case of Ministers – that has led government to prefer additional process, "third party validation" of responsible officials' work, and serial delay to achieving results.[88]

Given the issues regarding the culture in Ottawa and the current system, Donaldson believes "the "all or nothing" approach to fleet replacement introduces risks and complexities that may outweigh the benefits."[89] He believes the system is so badly broken that the CAF should consider "more frequent refreshing of parts of fleets (vehicles, aircraft and ships) with currently available technology in a rapid procurement process, despite the additional cost and challenges of operating and maintaining mixed fleets."[90] This indicates that due to the size of the project, a common platform for the rotary wing fleet is a risky endeavour in the current environment. The RCN has been hit particularly hard as it is currently experiencing a capability gap in its ability to sustain the fleet at sea. These capability gaps could become the norm if the top priority of the DPS is not truly delivering the right equipment to the CAF in a timely manner.

Mark Lorell highlights a potential unintended negative consequence that impacts military industry resulting from commonality. In recent decades the number of companies manufacturing fighter aircraft has declined from eight in 1985 to three today[91] and Lorell believes the pursuit of joint fighter programs is to blame. This potential downside of common platforms is a challenge for project management teams that are forced to deal with a smaller, less competitive industrial

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[87] Bruce Donaldson, *Defence Policy Review Submission*, 21 April 2016: 2. http://dgpaapp.forces.gc.ca/en/defence-policy-review/docs/donaldson-submission-vancouver.pdf

[88] *Ibid*.

[89] *Ibid*., 3.

[90] *Ibid*.

[91] Lorell, "Do Joint Fighter Programs Save Money?"…, xviii.

base.[92] Therefore, the work in creating the DPS and strengthening Canadian military industry could be hurt by commonality projects if the trend of fewer providers is a result.

Summary

The Griffon project was discussed earlier in this chapter as a cost-benefit success story, but was it? One thing that is not clear in the cost-benefit analysis is what savings were due to the consolidation of fleets with a common platform and what savings were due to reducing the number of helicopters from 142 to 100. This example leads to one assumption that will be used throughout the paper: the number of aircraft in the RCAF rotary wing fleet will remain unchanged for the purposes of the commonality analysis.

This paper will use the arguments outlined in existing literature to shape the evaluation criteria in looking at the current RCAF rotary wing fleet while considering a common platform. The topics covered will be capability, cost, organizational structure and political factors, to determine if a common rotary wing platform would benefit the CAF. If so, this paper will determine if the common platform could be an extension of one already in the RCAF inventory, or if other options should be considered.

[92] *Ibid*., 35.

CHAPTER 3: CAPABILITIES

For the purposes of the analysis of the rotary wing fleet, two assumptions will be made. First, the current missions of the RCAF helicopter communities will remain unchanged in the future fleet and will not be affected by any decisions regarding platform commonality. Even if the operating environment is changed, such as operating the Chinook fleet in the arctic or operating the Griffon fleet in a high threat environment, for the purposes of this paper these missions will remain constant. Second, the number of helicopters required by the CAF will remain unchanged, meaning the fleet will not be increased or reduced based on any decisions regarding platform commonality. Bourdon highlights the example of the CF-18 procurement and the difficulty in making cost estimates if these assumptions are not adhered to:

> Estimating the savings realized by replacing the CF-101, CF-104, and CF-5 with the CF-18 is quite challenging to do in any meaningful way. The number of aircraft was reduced through this process as was the scope of the missions carried out by the fighter force. This means that even if reliable costing data from that era were available, which is not the case, any cost comparison would be of an apples to oranges variety.[93]

These assumptions will be used through the capability, cost, organizational structure and political chapters unless mentioned otherwise.

This chapter will outline the current RCAF fleet and the capabilities of each rotary wing aircraft. The chapter will conclude by conducting a capability analysis of the current fleet in each of the RCAF rotary wing missions: SAR, embarked operations in support of the RCN, troop transport and utility operations. This analysis will outline where capability overlap exists with our current fleet and determine how well each platform could theoretically perform each of the other missions.

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[93] Bourdon, "A Comparative Analysis of Minimum Resource Requirements…", Last Accessed 3 February 2016. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2005%20Mixed%20Fleet%20(En)%20-%20final.pdf

CH-146 Griffon

The Griffon first entered service in the RCAF in 1995. One hundred Griffons were originally purchased from Bell for C$1.293 billion.[94] There are currently 85 Griffons in the fleet that are distributed throughout the country to carry out a number of roles. The Griffon operational training units are allocated 17 aircraft, 1 Wing is allocated 37 aircraft for Canadian Army use, 15 aircraft are allocated to 427 Squadron for Special Forces use, nine aircraft are allocated to the Combat Support Squadrons, five aircraft are dedicated to primary SAR in Trenton and two aircraft are used in research and development.[95] The Griffon purchase was a consolidation project itself as the Griffon replaced 142 helicopters from the Chinook, Kiowa, Twin Huey and Iroquois classes.[96]

The Griffon is classified as a Utility Transport Tactical Helicopter (UTTH) and according to the RCAF website, "the Griffon's primary role is tactical transportation of troops and material. It is also used at home and abroad for search and rescue missions, surveillance and reconnaissance, casualty evacuation and counter-drug operations."[97] The Griffon is smaller than a medium lift helicopter, but in many cases is expected to fill the same role, especially during the period that the RCAF did not have Chinook helicopters. It is crewed by two pilots and a flight engineer in its tactical aviation role, and a SAR Technician is added in the SAR role. The Griffon's technical specifications are outlined in Table 3.1.

Table 3.1 – Griffon Technical Specifications

Speed	Range	Length	Rotor Span	Height	Empty Weight	Max Gross	Troop Carrying

[94] J.W. MacAleese, "The CH-146 Griffon: Underrated and Over-Criticized?" (Command and Staff Course New Horizons Paper, Canadian Forces College, 2001): 2.

[95] Department of National Defence, *Business Case: Griffon Limited Life Extension (GLLE)…,* 10-12.

[96] *Ibid.*, 5.

[97] Royal Canadian Air Force, Last accessed 1 February 2016. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-146.page

						Weight	Capacity
140 kts	354 nm	17.1 m	14 m	4.6 m	3500 kg	5400 kg	10

Source: RCAF website: http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-146.page

The estimated life expectancy of the Griffon is 2021[98] and the avionics of the Griffon face obsolescence by 2020. The Griffon Limited Life Extension (GLLE) project is required to upgrade the avionics and extend the life of the fleet until 2030. These upgrades come with a rough order of magnitude cost of $2 billion.[99]

CH-147F Chinook

In 2009, the Minister of National Defence Peter McKay, announced the purchase of 15 Chinook helicopters which included a 20 year in-service support contract.[100] *Jane's Defence* reports the purchase price for the Chinooks was $1.4 billion and the in-service support contract cost was $2.5 billion.[101] The CH-147F model is a Canadianized version of the Chinook that has been optimized to perform in the Canadian environment. It includes larger fuel tanks, which have doubled the Chinook's operational range compared to previous models.[102] Additional equipment on the F model includes a laser-based active missile counter-measure system, a chaff and flare dispensing system, a radar and laser warning system, a full armour kit, an electro-optic/infra-red sensor, and defensive machine guns.[103]

[98] Department of National Defence, *Business Case: Griffon Limited Life Extension (GLLE)…,* 2.

[99] Ringer, *Briefing Note for CFD…,* 2.

[100] National Defence and the Canadian Armed Forces, "Archived – Government of Canada Buys Chinook Helicopters for The Canadian Armed Forces," Last accessed 16 February 2016. http://www.forces.gc.ca/en/news/article.page?doc=government-of-canada-buys-chinook-helicopters-for-the-canadian-forces/hnps1uh7

[101] Lindsay Peacock, and Alexander von Rosenbach, "IHS Jane's World Air Forces – 2014," (Issue 39): 111.

[102] Royal Canadian Air Force, Last accessed 1 February 2016. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-147f.page

[103] *Ibid*.

The RCAF previously had eight CH-147C models in its inventory, but these were sold in 1991.[104] The RCAF attempted to mitigate the risk of losing the Chinook fleet by using an increased number of the Griffon helicopters distributed across the country to meet the tactical lift demand.[105] With the repurchase of the Chinooks the RCAF took a step closer to achieving better "balance" within its tactical aviation fleet.[106]

The RCAF website calls the Chinook "an advanced, multi-mission, medium to heavy-lift helicopter."[107] The Chinook's "primary mission is the tactical transport of equipment and personnel during domestic or deployed operations."[108] Table 3.2 outlines the Chinook's technical specifications.

Table 3.2 – Chinook Technical Specifications

Speed	Range	Fuselage Length	Rotor Tip to Rotor Tip Length	Rotor Span	Height	Max Gross Weight	Troop Carrying Capacity
170 kts	594 nm	15.9 m	30.2 m	18.3 m	5.8 m	24,494 kg	33[109]

Source: RCAF website: http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-147f.page

CH-124 Sea King/ CH-148 Cyclone

The Sea King helicopter entered service with the RCAF in 1963. The RCAF's maritime helicopter, the Sea King embarks with the RCN and its primary roles include anti-submarine warfare, surface surveillance, disaster relief, search and rescue and fisheries patrols. There are currently 27 Sea Kings in the RCAF fleet,[110] which are being retired from service. The Sea King

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[104] Department of National Defence, *Business Case: Griffon Limited Life Extension (GLLE)…,* 5.
[105] *Ibid*.
[106] Canadian Forces Aerospace Warfare Center, *Project Laminar Strike…,* 28.
[107] Royal Canadian Air Force, Last accessed 1 February 2016. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-147f.page
[108] *Ibid*.
[109] Aeroweb, "Boeing CH-47 Chinook," Last accessed 22 February 2016. http://www.bga-aeroweb.com/Defense/CH-47-Chinook.html
[110] Royal Canadian Air Force, Last accessed 1 February 2016. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-124.page

replacement project has been a sensitive political topic since 1993, and that will be discussed in more detail in Chapter 6.

In the second attempt to replace the Sea King, Sikorsky won the bidding process and a contract was signed in 2004. Sikorsky agreed to provide 28 Cyclone helicopters for $1.8 billion, plus an in-service support contract for an additional $3.2 billion.[111] Once in service, the Cyclone will carry out the same operational missions as the Sea King in connection with the RCN. Sikorsky boasts its H-92 is able to "maximize value to government,"[112] happy to be the economic choice and certainly a factor leading to its selection to replace the Sea King in Canada. The technical specifications of the Cyclone are highlighted in Table 3.3.

Table 3.3 – Cyclone Technical Specifications

Speed	Range	Gross Weight	Length	Rotor Diameter	Height	Troop Carrying Capacity
155 kts	490 nm	12,018 kg	20.85 m	17.17 m	6.45 m	Data Unavailable

Source: Leversedge, "Canadian Combat and Support Aircraft", 249.

CH-149 Cormorant

The Cormorant entered service in 2002 and is the RCAF's only dedicated SAR helicopter. Fifteen Cormorants were originally purchased for $580 million.[113] There are currently 14 Cormorants in service with the RCAF as one was lost in a crash off the coast of Nova Scotia in 2006.

The Cormorant is a civilian off-the-shelf version of the EH-101 medium-lift military transport helicopter. It includes SAR specific equipment including a rear-fuselage ramp, a single

[111] Peacock, "IHS Jane's World Air Forces…", 113.
[112] Sikorsky, Last accessed 24 February 2016. http://www.sikorsky.com/Pages/Products/Military/H92/H92.aspx
[113] National Defence and the Canadian Armed Forces, "Archived – Search and Rescue Helicopter Contract Signed," Last accessed 16 March 2016. http://www.forces.gc.ca/en/news/article.page?doc=search-and-rescue-helicopter-contract-signed/hnlhlxbr

rescue door with two rescue hoists, and the ability to carry up to 12 stretchers or a load of 5000 kg.[114] The EH-101, now labeled the AW101 and manufactured by Finmeccanica, claims to be the helicopter with the "highest levels of safety, reliability and availability"[115] in its class.

Table 3.4 – Cormorant Technical Specifications

Speed	Range	Length	Rotor Span	Height	Max Weight	Troop Carrying Capacity
150 kts	550 nm	22.8 m	18.5 m	6.5 m	14,600 kg	30[116]

Source: RCAF website: http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-149.page

The Cormorant Mid-Life Upgrade (CMLU) project includes a plan to upgrade the avionics systems on the aircraft with a rough order of magnitude cost of $732 million.[117] The mid-life upgrade will also extend the operational life of the Cormorant beyond 2040.[118] The Cormorant's small fleet size combined with the requirement to continue sustaining a 24/7 SAR posture is seen as the largest risk to the CMLU project and could cause an implementation schedule that stretches over an 8-10 year period.[119]

CH-139 Jet Ranger/ Bell 412

The RCAF purchased the Jet Ranger for training purposes in 1981. This single-engine helicopter is used alongside the Bell 412 at 3 Canadian Forces Flying Training School (3 CFFTS) in Portage la Prairie, Manitoba for rotary wing pilot training. There are 13 Jet Rangers being utilized by the RCAF, operated by Allied Wings.[120] The technical specifications for the

[114] Royal Canadian Air Force. Last accessed 1 February 2016. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-149.page
[115] Finmeccanica, "AW101," Last accessed 23 February 2016. http://www.finmeccanica.com/en/-/aw101
[116] *Ibid*.
[117] Department of National Defence, *Business Case: CH149 Cormorant Mid-Life Upgrade (CMLU) Project.* Version 2.0 (Ottawa: 2014): 12.
[118] *Ibid*., 10.
[119] *Ibid*., v.
[120] Royal Canadian Air Force. Last accessed 2 February 2016. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-139.page

Bell 412 are similar to the Griffon in Table 3.1. The technical specifications of the Jet Ranger are outlined in Table 3.5.

