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RCAF SIXTH-GENERATION AIR COMBAT CAPABILITY CONSIDERATIONS

Squadron Leader Bart Birrell

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RCAF SIXTH-GENERATION AIR COMBAT CAPABILITY CONSIDERATIONS

AIM

1. The aim of this Service Paper is to discuss the implications of the development of the 6th Generation Fighter Aircraft on the Royal Canadian Air Force (RCAF).¹ This topic is relevant to the RCAF Aerospace Warfare Centre (notably its Air and Space Power Development Centre) and the Director General of Air and Space Force Design. The analysis within the Service Paper will generate recommendations for consideration in future doctrine and force design activities.

INTRODUCTION

2. This paper will discuss the 6th Generation Fighter Aircraft, as a future important RCAF capability decision. It examines air combat capability as a whole, vice solely the fighter aircraft, given the concepts that are being considered for 6th Generation capabilities. A 6th Generation fighter capability (6th GFC) is important to the RCAF, and the broader Canadian Armed Force (CAF) writ large, as a key enabler to the strategic vision outlined in Canada's *Strong, Secure and Engaged* defence policy.² Even though Canada is yet to select its new fighter, it is still important to discuss and identify the implications of the development of the next 6th GFC.³

3. To begin, this paper will define the 6th GFC as a capability. It will then provide examples of developments and concepts being considered by Allied and non-Allied actors. Subsequently, the paper will provide insight into the development methodologies that are being explored and used to design, build and test 6th Generation capabilities, predominantly using the United States Air Force (USAF) Next Generation Air Dominance (NGAD) program as a case study. The discussion will conclude by outlining the importance of a 6th GFC to the RCAF, and the implications which need to be considered given NGAD could be in service with the USAF by 2030.⁴

DISCUSSION

¹ This topic answers question A14 for Air and Space Force Development in the JCSP topics list. "What are the implications for the RCAF with the development of 6th Generation fighter aircraft and/or Unmanned "Loyal Wingman" Combat Aircraft? Gen Charles Brown (USAF COS) sees 6th Gen more about how fighters are procured and produced in a distributed modular fashion and less about the systems and capabilities on board."

² Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy*: Government of Canada, 2017, 14.

³ At time of writing the Canadian *Future Fighter Capability Project* down-selected to the F-35, a 5th Generation fighter, and the Gripen-E, a 4th Generation fighter.

⁴ Air Force Magazine, "New Force Design: NGAD Needed Soon, F-22 Sunset Begins in 2030", last modified 13 May 2021, <https://www.airforcemag.com/new-force-design-ngad-needed-soon-f-22-sunset-begins-in-2030/>.

4. This section of the paper will discuss the 6th GFC by defining what it entails, outline the importance of considering its introduction into service with the RCAF and its allies, identify potential implications, and recommend courses of action. This discussion will analyse the PRICIE-G and Canadian industry considerations related to a 6th GFC, both being important to Force Design and government approval processes.⁵ Of importance to Canada is the need to remain interoperable with the USAF following the introduction of NGAD in 2030.⁶

6th Generation Fighter Capability Definition And Characteristics

5. Using the terminology and concepts of the USAF NGAD program, a 6th GFC will involve a mixture of *manned* and *unmanned* systems.⁷ USAF Chief of Staff General Brown briefed that the 6th GFC will be a highly integrated *system of systems* which forms a complete air combat capability.⁸ At the centre of this system will be the 6th Generation fighter aircraft.⁹ As the new fighter will be built upon the technological advancements of the previous generations, it will therefore likely possess most of their attributes – but with significant advancements.

6. Stealth is likely to be included however, future conflicts will include significant Anti-Access / Area-Denial (A2/AD) mission sets for NGAD. These missions will require NGAD to employ stand-off and long range weapons, to overcome improved detection capabilities and extended ranges of future anti-air missiles of the A2/AD operating environment. This could result in stealth technology being reduced or removed, from the design of some NGAD variants or weapon systems.¹⁰ Additional technologies that are

⁵ PRICIE-G is the Canadian method of assessing and defining a capability. The acronym stands for: Personnel; Research and development / operations research; Infrastructure and organization; Concepts, doctrine and collective training; Information Management; Equipment Supplies and Services; and Gender Based Analysis – plus (GBA+); Government of Canada, “2019-2020 Department of National Defence departmental progress report for Canada’s National Action Plan on Women, Peace and Security”, last accessed 08 January 2022, <https://www.international.gc.ca/transparency-transparence/canada-national-action-plan/2019-2020-progress-reports-rapports-etapes-dnd.aspx?lang=eng>.

