National Defence Défense nationale

Canadian Forces College

Collège des Forces Canadiennes

# CANADIAN AEROSPACE : APOGEE TO PERIGEE

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## JCSP 44

## Exercise *Solo Flight*

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## PCEMI 44

## Exercice *Solo Flight*

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Canada

CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES

JCSP 44 – PCEMI 44
2017 – 2019

EXERCISE *SOLO FLIGHT* – EXERCICE *SOLO FLIGHT*

# CANADIAN AEROSPACE: APOGEE TO PERIGEE

By Major Peter McRae

# CANADIAN AEROSPACE: APOGEE TO PERIGEE

"*Decisions around Canadian policy are made in Canada by Canadians*."

Right Honourable Justin Trudeau
- NATO leaders summit in Brussels, May 2017

Canada is a first world, middle power with aspirations for global influence. However, since the nation's 'coming of age' at Vimy Ridge in 1917 and the considerable war efforts during the Second World War, there have been inconsistent efforts to balance the timber of Canada's international voice with domestic policy and perceived fiscal prudency. This has included the early support of soft power and quickly seizing opportunities to realize peace dividends. It has seen shifting support from NATO to the United Nations peace support missions and back again. It has also seen governments choosing to invest in specific national technologies or partner with allies to achieve some lofty goal. There can be no doubt that it is a challenge for any government to find the perfect mix of national interest and international involvement while ensuring the voting populace is supportive of the associated costs. Canada is no exception to that truism, and in no stream is this challenge more prevalent than in national aerospace capability.

This paper will explore the impacts of decisions Canada has made regarding its investments, monetarily and intellectually, in the realm of sovereignty and security based aerospace assets, to argue that future decisions must weigh independent capability versus interdependent collaboration through a different lens. Specifically, this paper will make the argument that, should Canada continue along its current niche market trajectory in the realm of space based surveillance systems (SBSS), the nation is placing its ability to exercise sovereignty in jeopardy through a lack of forward thinking investments in nationally owned, operated and controlled multi-sensor SBSS.

The paper will approach that argument through the examination of historical and existing national aerospace capabilities and the transitional state of our major alliances. The paper will also highlight some significant pros and cons of independent capabilities versus allied dependencies in the realm of SBSS.

**Stage Setting**

Canada is acknowledged as the second largest country in the world by landmass. It has the longest coastline, the seventh largest Economic Exclusion Zone[1] and asserts ownership of significant internal waterways based on the United Nations Convention on the Law of the Sea and an Archipelagic State view of its Arctic islands. Canada's claims to sovereignty over large portions of the High Arctic are not universally accepted, and the ability to prove those claims is based, at least partially, on the ability to monitor and control what occurs within the claimed territory. With the bulk of the population clustered within 200 nautical miles of the Southern border, multiple First Nations peoples and an immensely diverse immigrant population, abundant natural resources, and vast tracks of unspoiled and marginally habitable land, Canada is a complex environment to control and govern. It is equally difficult to govern territories and peoples when there is no clear picture of the extent of everything. It should be surprising, concerning and a relief that Canada finished mapping its claimed territories at the 1:50,000 scale in the year 2012[2]. Indeed, 65 years of effort was required to complete that daunting challenge, and it would have been longer had it not been for the availability of Space Based Earth Observation technologies and techniques. Unfortunately, the optical imagery sources were not owned by the government of Canada, so some of the final delays involved negotiating and funding contracts that would allow for the use of the derived mapping data for public consumption.

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[1] https://www.worldatlas.com/articles/countries-with-the-largest-exclusive-economic-zones.html

[2] https://www.canadiangeographic.ca/article/2013-gold-medal-winners-nrcan-mapping-information-branch

As far back as the 1950s Canada has embarked on a slippery slope of achieving cost savings through alignment with and dependence on the capabilities of our Allies. This could be inferred from the termination of the costly AVRO Arrow [3] program and the subsequent purchase of the BOMARC missile system[4]. The 1960s were a hectic period of space science development, with Canada near the forefront of many of the advances. The fifties and sixties may have been the golden age for Canadian aeronautics and space sciences. While Canada has maintained some excellence in these fields, our astronauts and space robotics are acknowledged assets; we are no longer the font of promise that we were. It could be said that NASA and Boeing are built upon the strong skeleton of the Canadian aerospace experience.