Table 3.5 – Jet Ranger Technical Specifications

Speed	Length	Rotor Span	Height	Empty Weight	Max Gross Weight
130 kts	11.9 m	10.2 m	3.5 m	839 kg	1451 kg

Source: RCAF Website: http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-139.page

In March of 2005, the DND announced its intentions to privatize its flying training support with KF Aerospace. The 22-year $1.77 billion contract was made jointly with the Ministry of Industry and included simulators, maintenance and servicing, work offices, meteorological services, air traffic control, emergency response and airfield aviation services.[121] Additionally, the Contracted Flying Training Support contract included the transfer and conversion of Jet Ranger and Bell 412 helicopters from the RCAF inventory to Allied Wings for Advanced Helicopter Flying Training.[122] As part of this contract the RCAF buys back training hours from the company to train RCAF pilots at 3 CFFTS using RCAF instructors.[123]

Capability Analysis of the RCAF Rotary Wing Fleet

In looking at the rotary wing platforms in the RCAF inventory it is obvious that there is overlap in assigned missions. Table 3.6 shows the information of the rotary wing performance in each of the RCAF's four rotary wing missions: SAR, embarked operations with the RCN, troop transport, and utility operations. These missions will be expanded upon below. Of note, the Jet Ranger and Bell 412 will not be considered in the capability matrix, as both are for domestic training and leased from a third party.

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[121] National Defence and the Canadian Armed Forces, "Archived – Contracted Flying Training and Support," Last Accessed 22 February 2016. http://www.forces.gc.ca/en/news/article.page?doc=contracted-flying-training-and-support-cfts/hnocfoke

[122] Government of Canada, "Contracted Flying Training and Support," Last accessed 16 February 2016. http://www.forces.gc.ca/en/training-establishments/contracted-flying-training-support.page

[123] Peacock, "IHS Jane's World Air Forces…", 113.

Table 3.6 – RCAF Rotary Wing Capability Matrix

Fleet	SAR (range)	Embarked Maritime Ops w RCN	Troop Transport Capacity	Utility Operations
Griffon	354 nm	N	10	Y
Chinook	594 nm	N	33	Y
Cyclone	490 nm	Y	Unavailable	Y
Cormorant	550 nm	Y	30	Y

Intentionally omitted from the rotary wing missions are surveillance and escort. Every aircraft in the RCAF fleet is a surveillance platform; therefore procuring a manned rotary wing platform for this sole purpose is unnecessary. With the advancements in fixed and rotary wing UAVs, these appear to be the optimum surveillance platform of the future.[124] A purpose built attack helicopter normally carries out the escort mission. Colonel Wakelam points out that attack helicopters have been rejected in the past due to "cost and politics,"[125] and it is unlikely that this will change in the future.

Search and Rescue

SAR aircraft require less equipment in comparison to the other RCAF rotary wing missions. SAR aircraft need a rescue hoist and aircraft sensors such as radar and forward-looking infrared. It also requires a mission management system capable of navigation over land and water, capable of tracking search areas and capable of integrating the information from all of the aircraft's sensors.

The RCAF uses the Cormorant and a portion of the Griffon fleet in the primary SAR role, but all RCAF aircraft are secondary SAR assets. All of the rotary wing assets in Table 3.6 are

[124] Richard Gardner, "Vayu's UK Editor Richard Gardner reports from the largest defence and security show of the year", *Vayau Aerospace and Defence Review* 6 (Nov/Dec 2015): 88-92. http://search.proquest.com/docview/1758011111/fulltext/22A3691776684D50PQ/1?accountid=9867

[125] Wakelam, "A Fine Mess…", 50.

capable of being a primary SAR aircraft with little to no modification to the airframe. A key factor that distinguishes an ideal primary SAR asset from a less desirable primary SAR asset is aircraft range. The Cormorant is capable of flying faster and almost 200 nautical miles farther than the Griffon on a tank of gas, allowing it to arrive at an isolated crash site faster with fewer fuel stops along the way. The CMLU Business Case Analysis states that using the "less capable" Griffon in a primary SAR role was only intended as a temporary measure.[126] Based on aircraft range and speed, the Chinook, Cormorant and Cyclone possess the best capabilities to be a SAR specific platform for the RCAF and the Griffon is a less desirable option.

Embarked Operations in support of the RCN

Embarked operations with the RCN require a significant amount of mission specific equipment to be installed in the helicopter. Anti-submarine warfare (ASW) requires active dipping sonar, active or passive sonobuoys (or both) and processors, and a mission management system to integrate that information with aircraft navigation and other aircraft sensors. During ASW missions, the embarked helicopter may be required to hover very shortly after take-off at all-up weight. An aircraft assigned to this role would require engine power sufficient to carry the additional equipment and maintain an endurance of almost three hours plus reserves. The Griffon helicopter lacks the engine power to carry out the ASW role with the associated equipment requirements. As pointed out by Major McManus "as the Bell 412 has never been marinised" it was not a candidate to be the next maritime helicopter.[127] The Chinook, Cormorant, and Cyclone all have the engine power to carry out the ASW mission.

[126] Department of National Defence, *Business Case: CH149 Cormorant Mid-Life Upgrade…,* v.
[127] McManus, "Rationalisation of Rotary Wing Aircraft in the ADF,"…, 6.

The current RCN fleet capable of operating with an embarked helicopter is comprised of Halifax class frigates and a destroyer. The future RCN fleet will include Arctic Patrol Vessels, a Joint Support Ship sustainment vessel, and a Combined Surface Combatant to replace the existing frigates and the destroyer. The Chinook is too large to embark on any of these vessels without expensive modifications to the ship's designs. Additionally, during the National Shipborne Aircraft project to replace the Sea King helicopter, Boeing admitted it could not fulfill Canada's naval helicopter requirement.[128] The Cyclone and Cormorant are appropriately sized to operate from any of the current and future RCN vessels with minor modifications to the ships. The Cyclone is specifically designed for this role. Also, the Cormorant has a maritime variant, the EH-101, in service with other navies.

Troop Transport

A suitable troop transport helicopter requires cabin space, seating and engine power to transport troops. The Chinook, the largest and most powerful helicopter in the RCAF fleet, is clearly the best platform for troop transport. Finmeccanica, the manufacturers of the AW101 and the Cormorant, has a support version of its aircraft in service with the United Kingdom and Italy[129] that can carry 30 passengers.[130] The H-92 is the Army version of Sikorsky's Cyclone,[131] but the manufacturer offers no suggestions on maximum troop carrying capacity. The Griffon's capacity to carry 10 troops per lift is the lowest of the RCAF's rotary wing platforms.

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[128] Plamondon, *The Politics of Procurement…,* 101.

[129] Army Technology, "AW101 (EH101) Merlin / Cormorant Medium-Lift Military Helicopter, United Kingdom," Last accessed 18 April 2016. http://www.army-technology.com/projects/aw101/

[130] Finmeccanica, "AW101," Last accessed 23 February 2016. http://www.finmeccanica.com/en/-/aw101

[131] Sikorsky, Last accessed 23 February 2016. http://www.sikorsky.com/Pages/Products/Military/H92/H92.aspx

Utility Operations

All of the RCAF helicopters are capable of utility operations. Utility operations include the internal or external transfer of supplies or equipment, medical evacuations, casualty evacuation, and other administrative personnel or equipment transfers. In transporting equipment and other tactical goods, engine power and range are the most important factors. Again, the Chinook is the best utility helicopter as it is the most powerful and has the longest range. The Cormorant and Cyclone are also a good utility platforms and the Griffon is capable, but to a lesser degree.

Summary

Based on the capability analysis, the Cormorant platform appears to be the best option within our inventory to be a common platform for the RCAF based on its ability to conduct all of the RCAF rotary wing missions. The Cyclone is also capable of carrying out all four missions, but to a lesser degree than the Cormorant. The Chinook is the best platform for SAR, troop transport and utility operations but it cannot conduct embarked operations with the RCN. Although capable of conducting SAR, troop transport and utility operations, the Griffon is the least capable platform given its limitations with engine power and range. It is no surprise that the largest, most powerful helicopters are the most capable.

The RCAF often operates in high-threat environments. In the past the RCAF has modified platforms by adding additional sensors, self-defence systems, and offensive weapons to counter the threat and operate in these environments. This is possible with a common fleet designed with “fitted for but not with” mission kits. It also offers the RCAF increased flexibility in transferring assets from one community to another as operational demand dictates. The next chapter will analyze the costs associated with each of the RCAF’s helicopters.

CHAPTER 4: COSTS

In evaluating the appropriateness of commonality, Chapter 2 outlined the various costs to consider in making these decisions. This chapter will analyze three categories of costs: acquisition costs, operating costs and life cycle costs.[132] As acquisition and life cycle costs are difficult to predict in evaluating future fleet options, historical data will be used. Defence economist Binyam Solomon believes that defence inflationary costs tend to be different than other measures of the general economy such as consumer price index and gross domestic product deflator.[133] Since these broad economic indicators do not accurately reflect the fact that defence costs tend to fluctuate to a greater degree during periods of high inflation, the DND has developed its own economic models for measuring defence specific inflation, and the subsequent impact of inflation on purchasing power.[134] This paper will use defence specific inflation data from the DND Economic Model vice the more generic Consumer Price Index to adjust past acquisition and support contracts to a common year (present value as at 01 January, 2015) for comparison purposes.

Acquisition Costs

Table 4.1 shows the initial acquisition cost and year of purchase for each rotary wing platform as well as the present value of the acquisition costs.[135] Although these numbers will be

[132] For the purposes of this paper, acquisition costs refer to the purchase price of the aircraft and associated mission equipment. Operating costs refer to the fuel economy of each platform. Life cycle costs refer to the infrastructure; supply lines; spare part storage and management; engineering support; aircraft certification; project management; and operational and maintenance training. The majority of these life cycle cost are now being included within in-service support contracts. Operational and maintenance training will be covered separately in Chapter 5.

[133] Binyam Solomon, “Defence Specific Inflation: A Canadian Perspective,” *Defence and Peace Economics* Vol 14(1) (2003): 19-36. http://www.tandfonline.com/doi/pdf/10.1080/10242690302935

[134] Department of National Defence, Assistant Deputy Minister (Finance), *DND Economic Model*. Last accessed 7 April 2016 http://cfo-dpf.mil.ca/en/about-fincs/reports.page

[135] Although present value calculations are primarily used by the private sector when there is an expectation of a future revenue stream relating to an equipment purchase, in this paper they will be used to analyze the RCAF rotary wing fleet. When the term “present value” is used in this paper, it refers to the value of the historical acquisition and support contracts as at 01 January 2015, calculated using the DND Economic Model inflation values. All calculations are shown in Annex A.

compared in order to evaluate differences between fleets, they are not intended to accurately estimate a purchase price for these fleets. As outlined in Chapter 2, Swedish truck manufacturer Scania estimates that for every doubling of production quantities, production costs fall by 10 percent.[136] This value will be used throughout this chapter in applying an economy of scale factor to past RCAF rotary wing purchases.[137]

Table 4.1 – Historical Aircraft Acquisition Cost Comparison

Fleet (number purchased)	Initial Acquisition Cost (year)	Final Acquisition Cost[138] (present value- 2015)	Aircraft Still in Service
Griffon (100)	$1.293 B[139] (1992)	$2.081 B	85
Cyclone (28)	$1.8 B[140] (2004)	$2.211 B	28[141]
Cormorant (15)	$580 M[142] (1998)	$823.31 M	14
Chinook (15)	$1.4 B[143] (2009)	$1.535 B	15
Total		$6.650 B	142

In calculating the theoretical fleet acquisition costs in Table 4.2, the present value of the acquisition cost of each fleet from Table 4.1 is divided by the number of aircraft within each fleet purchased in the original contract.[144] This provides the per-unit present value. The number of aircraft still in service in each fleet is then multiplied by the per-unit present value. The results of these calculations are shown in Table 4.2, where the present value of our current fleet is estimated to equal $6.283 billion.

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[136] Held, "Commonality in Military Equipment…", 23.

[137] The best way to determine the actual economy of scale factor is through the procurement process. A project management office could ask the manufacturer to quote the per-unit price at different purchase quantities. That is beyond the scope of this paper. Ideally a value associated with helicopter production would be used, but that value could not be located in the literature. Therefore, the Scania value will be used as both truck and helicopters are mass-produced on an assembly line and both should experience a similar economy of scale factor for increased production.

[138] Calculations are shown at Annex A.

[139] MacAleese, "The CH-146 Griffon: Underrated and Over-Criticized?"…, 2.

[140] Peacock, "IHS Jane's World Air Forces…", 113.

[141] This number represents the number of Cyclones that will be in service once all aircraft have been delivered and are operational.

[142] National Defence and the Canadian Armed Forces, "Archived – Search and Rescue Helicopter Contract Signed," Last accessed 16 March 2016. http://www.forces.gc.ca/en/news/article.page?doc=search-and-rescue-helicopter-contract-signed/hnlhlxbr

[143] Peacock, "IHS Jane's World Air Forces…", 111.

[144] Calculations are shown at Annex A.