⁶ In the US, NGAD is required to enter service by 2030 due to the commencement of the F-22 Raptor withdrawal.; Air Force Magazine, “*New Force Design: NGAD Needed Soon* . . .

⁷ This paper will use a mixture of gender related terms when discussing capabilities. When the term is italicised it reflects the wording from the cited sources; DUrso, Stefano. *The Aviationist - Automattic Inc.: The U.S. Air Force has Secretly Built and Flown A Full-Scale Demonstrator of its Next Generation Fighter*. Chatham: Newstex, 2020.

⁸ “Full Committee Hearing: “Department of the Air Force Fiscal Year 2022 Budget Request,”” House Armed Service Committee (HASC) video, 3:02:00, posted by “HASC,” 16 June 2021, <https://armedservices.house.gov/2021/6/full-committee-hearing-department-of-the-air-force-fiscal-year-2022-budget-request>; A *system of systems* can be further defined as “the collection of individual and independent systems that are brought together for specific goals”; Konur, Dinçer, Hadi Farhangi, and Cihan H. Dagli. “A Multi-Objective Military System of Systems Architecting Problem with Inflexible and Flexible Systems: Formulation and Solution Methods.” *OR Spectrum* 38, no. 4 (2016): 967-10.

⁹ Air Force Magazine, “*Brown: NGAD Will be a Multirole Fighter*”, last modified 16 June 2021, <https://www.airforcemag.com/ngad-multirole-fighter-f-35-block-4/>.

¹⁰ Business Insider, “*Why big plans for 6th-generation fighter jets may not work out*”, last modified 10 Nov 2021, <https://www.businessinsider.com/why-plans-for-6th-generation-fighter-jets-may-not-work-2021-11>; Hendrix, Jerry. “*The U.S. Navy’s Range has Diminished Dangerously*.” The Wall Street Journal. Eastern

likely included in NGAD relate to: improved performance engines to deliver high efficiency across all flight regimes, up to and including super-cruise; signature management; stand off and long range weapon systems, including directed energy weapons; advanced electronic warfare; and the ability to conduct a limited multi-role mission.¹¹ A significant attribute of the 6th Generation fighter will be its ability to control and operate with *unmanned aircraft*.¹² Little is known – due to limited US disclosure in the public domain – about the design requirements of the 6th Generation NGAD. What is known is that it will regularly evolve, as will the weapon systems that integrate with it.

7. The US will design and introduce 6th GFCs every five to eight years, utilising the following principles put forward by Dr Will Roper, the former USAF Assistant Secretary for Acquisition, Technology, and Logistics: agile software development; modular, open-systems architecture; and digital engineering.¹³ This will result in multiple 6th GFC types and their supporting systems being in service concurrently. Furthermore, they will have reduced periods of service, and receive no upgrades or life extensions.¹⁴ The US have designated the aircraft produced using these concepts as the *eSeries*.¹⁵

8. A key advantage to this rapid methodology is that the US, as well as allies that also adopt it, can regularly outpace threat actors by obtaining and maintaining *transient advantage*.¹⁶ The intent of transient advantage is to design a short to medium term capability state, which is temporary in nature, but enables an actor to more immediately and effectively counter a threat.¹⁷ Furthermore, the US is not the only ally seeking incremental capability states. Australia is pursuing a *Transient Capability Advantage* through *Plan Jericho*, with the intent of bringing disruptive warfighting capabilities against an adversary.¹⁸

Edition, 2021, Eastern; The Drive, “*The Air Force Might Make Two Distinct Versions Of Its Next Multirole Stealth Fighter*”, last modified 17 June 2021, <https://www.thedrive.com/the-war-zone/41138/the-air-force-might-make-two-distinct-versions-of-its-next-multirole-stealth-fighter>.