In the last five decades this past capability erosion has further expanded into the realm of nationally owned space based surveillance and imaging systems whereby Canada has become almost wholly dependent upon allied or commercial systems. The exceptions to this have been the niche capability of Synthetic Aperture RADAR (SAR) systems. While being able to contribute this one specialty to our allies is seen as a worthwhile effort, and the benefits to domestic commercial interests are clear, it still leaves Canada as a nation with no inherent on demand mapping or imagery surveillance capability. We are about to invest $2 billion CDN over 24 years (build yet another CANADARM) for the Lunar Gateway, and get some technology set up for Moon Base Alpha and the USA Space Force.

There are obvious benefits for a medium power such as Canada to be able leverage the vastly superior capabilities of our allies; however, there are potentially significant demerits also. Alliances can become unwieldy, they can become dormant, and they can be abandoned altogether by key members. The primary benefit of leveraging allies' capabilities is that lower or no investment can be made. The primary negative is that one cannot expect a guarantee of access at all times. In light of the changes and threatened changes to how some of Canada's key Allies conduct business, it behoves the nation to have a solid backup plan.

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[3] Campagna, P. *The Avro Arrow: For the Record.* Toronto, ON: Dundurn Press, 2019, pg2

[4] https://www.thecanadianencyclopedia.ca/en/article/bomarc-missile-crisis

**The Brightness of the Past**

After the Second World War, the increased industrial potential of Canada was infused with technologically savvy and scientifically inclined citizens (both returning and new) who had benefitted from the technology explosion necessitated by the war. Leading minds in aeronautics, ballistics, RADAR, communications, aerial mapping and other technologies dotted the Canadian academic, industrial and political landscapes. The CF105 Avro Arrow was a direct outshoot from the coalescence of some of these factors and actors. At the time of its development, the Arrow was a technological wonder, with some of its capabilities only surpassed decades after it was shelved.

Canada was the third space faring nation in the world, after the USSR and USA. There was a permanent space exploration and vehicle delivery rocket launch site at Fort Churchill, Manitoba, as early as 1959. There were multiple temporary rocket launch sites across the country (Nova Scotia, Quebec, North West Territories) expressly for launching space science research equipment. Canadian innovation was proven with the success of the Canadian conceived, designed, built and launched Alouette I ionospheric research satellite in Sep 1962[5] . The success of Alouette I lead to an international cooperation effort (International Satellites for Ionospheric Studies) for Alouette II in 1965, and several more joint satellite efforts, predominantly with the USA. Canada also made significant advances in the realm of synthetic aperture RADAR (SAR) systems, with RADAR SATELLITE (RS) 1 and RS2 both outperforming their forecasted life expectancies. RS2 is still a viable commercial satellite today and could well remain so for another decade. Not only did Canada conduct pioneering work in space science equipment and vehicles, there was extensive rocket and propellant development undertaken as well.

Early signs of Canada's desire to push technology to the commercial sector are displayed as elements of DeHavilland Aerospace (latter SPAR Aerospace and then MacDonald Detwiller) and RCA Montreal were heavily involved in the Alouette programs. There were also some

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[5] Shepherd, G., Kruchio, A. *Canada's fifty years in space: the COSPAR anniversary*. Burlington, ON: Apogee Books, 1971.pg 128

telltale indications regarding the potentially fickle position of the USA on use and sharing of Earth Observation systems information. The NASA ERTS system collected satellite based imagery over the entire continental North America, but they were initially unwilling to share and Canada considered launching a formal complaint[6] of this violation of the Chicago Accord (involuntary imaging of one nation by another without permission).

On the Aeronautical side, in 1959 A.V. Roe was the third largest firm in Canada next to Canadian Pacific Railway and the Aluminum Company of Canada[7], with several successful experimental concepts turned into highly viable craft like the C102 Jetliner and CF-100 CANUCK. The Avro ARROW was showing excellent promise and was arguably leading edge technology across all facets of materials, fabrication, design and capabilities[8]. The unexpected and poorly explained decision of C.D. Howe to discontinue the Jetliner may have been a foreshadowing of the later cancellation of the Arrow and the subsequent demise of A.V. Roe.

**Potentia intermissis**

The Avro Arrow program was cancelled in 1958 for multiple reasons reported or conjectured, and there was a resulting exodus of highly skilled aeronautical field employees to European or USA firms and organizations. Twenty-five of the top engineers ended up at NASA working multiple lunar projects from John Glenn's capsule through Gemini and Apollo, and one individual was instrumental in the development of the Concorde[9]. Regardless of the validity of the cancellation reasons, which form the basis for numerous volumes, the resulting negative impacts to the Canadian aeronautical industry and the broader economy and technology development fields (it was postulated that 650 firms and 100,000 Canadians were directly impacted and indirect impacts were incalculable[10]) are arguably present to this day.