Table 4.2 – Theoretical Fleet Acquisition Cost Comparison[145]

Acquisition Cost			
Current Mixed Fleet		Theoretical single platform fleet acquisition cost	
Griffon (85)	$1.769 B	Griffon (142)	$2.955 B
Cyclone (28)	$2.211 B	Cyclone (142)	$9.082 B
Cormorant (14)	$768.4 M	Cormorant (142)	$5.681 B
Chinook (15)	$1.535 B	Chinook (142)	$10.593 B
Total	$6.283 B		

To calculate the "theoretical single platform fleet acquisition cost," the per-unit present value of each fleet is multiplied by the total number of helicopters in the current RCAF fleet. The economy of scale factor is then applied where appropriate. The calculated "theoretical single platform fleet acquisition cost" numbers alone can be misleading because of the differing costs between maritime and SAR models, so further explanation is required. In "The Politics of Procurement- Military Acquisition in Canada and the Sea King Helicopter," author Aaron Plamondon breaks down the NSA/NSH contract that was awarded to purchase 50 helicopters from European Helicopter Industries: 35 to replace the Sea Kings and 15 SAR helicopter to replace the CH-113 Labrador.[146] From that contract, the per-unit present value of the SAR version of the helicopter is $45.058 million and the maritime version is $109.428 million. Of note, the per-unit present value of the Cormorant fleet purchased in 1998, of which there were 15 built, is $54.89 million. Applying the economies of scale factor and then assuming between 30 and 60 Cormorants were purchased in 1998, the per-unit present value range is between $44.015 million and $49.401 million, a range that nicely captures the per-unit present value of $45.058 from the NSA/NSH contract and adds validity to the present value method of cost comparison.[147]

These numbers show that the added complexity of the maritime aircraft comes with a significantly increased cost. The SAR model cost in this example is 41% of the maritime model.

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[145] Calculations are shown in Annex A.
[146] Plamondon, *The Politics of Procurement…,* 111.
[147] Calculations are shown at Annex A.

This indicates that the "theoretical single platform fleet acquisition cost" of Cyclones would actually be less than indicated in Table 4.2 and the "theoretical single platform fleet acquisition cost" of Cormorants would be higher. For ease of calculation, it will be assumed that the cost of an army model of either of these aircraft falls directly between the two. Given these assumptions and assuming the same cost ratios for the Cyclone, table 4.3 shows the updated "theoretical single platform fleet acquisition cost."

Table 4.3- Updated Theoretical Single Platform Fleet Acquisition Costs[148]

Fleet	Per-Unit Cost (Maritime-28)	Per-Unit Cost (SAR-14)	Per-Unit Cost (Army-100)	Theoretical Single Platform Fleet Acquisition Cost
Cyclone	$63.96 M	$26.22 M	$45.09 M	$6.667 B
Cormorant	$97.598 M	$40.015 M	$68.807 M	$10.104 B

The per-unit present values in Table 4.3 better reflect the differing costs based on the present value of the maritime, SAR and army models of the Cyclone and Cormorant. This information shows that the Cormorant as a single fleet would cost much more than our current mixed fleet. Also, the "theoretical single platform fleet acquisition cost" of the Cyclone is within $400 million of the present value of our current mixed RCAF rotary wing fleet. This indicates that if savings of greater than $400 million can be achieved in operating and life cycle costs, then from an acquisition cost perspective a common fleet of Cyclones is a viable option and warrants further analysis.

In "Do Joint Fighter Programs Save Money?" Mark Lorell concludes that costs grew by 24 percent for single-service programs versus 65 percent for joint programs.[149] In applying these growth rates to the figures above, our current mixed fleet would have cost overruns of $1.5 billion and a common fleet of Cyclones would have cost overruns of $4.3 billion, making the

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[148] Calculations based on economy of scale amount assuming manufacture of between 100 and 142 Cormorants and 112-142 Cyclones. Calculations are shown at Annex A.

[149] Lorell, "Do Joint Fighter Programs Save Money?"…, 11.

difference $2.8 billion for the common platform.[150] If these rates are accurate, this will likely prevent the RCAF from pursuing the question of commonality further, as it would be difficult to achieve that level of savings in life cycle costs. However, there are a few key differences between a common rotary wing fleet for the RCAF and a joint fighter program for the United States Navy and Air Force. First, as mentioned in Chapter 2, unlike United States Navy and Air Force, all of the air assets in the RCAF fall under operational command of the Commander of the RCAF. Even though there will be differing priorities from each of the communities that support the maritime, army or SAR missions, the Commander can be a unifying force within the RCAF where the United States Navy and Air Force are competing entities under separate Commanders. Second, the level of complexity of a common rotary wing platform is less than a joint fighter aircraft. There are significant technological differences in a regular fighter aircraft and an aircraft that must be capable of taking off from an aircraft carrier. That alone would have caused a significant amount of difference of opinion between the United States Air Force and Navy. If the RCAF were to decide that the Chinook was the best option for a common fleet, a similar problem would arise in the procurement, as integration between our Chinook aircraft and the RCN is non-existent. A larger investment in ship modifications and training could lead to an increased probability of the cost overruns outlined by Lorell. In selecting either the Cormorant or the Cyclone, both designed for use with the Navy, the probability of significant cost overruns would be reduced by comparison.

Also mentioned in Chapter 2, Sean Bourdon's conclusion regarding the lower acquisition cost of lower capability aircraft can be applied to the present value calculations in Table 4.2 and

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[150] Current mixed fleet is $6.283 billion * 24% predicted cost overrun = $1.51 billion in estimated cost overruns. Theoretical single fleet of Cyclones is $6.667 billion * 65% predicted cost overrun = $4.3 billion in estimated cost overruns. $4.3 billion – $1.5 billion = $2.8 billion in predicted increased overruns in the single fleet versus the mixed fleet.

4.3. In Chapter 3, the Griffon was determined to be the lowest capability rotary wing aircraft in the RCAF fleet. According to Bourdon's theory, unless the Griffon's acquisition cost "is half or less than that of the higher capability aircraft, the mixed fleet is expected to … result in reduced overall fleet capability [and] cost more over its lifetime relative to a single fleet of higher capability aircraft."[151] Based on the present value calculations, the Griffon's acquisition cost is less than half of each of the other fleets, meaning that from a cost perspective the RCAF could benefit from having a tactical utility helicopter fleet alongside a more capable medium lift platform. Assuming a mixed fleet of 71 Griffons and 71 Cyclones,[152] the theoretical acquisition cost would be $5.341 billion,[153] which is $1.326 billion less than the theoretical cost of a single fleet of Cyclones. Major Stephen Allan recommended a two-platform rotary wing fleet in 2001, prior to the awarding of the Sea King replacement contract to Sikorsky, in his Canadian Forces College paper "Canadian Forces Rotary Wing Force Restructure." He also suggests a medium lift platform (the Cormorant- 43 aircraft) paired with a tactical utility helicopter (the Griffon- 99 aircraft).[154] A mixed fleet of two aircraft reduces the operational risk of a fleet wide stand down, as detailed by Mark Lorell.[155] Further analysis is required to determine which roles would be most appropriate for the tactical utility helicopter so the RCAF does not pay for the excess functionality of the more capable aircraft where it does not need to.

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[151] Bourdon, "A Comparative Analysis of Minimum Resource Requirements…", Last Accessed 3 February 2016. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2005%20Mixed%20Fleet%20(En)%20-%20final.pdf

[152] A mixed fleet of 50% medium lift and 50% tactical utility helicopters is used for calculation purposes. Given the current fleet of 142 helicopters, that equals 71 of each type. Further analysis is required to refine this estimate and determine if a different mix of medium lift and tactical utility helicopters will better serve the RCAF.

[153] 71 Cyclones (28 maritime cost $71.064 million each, 14 SAR cost $28.842 million each and 29 army cost $49.599 million each at a production quantity between 56 and 112 which totals $3.716 billion). 71 Griffons cost $22.9 million each at a production quantity between 50 and 100 for a total of $1.625 billion. $3.716 B + $1.625 B = $5.341 B.

[154] Stephen Allan, "Canadian Forces Rotary Wing Force Restructure," Command and Staff Course New Horizons Paper (Canadian Forces College, 2001): 27.

[155] Lorell, "Do Joint Fighter Programs Save Money?"…, 36.

Chapter 3 discussed the two mid-life upgrade projects that are planned by the RCAF: the Griffon Limited Life Extension (GLLE) and the Cormorant Mid-Life Upgrade (CMLU). It is worth noting that the estimated costs of these projects are similar in value to the present value of original *acquisition* costs of these fleets. The GLLE Business Case Analysis points out that as part of the Investment Plan process the Griffon replacement project was deemed unaffordable.[156] Yet the rough order of magnitude estimate for the GLLE project is $2 billion and only extends the life of the platform 10 years with no improvements in capability. On the surface this project appears to be poor value for money, but decisions in the past to delay a replacement project for the Griffon appear to have left the RCAF with no alternative. If the RCAF will be flying its future airframes for 30 to 50 years, expensive mid-life upgrade projects will be the norm and will need to be factored into total life cost calculations.

Operating Costs

This section will consider the fuel burn rates of the rotary wing aircraft in the RCAF inventory. The Cost Factors Manual, produced by Assistant Deputy Minister (Finance) includes the fuel burn rate for all RCAF aircraft. The values for the RCAF rotary wing fleet are shown in Table 4.4. The most recent Cost Factors Manual was published in 2014/2015, therefore data is not available for some of the newer platforms, such as the Chinook and the Cyclone.

Table 4.4- Helicopter Fuel Burn Rate (Litres per flying hour)

Fleet	Fuel Burn Rate (Litres per flying hour)
Sea King	535
Griffon	389
Cormorant	855

Source: Cost Factors Manual 2014-2015 Volume II- Equipment and Facility Cost

[156] Department of National Defence, *Business Case: Griffon Limited Life Extension (GLLE)…,* 6.

Jet fuel prices tend to mirror the price of crude oil. Looking at the past 5 years, prices averaged $0.80 per litre until September 2014 and have been under $0.40 since the start of 2016.[157] For calculation purposes, the range of $0.50 to $0.80 per litre will be used to capture the low prices of today and also account for the possibility of rising oil prices in the future. Therefore, fuel costs for the Sea King are $267.50 to $428.00 per flight hour, Griffon fuel costs are $194.5 to $311.20 per flight hour and Cormorant fuel costs are $427.50 to $684.00 per flight hour. *Global Security* reports that the CH47D version of the Chinook has a burn rate 1,355 litres per hour,[158] and since the Cost Factors Manual does not capture the Canadian model, this value will be used for fuel calculation purposes. Calculated fuel costs for the Chinook are $677.50 to $1,084.00 per flight hour. Regarding the Cyclone, it will be assumed that the burn rate is equal to the Sea King burn rate.

To calculate total fuel costs for the fleet, the yearly flying rate is required. Table 4.5 contains the fiscal year 2015/2016 planned flight hours and actual hours flown.

Table 4.5 – FY 2015/2016 Yearly Flying Rate

Fleet	Initial Allocation	Revised Allocation	Actual Hours Flown
Griffon	26,550	25,526	25,258
Chinook	4,000	2,800	2,787
Sea King	7,600	6,850	6,912
Cyclone	595	200	162
Cormorant	5,800	5,562	5,573
Totals	44,545	40,938	40,692

Source: Directorate Air Comptrollership and Business Management

[157] Index Mundi, "Jet Fuel Monthly Price- Canadian Dollar per Gallon," Last accessed 20 April 2016 http://www.indexmundi.com/commodities/?commodity=jet-fuel&months=60&currency=cad. These figures represent the commodity price for jet fuel and do not include delivery and other service charges.

[158] Global Security, "CH-47D Chinook," Last accessed 20 April 2016 http://www.globalsecurity.org/military/systems/aircraft/ch-47d.htm

Table 4.6 shows the total fuels costs based on the jet fuel cost ranges used above and the actual hours flown from Table 4.5. The total fuel costs for fiscal year 2015/2016 are between $11.1 million and $17.7 million. These values will be used as the baseline for further comparisons below.

Table 4.6 – FY 2015/2016 Estimated Fuel Cost

Fleet	Fuel Cost ($0.50 per litre)	Fuel Cost ($0.80 per litre)
Griffon	$4,912,681	$7,860,290
Chinook	$1,888,193	$3,021,108
Sea King	$1,848,960	$2,958,336
Cyclone	$43,335	$69,336
Cormorant	$2,382,458	$3,811,932
Totals	$11,075,627	$17,721,002

The previous section on acquisition costs highlighted the potential of a single fleet of Cyclones and a mixed fleet of Cyclones and Griffons as two possible future fleets for the RCAF. Using the actual hours flown as a baseline, the estimated annual fuel cost for a single fleet of Cyclones is $10,855,110 to $17,416,176 and the estimated annual fuel costs of the mixed fleet is $9,399,852 to $15,039,763.[159] This represents an annual savings of $220,517 to $304,826 for the Cyclone fleet and $1,675,775 to $2,681,239 for the mixed fleet. Over the 20-year life of the platform the fuel cost savings are significant, particularly for the mixed fleet, at $33.5 million to $53.6 million.[160]

Life Cycle Costs

When reviewing rotary wing contracts from 1992 to the present date, it is apparent that there has been a shift in how the DND manages life cycle costs. Many of the life cycle functions that were outlined in Chapter 2 are now being performed by contracted agencies and not by uniformed CAF members. It is debatable as to whether this trend will continue or if these

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[159] The mixed fleet of Cyclones and Griffons assumes 71 of each aircraft and the total hours flown evenly split between the two aircraft. Calculations are shown at Annex A.

[160] Calculations are shown at Annex A.

sustainment functions will be brought back into the military. Whether these functions are conducted by the military does not effect this discussion, as they need to be carried out regardless of who actually does the work. Both the military and private industry would look to streamline operations and benefit from economies of scale should a common platform be selected.