¹¹ Australian Defence Business Review, “*NGAD – Developing the next generation air combat system*”, last modified 12 September 2021, <https://adbr.com.au/ngad-developing-the-next-generation-air-combat-system/>; Air Force Magazine, “*Brown: NGAD Will be a Multirole Fighter*”, . . .; Business Insider, “*Why big plans for 6th-generation fighter jets may not work out*”, . . .

¹² Air Force Magazine, “*Future Fighter Force*”, last modified 22 July 2021, <https://www.airforcemag.com/article/future-fighter-force/>

¹³ DUrso, Stefano. *The Aviationist - Automattic Inc.* . . .

¹⁴ DUrso, Stefano. *The Aviationist - Automattic Inc.* . . .

¹⁵ Secretary of the Public Affairs / Published, September 14. *SECAF Unveils New "eSeries" Classification in Nod to Department's Digital Future*. Washington: Federal Information & News Dispatch, LLC, 2020.

¹⁶ Australian Strategic Policy Institute, “*Special Report – Projecting National Power: Reconceiving Australian air power strategy for an age of high contest*”, 2019, last accessed 08 Jan 2022, https://ad-aspi.s3.ap-southeast-2.amazonaws.com/2019-08/SR%20142%20Projecting%20national%20power.pdf?VersionId=QeRRGJoyHVP0x2SH_8p.527emrIPiXaa.

¹⁷ Albon, Courtney. “Air Force Finalizes NGAD Acquisition Strategy.” InsideDefense.Com's Aircraft Alert (2020).

¹⁸ C. Wrigley *et al* “*Air Force by Design: Applying Design for Transient Capability Advantage*”, 2020, 60, last accessed 08 Jan 2022, https://www.researchgate.net/publication/338902280_Air_Force_by_Design_Applying_Design_for_Transient_Capability_Advantages.

9. The following section will discuss how the evolution of the 6th GFC in the US will impact Canada. The US intends to continuously upgrade and evolve its capabilities using rapid design, production and introduction into service methodologies. A key characteristic of this concept is that it is highly likely the US will build and introduce aircraft to fulfil niche roles in the *systems of systems* construct, or whenever there is a capability advantage to do so.¹⁹

Importance Of 6th Generation Development To Canada

10. The development of a 6th GFC is of strategic importance to the RCAF, as well as the CAF writ large. In particular, a 6th GFC addresses some of the essential requirements that defence is required to do “to succeed in an unpredictable and complex security environment”, as outlined in Canada’s defence policy *Strong, Secure, Engaged (SSE)*.²⁰ There are also important implications for the RCAF.

11. With the US fielding a 6th GFC as early as 2030, Canada needs to consider the impacts to its abilities to meet the SSE strategic vision and success requirements.²¹ Three key impact areas related to these requirements are:

a. *Field an agile, well educated, flexible, diverse and combat ready military.* Given the planned arrival period of a 6th GFC, the RCAF may struggle to meet this SSE requirement. This will be due to the fact the RCAF will either be employing a 4th Generation fighter (Gripen-E) or 5th Generation fighter (F-35), and will not be fully educated on employing next generation capabilities. Furthermore, agility may suffer given a 4th or 5th Generation fighter may not be relevant to global threats or interoperable with the US and other allies. Budgetary implications are not included as part of this assessment, though would be a factor the department needs to manage and discuss with Government.

b. *Act as a responsible, value-added partner with NORAD, NATO and Five-Eyes partners.* Interoperability will be a key RCAF consideration with the arrival of the 6th GFC. In order to add value to NORAD and NATO mission requirements, the RCAF must be able to contribute to the *system of systems* fighting force.²² In order to gain *transient advantages* over the threat, the US will update the 6th GFC every five to eight years, using the *digital acquisition* concept discussed above.²³ As such, the RCAF also needs to consider having the ability to update its capabilities to maintain effective interoperability with the US.²⁴ Furthermore, given the global strategic environment, NATO and Five-Eyes partners will consider US interoperability as a future requirement, thus increasing RCAF interoperability risk.

¹⁹ Albon, Courtney. "Air Force Finalizes NGAD Acquisition Strategy." . . .

²⁰ Department of National Defence. *Strong, Secure, Engaged* . . . , 14.

²¹ Air Force Magazine, "New Force Design: NGAD Needed Soon, F-22 Sunset Begins in 2030" . . .