Although military personnel complete the majority of the aircraft maintenance for the Griffon, the purchase contract took advantage of "the Bell worldwide after-sale product support network" as the source for spare parts. Privatizing this function of the supply chain resulted in reducing the requirement for storage, cataloguing, inspecting, shipping, and administration of spare parts by military personnel. The contract also included a money-saving provision where the contractor would buy back excess and obsolete parts.[161]

The in-service support contract for the Cyclone is a 22-year contract with Sikorsky as the prime contractor and L3-MAS and General Dynamics as key sub-contractors.[162] The contract includes a number of contractor provided services, such as: engineering management; logistics support analysis; materiel support; training and simulators; infrastructure; modifications to RCN ships; and an integrated information environment.[163] Regarding materiel management, the contractor is responsible for supply chain management to include: procurement, inventory control, part transportation, warehousing, customer services and deployment services including coordinated delivery of materiel to operations.[164] The contractor, not DND, owns spare parts until they are installed on the aircraft.[165] Many of these duties were the responsibility of RCAF

[161] Caux, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet…, 109.
[162] D.A.G. Waldock, "PMO MHP In-Service Support Overview," PowerPoint Presentation (17 May 2010): 3-4.
[163] *Ibid*., 3.
[164] *Ibid*., 26.
[165] *Ibid*., 27.

personnel while operating the Sea King, so any personnel savings are already captured for higher priority RCAF and CAF missions when the transition to the Cyclone is complete.

As the Cormorant is a domestic SAR platform, civilian technicians carry out 100 percent of the maintenance on the aircraft as part of the in-service support contract. It is unlikely that this is an option for rotary wing support to the Army and RCN, as military technicians will likely always be required to conduct maintenance on aircraft in a theatre of operations. Even the Cyclone in-service support contract has military technicians completing first and second line maintenance, while the contractor is responsible for third line maintenance.[166]

Assuming the trend toward privatization continues, the best way for the DND to capture life cycle cost savings is through economies of scale of in-service support contracts. Table 4.7 shows the value of applicable in-service support contracts for the fleet. The present value is calculated, again using the DND Economic Model data from Annex 1.

Table 4.7 - Historical In-Service Support Cost Comparison

Fleet (number purchased)	ISS past value (year)	ISS present value
Griffon (100)	N/A	N/A
Cyclone (28)	$3.2 B[167] (2004)	$3.93 B
Cormorant (15)	$591 M[168] (2007)	$678.7 M
Chinook (15)	$2.5 B[169] (2009)	$2.741 B

Each of the in-service support contracts offers unique services and each is for a different length of time, therefore simply adding the totals together is not useful. The Cyclone contract is 22 years, while the Cormorant maintenance contract has been a series of shorter contracts. For example, the Cormorant contract signed in 2007 had a seven-year duration. The primary

[166] *Ibid*., 16.
[167] Peacock, "IHS Jane's World Air Forces…", 113.
[168] Charles Mandel, "Cormorants' life extended; Maintenance contract for troubled search, rescue copters," *The Windsor Star* (13 September 2007) http://search.proquest.com/docview/254762749?OpenUrlRefId=info:xri/sid:summon&accountid=9867
[169] Peacock, "IHS Jane's World Air Forces…", 111.

contractor of the in-service support contract for the Chinook fleet is Boeing and the contract length is 20 years.[170] It is worthwhile to look at a per year cost of each of the contracts. Table 4.8 displays these figures.

Table 4.8 – Per year In-Service Support Cost Comparison

Fleet (number purchased)	ISS present value	Per Year present value	Per Year per aircraft present value
Griffon (100)	N/A	N/A	N/A
Cyclone (28)	$3.93 B	$178.6 M	$6.4 M
Cormorant (15)	$678.7 M	$97.0 M	$6.5 M
Chinook (15)	$2.741 B	$137.1 M	$9.1 M
Total		$412.7 M	

The yearly per-aircraft in-service support costs are shown in the fourth column of Table 4.6. Although the details of each in-service support contract are unique, it is worth noting the cost per aircraft is similar when comparing the different platforms. In tallying the per year values in Table 4.6, the RCAF pays approximately $412.7 million per year for in-service support contracts for the Cyclone, Cormorant and Chinook fleets, which total 58 aircraft. This adds up to $8.254 billion over 20 years and does not include the Griffon fleet. It was estimated during the Options Analysis of New Search and Rescue Helicopter (NSH) project that "during the in-service life cycles of the NSA and NSH, the "cost avoidance" achievable through the use of a single aircraft type was a minimum of $275 million."[171] This project was planning to use a common platform for the maritime and SAR aircraft and the original plan was to purchase 50 airframes. When the estimated cost avoidance amount is applied to the 20 year in-service support total it represents a theoretical savings of 3.3 percent over 20 years and was for a procurement of only 50 aircraft. It is difficult to accurately estimate a total in-service support value that would

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[170] National Defence and the Canadian Armed Forces, "Medium-to-Heavy Lift Helicopter Project: Status," Last accessed 17 April 2016. http://www.forces.gc.ca/en/news/article.page?doc=medium-to-heavy-lift-helicopter-project-status/hgndblkw

[171] Plamondon, *The Politics of Procurement…,* 101.

include all 142 rotary wing aircraft. Even doubling the value above to $16.508 billion is useful in showing that applying estimated savings rates of 5 or 10 percent (as the Scanian estimate would suggest) the potential savings from combining in-service support contracts could fall somewhere between $825.4 million and $1.651 billion.[172]

Summary

The present value of our current fleet is $6.283 billion with a 20-year in-service support commitment of $8.254 billion that does not include the Griffon fleet. Annual fuels costs for our fleet are $11.1 million with current fuel prices and would be $17.7 million using historical fuel prices. This chapter shows that from a cost perspective there are two options that require further analysis. First, a common fleet of Cyclones could be a candidate to meet the RCAF needs with a theoretical acquisition cost of $6.667 billion, an annual fuel budget of $10.9 million to $17.4 million and a combined in-service support package that could approach $16.5 billion. The increased acquisition cost of the Cyclones is $384 million when compared to our current fleet and there is a risk that potential cost overruns of this multi-role platform could top $2.8 billion for a total of $3.184 billion. Potential operating cost savings are $4.4 million to $6.1 million over 20 years and in-service support savings could be between $825.4 million and $1.651 billion over 20 years. Second, there is merit in considering a mixed fleet of Griffons and Cyclones. A 50/50 split between the two aircraft has a theoretical acquisition cost of $5.341 billion, which is $942 million less than the current fleet. The estimated annual fuel costs of this mixed fleet are $9.4 million to $15 million. The mixed fleet could experience reduced cost overruns yet would likely also achieve reduced in-service support savings. Both options are worth considering and further analysis is required.

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[172] $16.508 billion * 5% = $825.4 million. $16.508 billion * 10% = $1.651 billion.

CHAPTER 5: ORGANIZATIONAL STRUCTURE

While the previous chapter focused on platform costs, this chapter will focus on the cost of people. The Commander of the Royal Canadian Navy, Vice-Admiral Mark Norman was quoted recently at the Mackenzie Institute Defence Conference, stating “we like to get cranked up about how much the ships cost [but] arguably over the 50-year life of the platform – if that’s what you’re planning for, but [ideally] let’s plan for 35 or 40 – the most expensive component of that ship is the crew.”[173] Providing similar or improved capabilities with fewer people can save significant costs over the life of the platform.

For the purposes of this section, the focus of the analysis will be on aircrew and technician trades that are common across all rotary wing fleets: pilots, Aviation System (AVN) technicians and Avionics System (AVS) technicians. Additional efficiencies are possible in the training systems of other trades associated with rotary wing aircraft, such as Air Combat Systems Officers (ACSO), Airborne Electronic Sensor Operators (AESOP), Flight Engineers (FE) and SAR Technicians and further analysis is required in this area. This type of organizational structure analysis, although focused on the rotary wing fleet, could also be applied across the greater RCAF and the CAF as a whole.

Pilot Training

The normal progression for rotary wing pilots is to conduct three phases of flying training prior to wings graduation. In phase one all pilots fly the Grob, a small fixed wing airplane, and in phase two all pilots fly a second fixed wing aircraft, the Harvard. Phase three is where pilot trainees diverge into streams, and rotary wing pilots fly a basic helicopter, the Jet Ranger, followed by an advanced helicopter, the Bell 412. After graduating phase three, pilots have

[173] Murray Brewster, “HMCS Montreal part of navy trial to experiment with reducing crews,” *CBC News*, 1 April 2016 http://www.cbc.ca/news/canada/nova-scotia/royal-canadian-navy-reducing-crews-1.3516037

earned their wings and are ready to be sent to one of the RCAF rotary wing operational training units or operational training flights for further training. Griffon training occurs at 403 Helicopter Operational Training Squadron, Sea King or Cyclone training occurs at 406 Maritime Operational Training Squadron, Chinook training occurs at an operational training flight within 450 Tactical Helicopter Squadron, and Cormorant training occurs at an operational training flight within 442 Transport and Rescue Squadron. Under the contract with Allied Wings, the cost per-student up to the end of phase three, but prior to attending any of the operational training units, is $1,282,755.[174] The historical pilot production for fiscal years 2013/2014 and 2014/2015 is shown below in Table 5.1.

Table 5.1 – Historical Rotary Wing Co-Pilot Production

Fleet	2013/2014	2014/2015	Total
Griffon[175]	26	26	52
Chinook[176]	0	4	4
Sea King[177]	16	12	28
Cormorant[178]	8	7	15
Jet Ranger/ Bell 412[179]	52	33	85
Totals	102	82	

A common rotary wing platform has the potential to streamline pilot training in number of ways. First, if the common platform were flown as the advanced helicopter at 3 CFFTS, all pilots would have experience in the operational aircraft prior to commencing training at the operational training units. The courses at the operational training units could therefore be

[174] Department of National Defence, Assistant Deputy Minister (Materiel), Directorate Major Procurement. *Excel Spreadsheet- Full Cost of All Programs: Pilot Phase Training* (February 2016). Cost breakdown: Phase I (Grob) $152,497 + Phase II (Harvard) $455,000 + Phase III (Jet Ranger) $211,995 + (Bell 412) $463,263 = $1,282,755.

[175] Data provided by A3 Individual Training, 1 Wing Headquarters.

[176] Data provided by Officer Commanding Operational Training Flight, 450 Tactical Helicopter Squadron. Of note, co-pilot training only commenced at 450 Squadron in 2015 and was previously conducted at Fort Rucker on the CH-147D model and statistics are not available.

[177] Data provided by Training Support Flight Commander, 406 (M) OTS.

[178] Data provided by Operational Training Flight Commander, 442 Transport and Rescue Squadron.

[179] Data provided by Administrative Assistant to Commandant, 3 CFFTS.

shortened as new pilot trainees would not need to relearn a new platform, as they currently do at all operational training units except 403 Helicopter Operational Training Squadron. Second, any pilot transfers between communities, such as a transfer from SAR to tactical aviation, would require minimal training. With today's mixed fleet, pilot transferees require the full course at the respective operational training unit, as a new aircraft needs to be learned. A common fleet would eliminate or significantly decrease the amount of training required in this regard. Transfers between communities have decreased significantly over the past two decades due to the training cost and a common platform could rejuvenate community transfers. Regarding the Griffon procurement, Major Caux agrees and concludes "that a single fleet offered many operational benefits including … elimination of cross-training inefficiencies [and] improved standardization and interoperability."[180] Finally, this could lead to reductions in the number of instructors required at the operational training units. This will be explored in more detail later in this chapter.

Adding a larger, more complex advanced platform to rotary wing training at 3 CFFTS could come with increased operating costs. Table 5.2 shows the full cost per flying hour for the Sea King, Griffon and Cormorant.

Table 5.2- Full Cost Per Flying Hour[181]

Fleet	Full Cost Per Flying Hour
Sea King	$36,350
Griffon	$19,600

[180] Caux, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter…, 104.

[181] The costs included in Full Cost Per Flying Hour are: Direct Variable Costs (Aviation Petroleum, oil and lubricants; operations and maintenance; national procurement (including contracted costs of In Service Support Contracts)), Direct Fixed Costs (Aircrew salaries), and Indirect Fixed Costs (In-Service Maintenance Personnel, Wing Support Personnel, Wing Support operations and maintenance and amortization). All costs are from either FY 2012/2013 or calendar year 2013. Director Costing Services notes that these standard costs are not designed to provide a reliable estimation when evaluating future budgets and alternate service delivery programs. For the purposes of this paper, the Griffon full cost per flying hour value will be adjusted (aircrew cost removed) and used as a baseline to compare the military cost per flying hour with that achieved through the contracting of training flight hours with Allied Wings.

Cormorant	$36,350

Source: Cost Factors Manual 2014-2015 Volume II- Equipment and Facility Cost

The costs in Table 5.2 are significantly higher than the hourly cost through the Allied Wings contract. In Phase three pilot training the estimated Jet Ranger cost per flight hour is $3,164 and the Bell 412 cost per flight hour is $6,914.[182] As military instructors are used at 3 CFFTS, to better compare the Bell 412 cost per flight hour with the Griffon full cost per flying hour, the aircrew component of the Griffon cost will be removed, making the new value $16,300.[183] This indicates that the RCAF is receiving value for money in contracting its rotary wing training hours through Allied Wings. However, the Allied Wings numbers above include fixed costs for ground school, therefore per flight hour costs are actually higher than indicated above. Further analysis is required to confirm the Allied Wings cost per flight hour before a final determination is made on the cost savings associated with Allied Wings.

If the RCAF chooses to pursue a common rotary wing fleet it should consider maintaining the contract with Allied Wings, but the terms of the contract would need to be carefully evaluated. To achieve the greatest training benefit from commonality and reduce the platform focused training requirement at the operational training units, the advanced helicopter operated by Allied Wings should be the same operational rotary wing aircraft flown by the RCAF. Further analysis is required to determine if the benefit from a common platform in the training and operational domains would outweigh any increased operating costs. If the RCAF decides to pursue this, nine additional aircraft would be required in the acquisition contract,

[182] Department of National Defence, Assistant Deputy Minister (Materiel), Directorate Major Procurement. *Excel Spreadsheet- Full Cost of All Programs: Pilot Phase Training* (February 2016).

[183] Department of National Defence, *Cost Factors Manual 2014-2015 Volume II – Equipment and Facility Costs* (Ottawa: 2014): 4. $19,600 - $3,300 = $16,300.

bringing the total to 151. The RCAF could then sell nine aircraft to Allied Wings at cost and lease the flying time back from them, similar to the current situation.

Although not directly related to commonality, the preferred manning level (PML) of the pilot trade is worth noting. For years the pilot trade has been below PML and in an attempt to eliminate this shortfall pilot training was increased. Increasing pilot training had a negative effect of pushing newly trained pilots through their first operational tour very quickly because the organizational structure of the operational units was not changed to accommodate the increase in pilots. Therefore, as new pilots were trained, they pushed other new pilots out of the operational unit to work as instructors or into non-flying headquarters' positions. The organizational structures of the higher headquarters that contain many pilot-only staff positions, such as 1 and 2 Canadian Air Division, need to be rationalized to verify which staff positions are truly necessary and to confirm if these positions can be filled by any air trade. Another rationalization is required to confirm there are no unnecessary redundancies between 1 Canadian Air Division Combined Air Operations Centre and the Canadian Joint Operations Command (CJOC) and between the Air Expeditionary Wing (2 Wing Bagotville) and CJOC. If there are redundancies they need to be eliminated, however this is easier said than done. As Major Devin Conley and Dr. Eric Ouellet wrote in their article "The Canadian Forces and Military Transformation: The Elusive Quest for Efficiency" in *The Canadian Army Journal*, the loyalty of individuals to the individual services is stronger than the loyalty to the institution.[184] None of the organizations mentioned above are likely willing to give up positions, as each sees its role as legitimate and will fight to prove its legitimacy. As opposed to increasing pilot production, which in hindsight appears to be treating the symptoms of an inflated PML, fixing the organization could reduce or eliminate the

[184] Conley, "The Canadian Forces and Military Transformation…", 80.

pilot shortage and keep the pilots doing what they have been expensively trained to do: fly RCAF aircraft on operations.

In addition to PML, Sean Bourdon of DRDC points out "because of military posting cycles, a significant portion of the pool of combat-ready pilots is transferred to non-flying positions, increasing the overall amount of training required."[185] This would indicate that the RCAF is producing more pilots than it requires to fill its operational flying positions and the numbers in Table 5.1 are higher than they need to be. Pilots are being trained, at a cost of $1,282,755 up to wings graduation, and in some cases are only flying operationally for two to three years before moving on to become a flight instructor or take a non-flying position within a headquarters. The addition of a common platform could be the catalyst to review and improve the entire organizational structure of the RCAF.

Technician Training

Both AVN and AVS technicians receive basic occupational training prior to the more advanced training received at the operational training units. AVN technicians receive a 38-week course at the Canadian Forces School of Aerospace Technology and Engineering in Borden.[186] AVS technicians attend the 30-week "Performance- Oriented Electronics Training" course at the Canadian Forces School of Communications and Electronics in Kingston followed by 24 weeks of training at the Canadian Forces School of Aerospace Technology and Engineering in Borden.[187] The training received at the operational training units is the first hands-on training on the specific aircraft that these technicians will work on through their careers. Table 5.3 shows the

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185 Bourdon, "A Comparative Analysis of Minimum Resource Requirements…", Last Accessed 3 February 2016. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about-reports-pubs/06%2005%20Mixed%20Fleet%20(En)%20-%20final.pdf

186 National Defence and the Canadian Armed Forces, "Aviation Systems Technician," Last accessed 28 April 2016 http://www.forces.ca/en/job/aviationsystemstechnician-46#boqt

187 National Defence and the Canadian Armed Forces, "Avionics Systems Technician," Last accessed 28 April 2016 http://www.forces.ca/en/job/avionicssystemstechnician-47

number of technicians (AVN and AVS technicians) that were trained in fiscal year 2013/2014 and 2014/2015.

Table 5.3 – Historical Rotary Wing Technician Production

Fleet	2013/2014	2014/2015	Total
Griffon	30[188]	43[189]	73
Chinook	52[190]	36[191]	88
Sea King[192]	44[193]	18[194]	62
Cormorant	0	0	0[195]
Jet Ranger/ Bell 412	0	0	0[196]
Total	126	97	

Over the two years covered in Table 5.3, an average of 111 technicians were trained per year in the Griffon, Chinook and Sea King communities. The number of technicians being trained may be higher than it needs to be because of the number of fleets in service. Major Caux states estimated savings of 190 first and second line maintenance personnel were expected[197] with the Griffon purchase and the consolidation of multiple fleets. Introducing a common platform to the rotary wing fleet has the potential to significantly increase the organizational efficiency of technician training. First, technicians could transfer between rotary wing communities with very little training. Also, with the current structure of technician training, the option of centralizing technician training at a single base should be considered. This will be discussed in the following section.

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[188] 18 AVN technicians and 12 AVS technicians.

[189] 29 AVN technicians and 14 AVS technicians.

[190] Initial Cadre Training 2 produced 24 AVN technicians and 14 AVS technicians. Initial Cadre Training 3 produced 16 AVN technicians. This training was conducted at Summit Aviation in Delaware.

[191] 36 AVN technicians and 12 AVS technicians. Of note, these are the first technicians trained at 450 Squadron. Previous training was conducted at Summit Aviation in Delaware.

[192] Data provided by Training Support Flight Commander, 406 (M) OTS.

[193] 27 AVN technicians and 17 AVS technicians.

[194] Nine AVN technicians and nine AVS technicians. Three courses were zero-loaded to allow for course redesign.

[195] All maintenance on the Cormorant fleet is carried out by civilians as part of the in-service support contract.

[196] All maintenance on the Jet Ranger and Bell 412 is carried out by civilian technicians as part of the Allied Wings contract.

[197] Caux, "Cost Benefit in the Acquisition of a Utility Tactical Transport Helicopter Fleet…, 110-111.

Operational Training Units

Table 5.4 shows the establishment and the actual manning of pilot and technician instructors at each of the operational training units.

Table 5.4 – Operational Training Unit Manning

Fleet	Pilot Inst Establishment	Pilot Inst Actual	Manning Percentage	Tech Inst Establishment	Tech Inst Actual	Manning Percentage
Griffon[198]	12	11	91.7%	18	18[199]	100%
Chinook[200]	14	8	57.1%	18	13	72.2%
Sea King[201]	16	8[202]	50%	27	20[203]	74.1%
Cormorant[204]	6	4	66.7%	[redacted]		
Jet Ranger/Bell 412[205]	33	31	93.9%			

The actual manning levels require further investigation to determine the trends regarding these numbers. For instance, as the Sea King training is decreasing, personnel are being transferred to commence training on the Cyclone. Also, training by military personnel on the Chinook has only recently commenced, so the manning levels will likely increase to fill the

[198] Pilot establishment data is from the 403 (H) OTS automated establishment report and technician establishment data is from the 438 Tac Hel Sqn automated establishment report dated 21 April 2016 provided by Director General Defence Force Planning, Chief of Programme. Pilot manning levels were provided by A3 Individual Training, 1 Wing Headquarters. Technician instructor manning levels were provided by the Officer Commanding Fleet Technical Training Flight, 438 Tac Hel Sqn.

[199] Seven MCpl AVN instructors, five MCpl AVS instructors and six Sgt Course Directors and Standards personnel.

[200] Establishment data is from the 450 Tac Hel Sqn automated establishment report dated 4 February 2016 provided by DG DFP, C Prog. Pilot manning levels were provided by OC Operational Training Flight, 450 Tac Hel Sqn. Technician manning levels were provided by OC Fleet Technical Training Flight, 450 Tac Hel Sqn.

[201] Establishment data is from the 406 (M) OTS automated establishment report dated 4 February 2016 provided by DG DFP, C Prog. Actual manning levels were provided by Training Support Flight Commander, 406 (M) OTS.

[202] Seven Pilot instructors continue to teach the Sea King and one has started teaching the Cyclone.

[203] Four MCpl AVN instructors remain teaching the Sea King and four have started teaching the Cyclone. Three MCpl AVS instructors remain teaching the Sea King and four have started teaching the Cyclone. The remaining personnel are: two Sgt Course Directors, two WO Leads and one MWO senior instructor.

[204] Establishment data is from the 442 Transport and Rescue Squadron automated establishment report dated 4 February 2016 provided by DG DFP, C Prog. Pilot manning levels were provided by Operational Training Flight Commander, 442 Transport and Rescue Squadron.

[205] Establishment data is from the 3 CFFTS automated establishment report dated 4 February 2016 provided by DG DFP, C Prog. Pilot manning levels were provided by the Administrative Assistant to Commandant, 3 CFFTS.

establishment positions. If it is determined that the difference between the establishment and actual manning levels is enduring, the positions should be considered for harvesting for higher priority RCAF and CAF initiatives.

Structural reorganizations can be quite complex with many second and third order effects. There are infinite options that could be considered in reorganizing the RCAF rotary wing training system. For the purposes of this paper, it will be assumed that a single common rotary wing platform is selected and further analysis is required to determine the results in the two-platform option. This paper will explore three general options for an RCAF training organization restructure: the status quo, moderate centralization and complete centralization. Each will be looked at in more detail below.

The status quo option for pilot and technician training would see all advanced training continue at each of the established operational training units and operational training flights. For this option it will be assumed the current manning levels are sufficient to continue producing the historical number of pilot and technician students, which is satisfactory to meet future operational demand. This option will only realize the current delta between the establishment and actual manning numbers as harvested opportunity cost savings.

The moderate centralization option will utilize a common advanced rotary wing platform at 3 CFFTS for pilot training. Pilots will be trained to the point that they are completely comfortable with the aircraft and its systems via a course following wings graduation and will only require community specific advanced tactical flight training. This advanced tactical flight training will be conducted at the operational training units. For technicians, all training will be centralized. A technician training flight will be stood up at an existing organization, one option being the Canadian Forces School of Aerospace Technology and Engineering in Borden. This central technician training school would be equipped with the necessary training aids and part task trainers to conduct training. Any community specific training requirements will be learned on the job at the operational units. This option will see the transfer of some establishment positions to the central training school, some positions staying with the operational training units and flights, and the remainder will be harvested as savings and reallocated to emerging capabilities.

The complete centralization option will see all operational training units or operational training flights disbanded. All helicopter pilot training will be conducted at 3 CFFTS, including community specific training. Any community specific additional training requirements not able to be completed at 3 CFFTS will be the responsibility of the operational units. This option could also consider the replacement of some military pilot positions at 3 CFFTS with civilian instructors. Technician training will be centralized in the same manner as the moderate centralization option. Some positions from the disbanded operational training unit and operational training flights and will be transferred to the central agencies, some will be transferred to operational units and the remainder will be harvested as savings.

Table 5.5 shows the annual full costs of regular force personnel to the DND and Table 5.6 shows the daily full cost of Class A reserve force personnel to the DND. These values will be used to quantify the opportunity cost of the three options outlined above.

Table 5.5 – Annual Personnel Full Costs: Regular Force[206]

Officers	Full Cost (Annual)
Lieutenant Colonel	$183,600
Major	$167,200
Captain	$133,800
Non-Commissioned Members	
Chief Warrant Officer	$138,000

[206] Full cost includes full pay (pay and allowances), indirect O&M (corporate funds and local funds) and the employee benefit plan.

Master Warrant Officer	$126,800
Warrant Officer	$115,700
Sergeant	$106,400
Master Corporal	$99,900
Corporal	$91,800

Source: Cost Factors Manual 2015-2016 Volume I- Personnel Costs

Table 5.6 – Daily Personnel Full Costs: Class A Reserve Force[207]

Officers	Full Cost (Daily)
Captain	$312
Non-Commissioned Members	
Master Warrant Officer	$283
Warrant Officer	$256
Sergeant	$232
Master Corporal	$218
Corporal	$206

Source: Cost Factors Manual 2015-2016 Volume I- Personnel Costs

The status quo option would realize 31 regular force positions available for reallocation: 19 officer positions and 12 non-commissioned member positions.[208] This equates to annual personnel savings of $3,741,000 annually, or $74.8 million over 20 years.[209] The positional savings in this option could be realized whether a common platform is selected or not, therefore this option will be the baseline against which the other two options will be measured.

The moderate centralization would realize 38 positions available for reallocation: 27 regular force and 11 reserve force positions.[210] In transferring positions to 3 CFFTS for pilot training, pilot training production is assumed to remain constant going forward at 42 students per year based on historical 3 CFFTS production. The annual student to instructor ratio was kept constant with the operational training units at 2:1. The proposed structure is in an A Flight and B

[207] Full cost includes full pay (pay and allowances), premium in lieu of leave, indirect O&M (corporate funds and local funds) and the employee benefit plan.

[208] Calculations shown at Annex B. The 19 officer positions are front line instructors (Captains) and the 12 non-commissioned member positions are also front line instructors (Master Corporals).

[209] Calculations shown at Annex B.

[210] The breakdown by rank is shown at Annex B.