²² Royal Canadian Air Force, *Future Concepts Directive Part 2: Future Air Operating Concept* (Ottawa: DND Canada, 2016), 7.

²³ Acquisition Talk, "Agile, modular, and digital engineering . . .

²⁴ D’Urso, Stefano. *The Aviationist* - Automattic Inc. . .

c. *Field advanced capabilities to keep pace with allies and maintain an advantage over potential adversaries.* Two options to meet this requirement are: form a developmental alliance with the US, and where applicable other allies; and prepare Canadian industry to support the 6th GFC. The first can be achieved by ensuring Canada is a contributor to the US NGAD program. This provides a means to ensure Canada's requirements are considered in developments, or it has the knowledge to update capabilities using sovereign means. The second option is ensuring Canadian defence and aerospace industries are able to produce systems or capabilities that are interoperable with US NGAD systems. This will require Canadian industry to continually field new capabilities in timeframes which meet the needs of defence and consider ally and adversary capabilities.²⁵

Sixth-Generation Fighter Implications Using PRICIE-G

12. Development and introduction of a 6th GFC requires a detailed PRICIE-G analysis to identify additional implications for the RCAF.

13. *Personnel; Research and development / operations research.* Personnel considerations with respect to the development of a 6th GFC will be felt in many areas of the RCAF. Pilot requirements will need to be assessed, given the capability will involve crewed and un-crewed systems working together.²⁶ The *systems of systems* nature of the 6th GFC will also have implications on maintenance and technical trades required to generate serviceable associated weapon systems – the air vehicles, and their associated payloads.

14. Additionally, research and development (R&D) will be required to support continuous evolution of the 6th GFC, including RCAF interoperability to support NORAD, NATO and Five-Eyes, as outlined in the SSE strategic vision.²⁷ R&D will support development, operational employment, and inform future requirements to be included in follow on weapon systems, in response to the threat.

15. *Infrastructure and organization.* It is likely the RCAF's current fighter force will not support a 6th GFC. Given the capability will come with advanced technologies and sensitive materiel, security requirements will likely increase and a need to protect the systems from the physical environment²⁸. Furthermore, in order to meet NORAD and NATO requirements and support exercises or operations in Canada, additional infrastructure may be needed to support allies operating 6th Generation capabilities. Should Canada not select the F-35 as its future fighter aircraft, the transition from 4th to 6th Generation infrastructure will be larger, more expensive and riskier.

²⁵ Department of National Defence. Strong, Secure, Engaged . . . , 74, 78, 113.

²⁶ Australian Defence Business Review, "NGAD – Developing the next generation air combat system" . . .

²⁷ Department of National Defence. Strong, Secure, Engaged . . . , 14.

²⁸ Security requirements include those for the physical and information security environments.

16. The RCAF will need to create organisations to support the Mission Data requirements of a 6th GFC.²⁹ This capability needs data for its advanced electronic warfare sub-systems, as well as artificial intelligence (AI), which controls the behaviours of the un-crewed systems.³⁰

17. *Concepts, doctrine and collective training.* Operating concepts, doctrine and collective training will require detailed assessment should the RCAF acquire or interoperate with a 6th GFC. The RCAF will need to understand and prepare for collective training and operations that include *systems of systems*, some of which will be un-crewed and autonomous air vehicles that operate based upon AI or minimal human control. The earlier the RCAF understands how they will train and operate with a 6th Generation capability, the sooner operating concepts and doctrine can be updated to ensure effective employment.

18. The RCAF will need early engagement with policy makers at all levels, to understand the employment of, or the requirement to, operate with un-crewed or autonomous systems. This is required to ensure CAF policy pre-exists for these operational scenarios, and ensures Canada complies with international laws and conventions.

19. *Information Management.* A detailed assessment of this element will need to be conducted, dependent upon whether Canada procures or needs to interoperate with 6th GFCs. Areas for consideration may include: a requirement to transfer or store intellectual property sensitive to Canada and its allies; a need for additional *cyberworthy* computer systems to support the capability during its development and operational phases; data to support mission planning of all systems; and means to process, exploit and distribute intra and post mission data.³¹

20. *Equipment Supplies and Services.* Given the US will be the primary designer, manufacturer and user of the 6th GFC, International Traffics in Arms Regulations (ITAR) considerations must be addressed. This could impact Canadian industry involvement through reduced opportunities during manufacturing and sustainment. To lessen the impact Canada should investigate focussing its industry on producing systems that can integrate with the 6th Generation fighter at the core of the *system of system*.