Flight of instructors (1 Major and 11 Captains in each flight) to conduct the advanced flying training following the normal wings graduation. This training replaces the majority of the operational training unit course. For technician training, one technician training flight will be stood up consisting of one Captain AERE Officer, one Master Warrant Officer, three Warrant Officers, three Sergeants, and 30 Master Corporals at a centralized location linking into an existing unit. This option will realize annual personnel savings of $3,355,160 per year or $67.1 million over 20 years.[211] Of note, this savings level is less than the status quo option.

The complete centralization option would realize 137 positions for reallocation: 97 regular force positions and 40 reserve force positions.[212] This option includes locating a new home for training of other trades, such as FE, ACSO and AESOP, which is required because of the closing of a Squadron and a number of operational training flights. A FE operational training flight would be established and would be comprised of one Warrant Officer, two Sergeants and six Master Corporals. This training flight could be linked up with any of the operational squadrons: 403 Squadron and 450 Squadron are natural choices. Another operational training flight would be established for ACSO and AESOP training and would fit well with 423 Squadron. The flight would have one Major and five Captains for ACSO training and one Master Warrant Officer, one Warrant Officer and three Sergeants for AESOP training. The pilot and technician training would be the same as described in the moderate centralization option. This option realizes $13,087,912 in annual personnel savings or $261.8 million over 20 years.[213]

Summary

The costs associated with military purchases receive the majority of attention from our politicians and the media. However, organizational changes possess the potential for the CAF to

[211] Calculations are shown at Annex B.
[212] The breakdown by rank is shown at Annex B.
[213] Calculations are shown at Annex B.

deliver increased capability at a lower personnel cost, especially if redundant headquarters' positions can be eliminated. Institutional rigidity factors and emotion can play a significant role in preventing organizational improvements. Centralizing training could come with additional infrastructure costs if the facilities are not already in place. Closing a military unit has historical and military heritage considerations. These changes also have the effect of redistributing CAF personnel throughout the country, which has political implications. Political factors will be looked at in the next chapter, specifically investigating the case study of the Sea King helicopter replacement.

CHAPTER 6: POLITICAL FACTORS

Given the political and institutional considerations outlined in Chapter 2, it is safe to say that the government has had a significant influence in shaping the RCAF's rotary wing fleet. For example, the Mulroney government pushed the Griffon procurement to support industrial regional benefits in Quebec. However, there has arguably never been a military procurement in Canada's history has been influenced by politics more than the Sea King helicopter replacement. This chapter will cover some of the highlights to show that even when the DND correctly follows the process, overriding political and economic factors can change procurement outcomes in an instant.

The New Shipborne Aircraft (NSA) project was started in 1986 to replace the Sea King helicopter. After evaluating the choices the decision was made to purchase the EH-101, which was considered the only acceptable option by the DND.[214] This new platform "was being designed expressly to replace the British and Italian Sea Kings"[215] and was therefore a logical choice to replace Canada's Sea Kings. At the same time, the New Search and Rescue Helicopter (NSH) project to replace the fleet of Labrador helicopters was underway and the EH-101 was determined to be the best platform in both the maritime and SAR roles.[216] The EH-101 bid claimed to have significant industrial regional benefits. Aaron Plamondon states these benefits "were expected to total 113 percent of the purchase price" of the contract and would have been distributed evenly throughout the country.[217] This is equivalent to roughly "45,000 person years

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[214] Office of the Auditor General of Canada. "2010 Fall Report of the Auditor General." http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_06_e_34289.html
[215] Plamondon, *The Politics of Procurement…,* 92.
[216] *Ibid*., 101.
[217] *Ibid*., 109.

of work in Canada"[218] and included "a third assembly line in Canada, plus an offer of 7 percent of the value of all EH-101 future production."[219]

In 1993 the EH-101 contract was made an election platform item by the Liberal government. The Canadian economy had suffered through a severe recession in 1990 and 1991[220] and national unemployment had grown from 7.5 percent in 1989 to 11.2 percent in 1992.[221] Given the lackluster economy, the $4.4 billion NSA/NSH project became a hot political topic in the lead up to the 1993 election. Jean Chretien called the EH-101 an unnecessary "Cadillac" at a time when he believed the country should be exercising fiscal restraint. For the voting public, it was difficult to decipher fact from fiction. Aaron Plamondon states, "although many tried to refute the myths being circulated by the Liberal Party about the EH-101 purchase, the subject had become so politicized that the facts no longer mattered."[222] Within hours of the Liberals taking office, the NSA and NSH projects were cancelled without having an alternative plan in place to replace the Sea King or Labrador helicopters. While the 2010 Auditor General Report stated the cancellation fees incurred by the government were $478 million,[223] it was estimated an additional $250 million that was invested in the defence industry in preparation for the manufacture of the NSA and NSH was lost due to the contract cancellation.[224] Even though the acquisition process for the Sea King replacement restarted within the DND in 1995 as the

[218] *Ibid*., 134.
[219] *Ibid*., 95.
[220] Gordon Thiessen, "Canada's Economic Future: What Have We Learned from the 1990's," *Bank of Canada*, 22 January 2001 http://www.bankofcanada.ca/2001/01/canada-economic-future-what-have-we-learned/
[221] Statistics Canada, "Annual Average Unemployment Rate: Canada and Provinces 1976-2015" http://www.stats.gov.nl.ca/statistics/Labour/PDF/UnempRate.pdf
[222] Plamondon, *The Politics of Procurement…*, 129.
[223] Office of the Auditor General of Canada. "2010 Fall Report of the Auditor General." http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_06_e_34289.html
[224] Plamondon, *The Politics of Procurement…,* 159.

Maritime Helicopter Project,[225] the project did not receive any political traction while Chretien was Prime Minister, and the project required a change in leadership before progressing. However, the Labrador helicopter replacement was announced in 1998 and 15 "scaled-down" versions of the EH-101 were purchased and titled the Cormorant fleet.[226]

With Paul Martin serving as Prime Minister, the winning bid for the Maritime Helicopter Project was awarded to Sikorsky in 2004. Sikorsky agreed to provide 28 Cyclone helicopters for $1.8 billion plus 20 years of in-service support for an additional $3.2 billion.[227] According to the Office of the Auditor General (OAG), "the bids were evaluated based on compliance with the technical requirements, industrial and regional benefits, and lowest overall price."[228] In its report in 2010, the OAG was critical of the Maritime Helicopter Project procurement strategy and outlines areas of inconsistency with other defence procurement projects. For example, after the contract was awarded to Sikorsky, the CAF determined the aircraft required additional power and changed the engines. The OAG notes:

> This amendment is significant in principle because the procurement strategy, which was communicated to industry, was based on the lowest-price bid that met the stated (essential) requirements. The process did not give any credit to bids, or portions of bids, that exceeded the stated requirements.[229]

Aaron Plamondon is also critical of the procurement strategy. He states "if one company's bid was a dollar less than the others, as long as it was deemed compliant, then it would be chosen regardless of overall quality and value,"[230] which is contradictory to many previous defence procurements. By increasing the engine power after contract award, the DND is "now paying for

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[225] Office of the Auditor General of Canada. "2010 Fall Report of the Auditor General." http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_06_e_34289.html

[226] Paul Dixon, "Recent Political Decisions Compare to Past Missteps," *Helicopters Magazine,* 15 May 2013. https://www.helicoptersmagazine.com/operations/the-perils-of-procurement-4122

[227] Peacock, "IHS Jane's World Air Forces…", 113.

[228] Office of the Auditor General of Canada. "2010 Fall Report of the Auditor General." http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_06_e_34289.html

[229] *Ibid*.

[230] Plamondon, *The Politics of Procurement…,* 162.

more capability than it said it needed at the time the contract was signed."[231] Therefore the OAG concluded, "the contract amendment is not consistent with the original lowest price compliant procurement strategy."[232] Plamondon believes the government manipulated the process to allow weaker contenders into the competition and avoid the embarrassment and criticism that would surely arise if the politically unacceptable EH-101 were again selected as the winner.[233] He also points out three additional flaws with the Maritime Helicopter project. First, there was no consideration given to any potential savings resulting from operating a common fleet of maritime and search and rescue aircraft,[234] which was an option as the government had recently purchased the EH-101 Cormorant as the new SAR helicopter. Second, Plamondon is critical of the industrial regional benefits program, calling it "one of the primary reasons that the NSA program had taken so long to be defined and approved. The former program had made the latter program high risk."[235] Lastly, he states that given the CAF's history "with the CF-18 procurement, the military and the government agreed that they did not get good value from a first production run. The contract with EHI for the NSA, therefore was signed only after the British has committed to the EH-101."[236] The Liberal government either did not learn from this fact or simply determined that the increased risk of purchasing a first production run of Cyclones did not outweigh the political safety of the choice.

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[231] Office of the Auditor General of Canada. "2010 Fall Report of the Auditor General." http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_06_e_34289.html
[232] *Ibid*.
[233] Plamondon, *The Politics of Procurement…,* 188.
[234] *Ibid*., 162.
[235] *Ibid*., 159.
[236] *Ibid*., 188.

The RCAF has made a number of concessions with the Cyclone that deviate from the original Statement of Requirements, most notably the 30-minute run-dry capability.[237] According to Giuseppe Gasparini, head of transmission systems design and development at AugustaWestland, this capability ensures a main gearbox can continue to operate without failure for 30 minutes after losing its original lubricant, allowing the pilot to fly to a safe landing site.[238] In 2009, a civilian S-92 operated by Cougar Helicopters crashed in only 11 minutes after losing its main gearbox lubricant.[239] This concession has a significant impact on crew safety. The six other concessions are:

> The ability to secure the helicopter's ramp in various positions during flight, crew comfort systems during extreme temperature operations, unobstructed hand and food holds for technicians to conduct maintenance, the ability to self start in cold weather, cockpit ergonomics factors, and a system to automatically deploy personnel life rafts in emergency situations.[240]

If it was known that Sikorsky would not be able to deliver these seven Statement of Requirement items back in 2004, would the Cyclone still have been compliant with the contract or would a different aircraft have been selected? Or from a political perspective, does it even matter which aircraft was selected, as long as it was not the EH-101?

In the summer of 2012, then Minister of National Defence Peter MacKay called the Cyclone project "the worst procurement in the history of Canada,"[241] obviously a politically motivated statement directed at the Liberals, but also a testament to the project's continuous

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[237] James Cudmore, "Sea King replacements: $7.6B Cyclone maritime helicopters lack key safety requirement," *CBC News*, 23 June 2014 http://www.cbc.ca/news/politics/sea-king-replacements-7-6b-cyclone-maritime-helicopters-lack-key-safety-requirement-1.2684036

[238] Mark Huber, "AgustaWestland Sets New 'Run Dry' Standard for Helicopters." *AIN Online*. 17 June 2013. http://www.ainonline.com/aviation-news/2013-06-17/agustawestland-sets-new-run-dry-standard-helicopters

[239] Thierry Dubois, "Crash victims challenge s-92 certification," *AIN Online*, 29 March 2011 http://www.ainonline.com/aviation-news/aviation-international-news/2011-03-29/crash-victims-challenge-s-92-certification

[240] James Cudmore, "Sea King…", 23 June 2014 http://www.cbc.ca/news/politics/sea-king-replacements-7-6b-cyclone-maritime-helicopters-lack-key-safety-requirement-1.2684036

[241] Dixon, "Recent Political Decisions…", 15 May 2013. https://www.helicoptersmagazine.com/operations/the-perils-of-procurement-4122

delays, and increasing costs. In spite of this label, the Cyclone project has continued to progress and the aircraft has recently celebrated a number of milestones. The first, on 19 June 2015 Canada officially accepted its first six interim Cyclone helicopters.[242] Then, on 27 January 2016, a Cyclone landed on the deck of HMCS Halifax fully manned by RCAF aircrew for the first time.[243] These milestones indicate the project is moving forward and are to be celebrated, however the RCAF is still years away from deploying fully operational Cyclones with the RCN.

Summary

The Sea King replacement history is an anomaly, but it does highlight how politics can quickly derail a procurement project in spite of years of hard work and adherence to process. Aaron Plamondon concludes in "The Politics of Procurement":

> The political atmosphere must be favourable to the acquisition and remain that way throughout the procurement process. Timing is everything. If political support wanes along the way, the acquisition is in jeopardy. It also makes little difference whether a contract has already been signed. And because DND procurement officials are aware of these certainties in their business, they too must play the game.[244]

This unfortunate reality is something that will endure in defence procurement. Project management offices must continue to follow the correct process, remain positive and hope for a strong economy and defence-friendly politicians.

The 2010 OAG report also "raises the question as to whether a lowest price compliant strategy is compatible with the acquisition of complex military equipment requiring significant

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[242] Government of Canada, Royal Canadian Air Force, "Canada accepts six CH-148 Cyclone helicopters," 19 June 2015 http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=canada-accepts-six-ch-148-cyclone-helicopters/ib2cthzy

[243] Patrick McCarthy, "Milestone Flight for Cyclone Helicopter," *Royal Canadian Air Force*, 22 February 2016 http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=milestone-flight-for-cyclone-helicopter/ikwu706a

[244] Plamondon, *The Politics of Procurement…,* 190.

development."[245] A value for money strategy is more likely to deliver the appropriate equipment to the CAF.

[245] Office of the Auditor General of Canada. "2010 Fall Report of the Auditor General." http://www.oag-bvg.gc.ca/internet/English/parl_oag_201010_06_e_34289.html

CHAPTER 7: CONCLUSION

A common rotary wing platform would benefit the CAF. However, this is true only if capability, acquisition costs, operating costs, and life-cycle costs are considered holistically in conjunction with a structural reorganization of the rotary wing training system and favourable political and economic conditions. There are three distinct risks to the success of developing a common rotary wing platform for the RCAF. First, the potential for acquisition cost overruns in excess of those expected with single purpose platforms could eliminate any cost savings. Second, an unfriendly political environment could derail a project of this size. Third, by combining the fleets the larger overall purchase price and in-service support contract value, even if less than the sum of the smaller individual contracts, could be difficult to sell to the Canadian public and could be easily manipulated by opposition political parties. Two commonality options require further investigation: a single fleet of medium lift helicopters and a dual fleet with a medium lift helicopter and a tactical utility helicopter. Both options would benefit from a “fitted for but not with” series of mission kits for each of the operational communities as required.

It would be ideal if there were a platform from within the RCAF inventory that was the clear choice to be the RCAF’s common platform. Yet each platform comes with its own advantages and disadvantages. From a cost perspective the Cyclone appears to be a candidate, but it is an unproven military platform that it is not operated by any other militaries. There have not been any other countries that have decided to purchase it, meaning if the RCAF flies it for 50 years it may have difficulty sustaining the platform. If other countries purchase the platform, this risk would be reduced. From a capability perspective, the Cormorant is the best choice to fulfill all of the RCAF missions, however it is one of the most expensive options. The Cormorant fleet has had serviceability issues, which have led to low availability rates and have led to Griffons holding primary rotary wing SAR duties in Trenton. It is unclear if the serviceability and availability issues are solely due to the platform itself or if the 100 percent civilian maintenance contract is also to blame. The Griffon fleet is the most cost effective option, but is not suitable to be the choice for a common fleet. The Griffon has no maritime variant and when compared to medium lift platforms it is relatively underpowered and the least capable aircraft. The future Griffon replacement deserves consideration as the tactical utility helicopter if the two-platform option is pursued. The Chinook is the RCAF's most capable platform and is also the most expensive option. It does not have a maritime model compatible with the current or future RCN fleets. This evaluation of our current fleet opens the door for further analysis of options that are not in the RCAF inventory but are in service with other nation's militaries.

For the purposes of the analysis of the rotary wing fleet two assumptions were made and they need to be revisited at this point. First, it was assumed that the current missions of the RCAF helicopter fleets will remain unchanged in the future fleet and will not be affected by any decisions regarding platform commonality. Now that it has been determined that commonality will benefit the RCAF, the current missions of the RCAF rotary wing fleet must be reconsidered. Should any missions be added or removed? Further study is required in this regard. Second, the assumption was made that the number of helicopters required by the CAF will remain unchanged, meaning the fleet will not be increased or reduced based on any decisions regarding platform commonality. This assumption was made to ensure that any cost-benefit of commonality was linked to commonality and not to fleet reduction, as was the case with the CF-18 and Griffon purchases. Again, now that it has been determined that commonality will benefit the RCAF the optimal number of aircraft for the fleet should be considered. If a single common platform is selected, further study is required to determine how many medium lift helicopters it takes to do the job of a fixed amount of tactical utility or medium-heavy lift helicopters. Should the number of helicopters allocated to tactical aviation be reconsidered given the change in capability of a common aircraft? Is the current helicopter distribution between maritime, SAR and tactical aviation optimal, or does it require adjustment? If the two-platform fleet is selected, consideration must be given to the quantity of tactical utility and medium lift aircraft required. The tactical utility is the lower cost platform and should therefore be maximized and linked with the missions it is able to capably perform. The remaining missions are then allocated to the medium lift platform. What is the ideal number of each type of aircraft? Reconsideration of the RCAF rotary wing missions and the optimal number of aircraft in the fleet require further study while considering a common fleet.

What should be common and what should be unique in the RCAF future fleet? A few recommendations for common components include: engines, gearbox, cockpit layout, radios, radar, FLIR, EO/IR sensors, mission management system, and external cargo slinging equipment. Some recommendations for "fitted for but not with" equipment include: anti-submarine warfare mission kits, ACSO and AESOP work station, rescue hoist, troop seats, SAR mission kits, community specific self-defence and offensive weapons systems, plus folding rotor blades and tail cone for the maritime model.

The implementation plan for a common fleet would likely span 20-30 years. The RCAF should continue to operate each of its current platforms until the end of its useful life. As each platform is retired it is replaced with the new common aircraft. Ideally the implementation would start in 2020 when the Griffon's avionics becomes obsolete. The estimated $2 billion cost of the Griffon Limited Life Extension could be reallocated to the pursuit of commonality, whether that means a single fleet or a two-platform fleet. An implementation this quickly is unlikely, unless the RCAF were able to procure a helicopter currently in production that required minimal modifications. If the Cormorant is selected as the common platform, the RCAF should continue with the Cormorant Mid-Life Upgrade (CMLU) project. If any other platform is selected, the CMLU should not be pursued and the estimated $732 million cost of this project could also be reallocated to the new common fleet. The Chinooks and Cyclones are the newest aircraft in the RCAF inventory and will likely be flown for many years, but similar to the situation above, expensive mid-life upgrades should only be pursued with the Cyclone if it is chosen as the common platform. Otherwise, each should be retired at the end of its useful life. Under this implementation plan, the future common or two-platform fleet would likely not be fully realized until 2040 or later.

"What interests your boss should fascinate you"[246] is a phrase that is often used in providing career advice to someone starting out in the workforce. As an institution the CAF can learn from this statement. In justifying the selection of one piece of equipment over another, the CAF tends to focus on the capability argument, which is a mandate of the CAF as the specialist in providing professional military advice to the government. However, the argument for a specific piece of equipment needs to place more weight in the other factors: costs and organizational structure. To help with the success of defence procurement, the CAF needs to become fascinated with what the government wants. The government is less concerned with the capabilities the CAF receives, and is more concerned with in cost savings, value for money, effective use of personnel and efficiency.

[246] Martha Heller, "It Worked For Me: Career Advice from Top CIOs", *CIO* 29 January 2008, Last accessed 6 May 2016 http://www.cio.com/article/2437246/leadership-management/it-worked-for-me--career-advice-from-top-cios.html

ANNEX A: CHAPTER 4 CALCULATIONS

Table A1.1 – Acquisition Present Value Calculations ($ billions) (used in Table 4.1)

Year	Defence Inflation	Griffon (1992)	Cormorant (1998)	Cyclone (2004)	Chinook (2009)
		1.293	0.580	1.8	1.4
1992	3.7%	1.341			
1993	1.3%	1.358			
1994	2.3%	1.390			
1995	1.0%	1.403			
1996	2.0%	1.431			
1997	2.4%	1.466	0.580		
1998	3.2%	1.513	0.599		
1999	4.3%	1.578	0.624		
2000	2.8%	1.622	0.642		
2001	1.5%	1.646	0.651		
2002	2.7%	1.691	0.669		
2003	0.2%	1.694	0.670	1.8	
2004	2.9%	1.743	0.690	1.852	
2005	1.7%	1.773	0.701	1.884	
2006	2.2%	1.812	0.717	1.925	
2007	1.2%	1.834	0.726	1.948	
2008	3.5%	1.898	0.751	2.016	1.400
2009	0.7%	1.911	0.756	2.031	1.410
2010	0.1%	1.913	0.757	2.033	1.411
2011	2.6%	1.963	0.777	2.085	1.448
2012	1.6%	1.994	0.789	2.119	1.471
2013	2.8%	2.050	0.811	2.178	1.512
2014	1.5%	2.081	0.823	2.211	1.535
Present Value (01 January 2015)		$2.081	$0.823	$2.211	$1.535

Defence Inflation Source: Assistant Deputy Minister (Finance), "DND Economic Model."

Platform Per-Unit Acquisition Cost at Various Production Quantities (used in Table 4.2)

Griffon
Fleet Present Value/Quantity purchased = Per Unit Purchase price
$2.081 billion/100 = $20.81 million per aircraft at production of 100
Production of 50 is $20.81 million * 1.10 = $22.89 per aircraft

Cyclone
Fleet Present Value/Quantity purchased = Per Unit Purchase price
$2.2107 billion/28 = $78.96 million per aircraft at production of 28
Production of 56 is $78.96 million – ($78.96 million * 10%) = $71.064 million per aircraft
Production of 112 is $71.064 million – ($71.064 million * 10%) = $63.9576 million per aircraft

Cormorant
Fleet Present Value/Quantity purchased = Per Unit Purchase price
$823.3 million/15 = $54.89 million per aircraft at production of 15
Production of 30 is $54.89 million – ($54.89 million * 10%) = $49.4012 million per aircraft
Production of 60 is $49.4012 million – ($49.4012 million * 10%) = $44.4611 million per aircraft
Production of 120 is $44.4611 million – ($44.4611 million * 10%) = $40.015 M per aircraft

Chinook
Fleet Present Value/Quantity purchased = Per Unit Purchase price
$1.5349 billion/15 = $102.33 million per aircraft at production of 15
Production of 30 is $102.33 million – ($102.33 million * 10%) = $92.097 million per aircraft
Production of 60 is $92.097 million – ($92.097 million * 10%) = $82.8873 million per aircraft
Production of 120 is $82.8873 million – ($82.8873 million * 10%) = $74.59857 million per aircraft

Current Mixed Fleet Acquisition Cost (Table 4.2)
Griffon is $20.81 million * 85 = $1.769 billion
Cyclone is $79.96 million * 28 = $2.211 billion
Cormorant is $54.89 million * 14 = $0.7685 billion
Chinook is $102.33 million * 15 = $1.535 billion
Total is $1.769 billion + $2.211 billion + $0.7685 billion + $1.535 billion = $6.283 billion

Theoretical Single Fleets (Table 4.2)
Griffon is $20.81 million * 142 = $2.955 billion
Cyclone is $66.9576 million * 142 = $9.082 billion
Cormorant is $40.015 million * 142 = $5.681 billion
Chinook is $75.59857 million * 142 = $10.593 billion

Updated Theoretical Single Fleets (Table 4.3)
NSA/NSH contract was for 50 aircraft: 35 maritime helicopters and 15 SAR helicopters. $1.4 billion was for construction of the 50 airframes ($28 million per aircraft) and $1.4 billion was for the avionics for the 35 maritime helicopters ($40 million per maritime aircraft). Therefore in 1992 dollars, the per-unit cost of the SAR aircraft was $28 million and the per-unit cost of the maritime aircraft was $68 million per aircraft. Present value calculations are shown below, in millions of dollars.[247]

[247] Aaron Plamondon, *The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter* (Vancouver: UBC Press, 2010): 111.

Table A1.2 – Present Value Calculations: NSH and NSA

Year	Defence Inflation	NSH	NSA
		28	68
1992	3.7%	29.036	70.516
1993	1.3%	29.413	71.433
1994	2.3%	30.090	73.076
1995	1.0%	30.391	73.806
1996	2.0%	30.999	75.283
1997	2.4%	31.743	77.089
1998	3.2%	32.758	79.556
1999	4.3%	34.167	82.977
2000	2.8%	35.124	85.300
2001	1.5%	35.651	86.580
2002	2.7%	36.613	88.918
2003	0.2%	36.686	89.095
2004	2.9%	37.750	91.679
2005	1.7%	38.392	93.238
2006	2.2%	39.237	95.289
2007	1.2%	39.707	96.432
2008	3.5%	41.097	99.808
2009	0.7%	41.385	100.506
2010	0.1%	41.426	100.607
2011	2.6%	42.503	103.223
2012	1.6%	43.183	104.874
2013	2.8%	44.393	107.811
2014	1.5%	45.058	109.428
Present Value (01 January 2015)		$45.058	$109.428

Defence Inflation Source: Assistant Deputy Minister (Finance), "DND Economic Model."

Therefore, from the NSA/NSH contract the present value of the SAR aircraft is $45.058 million per unit and the maritime aircraft is $109.428 million per unit. In this contract, the SAR model costs 41% of the maritime model ($45.048 million/$109.428 million = 41%). This ratio is used to recalculate the theoretical single fleets for the Cyclone and the Cormorant. It is assumed that the per-unit cost of an army version falls between these values ($77.238 million per aircraft). These numbers are at a production quantity of 50 aircraft.