21. *Gender Based Analysis+ (GBA+).* Canadian capabilities require a GBA+ assessment. Given allies call the un-crewed components of a 6th GFC *Loyal Wingman* or *unmanned*, Canada should be prepared to identify a gender neutral naming convention.

²⁹ Qinetiq, “Mission Data Explained”, last accessed 15 Jan 2022, <https://www.qinetiq.com/en/what-we-do/services-and-products/mission-data-explained>.

³⁰ Raytheon Intelligence and Space, “Six predictions for the 6th-gen fighter,” last accessed 15 Jan 2022, <https://www.raytheonintelligenceandspace.com/news/feature/six-predictions-6th-gen-fighter>.

³¹ The Cove, “Australia’s Defence and National Security: How Defence is enhancing Australia’s cyber resilience,” last accessed 15 Jan 2022, <https://cove.army.gov.au/article/australias-defence-and-national-security-how-defence-enhancing-australias-cyber-resilience>.

CONCLUSION

22. The introduction of a 6th GFC by Canada or its allies will have implications for the RCAF. The SSE strategic vision requires interoperability with the US, which will be operating a 6th Generation fighter as early as 2030. Furthermore, Canada will need to be prepared to adapt to the concept where a 6th GFC is updated every five to eight years, and is likely only in service for 15 years. This will be a new paradigm for Canada, and it will have implications for R&D, acquisition, in-service support, industry, concept design and doctrine, and interoperability with 6th Generation allies.

23. Mitigation of these implications is achievable if Canada remains engaged with the US and includes the 6th GFC in future Force Design considerations – as an interoperability requirement and future acquisition consideration. Canada will also be successful in transitioning to a world with 6th Generation fighters, if it acquires the F-35 – providing a means to simplify transition from 5th to 6th Generation, vice 4th to 6th.

RECOMMENDATIONS

24. The following recommendations to CAF leadership are based upon the potential implications to the RCAF with the development of a 6th GFC.

25. *RCAF Future Fighter Capability Project.* Once the Government of Canada has confirmed the outcome of the Future Fighter Capability Project, the CAF should conduct Force Design activities which consider the arrival of a 6th Generation fighter to the USAF and future RCAF 6th GFC requirements.

26. These activities should consider how the CAF will remain interoperable with the US, while meeting its SSE mandated NORAD commitments. Furthermore, this Force Design activity should trigger Defence Research and Development Canada to conduct an operational research task to determine threat capabilities in the five-, ten- and twenty-year epochs, and the necessary capabilities the RCAF should have to remain *capability relevant* and meet SSE direction.

27. The Force Design activity will need to consider conducting two PRICE-G analyses. The first is to analyse the requirement to maintain interoperability with a 6th Generation US and understand changes that need to occur with the RCAF, and CAF writ large. A second analysis will be required to determine the fundamental inputs to capability required to support a 6th GFC in the RCAF.

28. *Canadian Defence and Aerospace Industry.* An assessment should be conducted into the ability of Canadian industry to support the development, manufacture, and support of a 6th GFC. This assessment is necessary to inform industry strategy going forward, as the Government of Canada will wish to identify opportunities for local industry. Noting the rapid development of the initial fighter capability by the US, and the short periods between new fighter types, it is likely Canadian industry may not be able to be involved with the 6th Generation fighter at the core of the *system of systems*. As such,

the assessment should identify areas where Canadian industry can contribute to other systems in the 6th GFC – for example, payloads, un-crewed air vehicles, weapons.

29. *Sixth-Generation Fighter Capability Cooperation.* It will be important to identify opportunities for dialogue with the US on the development and employment of the 6th GFC. The CAF, through Force Design and RCAF leadership, should investigate methods of establishing regular dialogue on the development and introduction of 6th GFCs within the US Department of Defense. This will facilitate future working groups, or other such forums, where Canada can contribute to the development of the fighter, should it choose to acquire the capability, or provide awareness on how interoperability will be maintained when the US introduces the 6th GFC

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