Cormorant (production quantity of 120+):
14 SAR models at $40.015 million (amount from 1998 contract with economy of scale factor added) = $0.560 billion
28 maritime models at $97.598 million ($40.015 million/41%) = $2.733 billion
100 army models at $68.807 million (($40.015 million + ($97.598 million - $40.015 million)/2) = $6.881 billion
Updated single fleet of Cormorants: $0.560 billion + $2.733 billion + $6.811 billion = $10.104 billion

Cyclone (production quantity of 112+)
28 maritime models at $63.9576 million = $1.791 billion
14 SAR models at $26.223 million ($63.9576 million * 41%) = $0.367 billion
100 army models at $45.09 million (($26.223 million + ($63.9576 million - $26.223 million)/2) = $4.509 billion
Updated single fleet of Cyclones: $1.791 billion + $0.367 billion + $4.509 billion = $6.667 billion

Estimated Fuel Costs (Table 4.6)

Griffon- 389 litres per flying hour
At $0.50 per litre of fuel, 389 * 0.50 = $194.50 per hour
At $0.80 per litre of fuel, 389 * 0.80 = $311.20 per hour
2015/2016 Griffon total fuel cost at $0.50 per litre of fuel: $194.5 * 25258 = $4,912,681
2015/2016 Griffon total fuel cost at $0.80 per litre of fuel: $311.20 * 25258 = $7,860,290

Sea King/Cyclone- 535 litres per flying hour
At $0.50 per litre of fuel, 535 * 0.50 = $267.50 per hour
At $0.80 per litre of fuel, 535 * 0.80 = $428.00 per hour
2015/2016 Sea King total fuel cost at $0.50 per litre of fuel: $267.50 * 6912 = $1,848,960
2015/2016 Sea King total fuel cost at $0.80 per litre of fuel: $428 * 6912 = $2,958,336
2015/2016 Cyclone total fuel cost at $0.50 per litre of fuel: $267.50 * 162 = $43,335
2015/2016 Cyclone total fuel cost at $0.80 per litre of fuel: $428 * 162 = $69,336

Cormorant- 855 litres per flying hour
At $0.50 per litre of fuel, 855 * 0.50 = $427.50 per hour
At $0.80 per litre of fuel, 855 * 0.80 = $684.00 per hour
2015/2016 Cormorant total fuel cost at $0.50 per litre of fuel: $427.50 * 5573 = $2,382,458
2015/2016 Cormorant total fuel cost at $0.80 per litre of fuel: $684 * 5573 = $3,811,932

Chinook- 1,355 litres per flying hour
At $0.50 per litre of fuel, 1355 * 0.50 = $677.50 per hour
At $0.80 per litre of fuel, 1355 * 0.80 = $1,084.00 per hour
2015/2016 Chinook total fuel cost at $0.50 per litre of fuel: $677.50 * 2787 = $1,888,193
2015/2016 Chinook total fuel cost at $0.80 per litre of fuel: $1084 * 2787 = $3,021,108

Total Fuel Costs
2015/2016 fleet fuel cost at $0.50 per litre of fuel: $4,912,681 + $1,848,960 + $43,335 + $2,382,458 + $1,888,193 = $11,075,627
2015/2016 fleet fuel cost at $0.80 per litre of fuel: $7,860,290 + $2,958,336 + $69,336 + $3,811,932 + $3,021,108 = $17,721,002

Theoretical single fleet of Cyclones fuel cost
At $0.50 per litre of fuel: $267.50 * 40692 = $10,855,110
At $0.80 per litre of fuel: $428 * 40692 = $17,416,176

Theoretical mixed fleet of Cyclones and Griffons fuel cost
At $0.50 per litre of fuel: ($267.50 * 20346) + ($194.50 * 20346) = $5,442,555 + $3,957,297 = $9,399,852
At $0.80 per litre of fuel: ($428 * 20346) + ($311.20 * 20346) = $8,708,088 + $6,331,675 = $15,039,763

Potential Fuel Savings
Current Fleet versus single fleet of Cyclones
At $0.50 per litre of fuel: $11,075,627 - $10,855,110 = $220,517 per year ($220,517 * 20 = $4,410,340 in savings over 20 years)
At $0.80 per litre of fuel: $17,721,002 - $17,416,176 = $304,826 per year ($304,826 * 20 = $6,096,520 in savings over 20 years)
Current Fleet versus mixed fleet of Cyclones and Griffons
At $0.50 per litre of fuel: $11,075,627 - $9,399,852 = $1,675,775 per year ($1,675,775 * 20 = $33,515,500 in savings over 20 years)
At $0.80 per litre of fuel: $17,721,002 - $15,039,763 = $2,681,239 per year ($2,681,239 * 20 = $53,624,780 in savings over 20 years)

Table A1.3 - In-Service Support Present Value Calculations ($ billions) (Table 4.7)

Year	Defence Inflation	Cormorant (1998)	Cyclone (2004)	Chinook (2009)
		0.591	3.2	2.5
2003	0.2%		3.200	
2004	2.9%		3.293	
2005	1.7%		3.349	
2006	2.2%	0.591	3.422	
2007	1.2%	0.598	3.464	
2008	3.5%	0.619	3.585	2.500
2009	0.7%	0.623	3.610	2.518
2010	0.1%	0.624	3.613	2.520
2011	2.6%	0.640	3.707	2.586
2012	1.6%	0.650	3.767	2.627
2013	2.8%	0.669	3.872	2.700
2014	1.5%	0.679	3.930	2.741

Present Value (01 January 2015)	[redacted]	$0.679	$3.930	$2.741

Defence Inflation Source: Assistant Deputy Minister (Finance), "DND Economic Model."

Per year In-Service Support (Table 4.8)
Cyclone: $3.93 billion / 22 = $178.6 million per year ($6.4 million per aircraft per year)
Cormorant: $679 million / 7 = $97 million per year ($6.5 million per aircraft per year)
Chinook: $2.741 billion / 20 = $137.1 million per year ($9.1 million per aircraft per year)
Total: $178.6 million + $97 million + $137.1 million = $412.7 million per year ($8.254 billion for 20 years)

ANNEX B: CHAPTER 5 CALCULATIONS

Table A2.1 - Status Quo Personnel Savings: Regular Force and Reserve Force Positions

Pilots/Community	Establishment	Manning	Difference
Griffon	12	11	1
Chinook	14	8	6
Sea King	16	8	8
Cormorant	6	4	2
3 CFFTS	33	31	2
Technicians/Community		Subtotal	19
Griffon	18	18	0
Chinook	18	13	5
Sea King	27	20	7
Grand Total			**31**

19 Captains: $133,800 * 19 = $2,542,200 annual savings
12 Master Corporals: $99,900 * 12 = $1,198,800 annual savings
Total Savings: $2,542,200 + $1,198,800 = $3,741,000 annual savings ($74.8 million over 20 years) for the status quo option

Table A2.2 - Moderate Centralization Personnel Savings: Regular Force

Sqn	Maj	Capt	MWO	WO	Sgt	MCpl	Cpl	Transfer to Central Training	Remain at OTU	Savings
403	1	8						5[248]	4[249]	0
438			0	0	4	10	0	10[250]	0	4[251]
406	2	16	1	2	5	12	3	26[252]	4[253]	11[254]
442	1	4						2[255]	2[256]	1[257]
450	1	12	1	1	4	8	0	15[258]	3[259]	9[260]
Total								58	13	27[261]

248 1 Maj, 4 Capt.
249 4 Capt.
250 10 MCpl.
251 4 Sgt.
252 1 Maj, 8 Pilot Capt, 1 AERE Capt, 2 WO, 2 Sgt, 12 MCpl.
253 4 Capt.
254 1 Maj, 3 Capt, 1 MWO, 3 Sgt, 3 Cpl.
255 2 Capt.
256 2 Capt.
257 1 Maj.
258 6 Capt, 1 WO, 8 MCpl
259 3 Capt.
260 1 Maj, 3 Capt, 1 MWO, 4 Sgt
261 3 Maj, 6 Capt, 2 MWO, 13 Sgt, 3 Cpl

Table A2.3 - Moderate Centralization Personnel Savings: Reserve Force[262]

Sqn	Capt	MWO	Sgt	MCpl	Transfer to Central Training	Remain at OTU	Savings
403	3				1	2	0
438		1	3	1	2[263]	0	3[264]
406	0	0	1	3	0	0	4[265]
442	1				1[266]	0	0
450	1	0	0	4	0	1[267]	4[268]
Totals					4	3	11[269]

Moderate Centralization Total Savings:
3 Reg Force Majors: $167,200 * 3 = $501,600 annual savings.
6 Reg Force Captains: $133,800 * 6 = $802,800 annual savings.
2 Reg Force Master Warrant Officers: $126,800 * 2 = $253,600 annual savings.
11 Reg Force Sergeants: $106,400 * 11 = $1,170,400 annual savings.
3 Reg Force Corporals: $91,800 * 3 = $275,400 annual savings.
3 Res Force Class A Sergeants: $232 * 12 * 12 * 3 = $100,224 annual savings.
8 Res Force Class A Master Corporals: $218 * 12 * 12 * 8 = $251,136 annual savings.
Total savings: $501,600 + $802,800 + $253,600 + $1,170,400 + $275,400 + $100,224 + $251,136 = $3,355,160 annual savings ($67.1 million over 20 years) for the moderate centralization option.

Table A2.4 - Complete Centralization Personnel Savings: Regular Force

Sqn	LCol	Maj	Capt	CWO and MWO	WO	Sgt	MCpl	Cpl	Transfer to Central Training	Transfer to Op units	Savings
403[270]	0	2	17	1	2	2	5	0	5[271]	5[272]	19[273]
438[274]	0	0	0	0	0	4	10	5	10[275]	0	9[276]

[262] Savings rate are calculated using 12 working days per month.
[263] 1 Class B MWO, 1 Class B Sgt
[264] 2 Class A Sgt, 1 Class A MCpl.
[265] 1 Class A Sgt, 3 Class A MCpl.
[266] 1 Class B Capt.
[267] 1 Class A Capt.
[268] 4 Class A MCpl.
[269] 3 Class A Sgt, 8 Class A MCpl.
[270] Complete centralization involves disbanding the operational training flight and the standards section of the standards and simulation flight.
[271] 1 Maj, 4 Capt.
[272] 3 Capt (for 403 Sqn Sim), 2 MCpl (For FE OTF).
[273] 1 Maj, 10 Capt, 1 MWO, 2 WO, 2 Sgt, 3 MCpl.
[274] Complete centralization involves disbanding the technical training section and the aviation/avionics training section.
[275] 10 MCpl.
[276] 4 Sgt, 5 Cpl.

406[277]	1	5	30	3	4	14	12	5	26[278]	11[279]	37[280]
442[281]	0	1	4	0	1	5	0	1	2[282]	0	10[283]
450[284]	0	1	14	1	3	9	14	2	15[285]	7[286]	22[287]
Total									58	20	97[288]

Table A2.5 - Complete Centralization Personnel Savings: Reserve Force

Sqn	Capt	MWO	WO	Sgt	MCpl	Cpl	Transfer to Central Training	Savings
403	4	0	0	2	2	0	1[289]	7[290]
438	0	1	0	3	1	0	2[291]	3[292]
406	3	1	3	5	5	1	0	18[293]
442	1	0	0	1	0	0	1[294]	1[295]
450	3	0	0	0	8	0	0	11[296]
Total							4	40[297]

Complete Centralization Total Savings:

1 Reg Force Lieutenant Colonel: $183,600 * 1 = $183,600 annual savings.
6 Reg Force Majors: $167,200 * 3 = $1,003,200 annual savings.
36 Reg Force Captains: $133,800 * 36 = $4,816,800 annual savings.
1 Reg Force Chief Warrant Officer: $138,000 * 1 = $138,000 annual savings.
3 Reg Force Master Warrant Officers: $126,800 * 3 = $380,400 annual savings.
5 Reg Force Warrant Officers: $115,700 * 5 = $578,500 annual savings.
27 Reg Force Sergeants: $106,400 * 27 = $2,872,800 annual savings.
5 Reg Force Master Corporals: $99,900 * 5 = $499,500 annual savings.
13 Reg Force Corporals: $91,800 * 13 = $1,193,400 annual savings.
9 Res Force Class A Captains: $312 * 12 * 12 * 9 = $404,352 annual savings.
1 Res Force Class A Master Warrant Officers: $283 * 12 * 12 * 1 = $40,752 annual savings.

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[277] Complete centralization involves disbanding 406 Sqn.
[278] 1 Maj, 8 Pilot Capt, 1 AERE Capt, 2 WO, 2 Sgt, 12 MCpl.
[279] 1 Maj, 5 Capt, 1 MWO, 1 WO, 3 Sgt (For ACSO/AESOp OTF)
[280] 1 LCol, 3 Maj, 16 Capt, 1 CWO, 1 MWO, 1 WO, 9 Sgt, 5 Cpl
[281] Complete centralization involves disbanding 442 Sqn operational training flight.
[282] 2 Capt.
[283] 1 Maj, 2 Capt, 1 WO, 5 Sgt, 1 Cpl.
[284] Complete centralization involves disbanding the 450 Sqn operational training flight.
[285] 6 Capt, 1 WO, 8 MCpl
[286] 1 WO, 2 Sgt, 4 MCpl (for FE OTF).
[287] 1 Maj, 8 Capt, 1 MWO, 1 WO, 7 Sgt, 2 MCpl, 2 Cpl.
[288] 1 LCol, 6 Maj, 36 Capt, 1 CWO, 3 MWO, 5 WO, 27 Sgt, 5 MCpl, 13 Cpl.
[289] 1 Class B Capt.
[290] 3 Class A Capt, 2 Class A Sgt, 2 Class A MCpl.
[291] 1 Class B MWO, 1 Class B Sgt
[292] 2 Class A Sgt, 1 Class A MCpl.
[293] 3 Class A Capt, 1 Class A MWO, 3 Class A WO, 5 Class A Sgt, 5 Class A MCpl, 1 Class A Cpl.
[294] 1 Class B Capt.
[295] 1 Class A Sgt.
[296] 3 Class A Capt, 8 Class A MCpl.
[297] 9 Class A Capt, 1 Class A MWO, 3 Class A WO, 10 Class A Sgt, 16 Class A MCpl, 1 Class A Cpl.

3 Res Force Class A Warrant Officers: $256 * 12 * 12 * 3 = $110,592 annual savings.
10 Res Force Class A Sergeants: $232 * 12 * 12 * 10 = $334,080 annual savings.
16 Res Force Class A Master Corporals: $218 * 12 * 12 * 16 = $502,272 annual savings.
1 Res Force Class A Corporals: $206 * 12 * 12 * 1 = $29,664 annual savings.
Total savings: $183,600 + $1,003,200 + $4,816,800 + $138,000 + $380,400 + $578,500 + $2,872,800 + $499,500 + $1,193,400 + $404,352 + $40,752 + $110,592 + $334,080 + $502,272 + $29,664 = $13,087,912 annual savings ($261.8 million over 20 years) for the complete centralization option.

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