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6 Shepherd, G., Kruchio, A. *Canada's fifty years in space : the COSPAR anniversary*. Burlington, ON: Apogee Books, 1971. Pg 153.

7 Campagna, P. *The Avro Arrow: For the Record.* Toronto, ON: Dundurn Press, 2019. Pg 3

8 Ibid. Pg 23

9 Ibid. Pg 5

10 Campagna, P. *The Avro Arrow: For the Record.* Toronto, ON: Dundurn Press, 2019. Pg 4.

While the Canadian space program flourished for another decade, government decisions again reduced the overall fields of advancement and soundly removed Canada from a leadership role in many fields. Rocketry experimentation substantially ended in 1967 after the successful completion of the Black Brant V launch in April and the conclusion of the McGill University's High Altitude Research Project in June[11] of the same year. In 1984, the same year Marc Garneau made history as the first Canadian in space aboard the space shuttle Challenger, the Fort Churchill Rocket Launching Facility closed as a government cost savings initiative[12], putting a definitive end to Canadian rocketry experimentation. The irrevocable decision to depend upon the launch capabilities of the USA, other Allies or commercial entities had, intentionally or otherwise, been made. Combined with the de facto dissolution of any Canadian capability to produce viable fighter aircraft, Canada signalled its willingness to be dependent on others in fields of technology that it had been a leader in.

**Alliance Reliance**

Canada has no inherent military aircraft industrial capability. With the demise of the Avro Arrow, the loss of that highly qualified workforce and a lack of government will, the aeronautical industry turned away from, and likely became incapable of, manufacturing viable fighter aircraft of any description. Upon the completion of the CF-100 Canuck sub-sonic fighter program, Canada began outsourcing all future RCAF fighter planes. The news in April of 2019 is that the government will put out a call for tenders on new fighter aircraft to replace the aged and used temporary replacement aircraft that will replace and augment the truly aged CF18's currently in service. One or some of our Allies will have the vendor(s) that will eventually fill our fighter requirements.

Similarly, Canada has no inherent, Crown owned, space based electro-optical or RADAR imaging capability as of 26 May 2019. Canada uses a combination of commercial contracts and

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[11] Godefroy, A. *The Canadian space program : from Black Brant to the International Space Station*. Chichester, UK: Springer Praxis Publishing, 2017.Pg 96.

[12] Shepherd, G., Kruchio, A. *Canada's fifty years in space : the COSPAR anniversary*. Burlington, ON: Apogee Books, 1971. Pg 170.

alliance, multilateral or bilateral based programs. The average price of a commercial satellite image is, with a conservative rough order of magnitude, $30USD[13] per km$^2$. With Canada having approximately 9.9 million km$^2$ landmass, imaging the country would cost $400,326,108.75 CDN (23/04/2019 conversion rates). In order for Canada to maintain truly accurate geospatial data (roads, infrastructure, land usage changes, etc.) with acceptable risk managed gaps, ten percent of the country should be imaged every year. The utility of space based imagery in domestic emergency response should be understood as a significant enabler to effective response. While natural disasters normally cause an international charter to be invoked, allowing for free satellite imagery to become available, national security issues do not enjoy that privilege.

This does not include Canada's expeditionary interests. What we get from our allies for the flanks of NATO, the UN missions we engage in, the coalitions of the willing we participate in, could easily dwarf our domestic governance requirements in volume, frequency and therefore cost. These costs must be borne by someone, and if it is not Canada then we are once again reliant upon our allies.

The lessons of alliances are that they only survive as long they advance the interests of the members, at an acceptable cost[14]. The further lessons learned about alliances would be that while they may have begun to achieve a unified end state, for example the defeat of Hitler's Germany or the resistance against the spread of communism, the individual member states still serve their own national self interest first. The United Kingdom experienced this with both the late entry of the USA in WWII and with the USA approach to the Zionist movement in the Palestine Mandate[15] prior to the end of WWII and immediately after and again more significantly in regards to the Suez Crisis of 1957. In the latter case, the USA effectively issued an ultimatum

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13 http://www.landinfo.com/LAND_INFO_Satellite_Imagery_Pricing.pdf

14 Herd G. and Kriendler J. *Understanding NATO in the 21st century : alliance strategies, security and global governance*. New York, NY. Routledge, 2013. Pg 1.

15 Mumford, A. *Counterinsurgency wars and the Anglo-American alliance : the special relationship on the rocks*. Washington, DC: Georgetown University Press, 2017. Pg 47.

for the British to withdraw their forces or face bankruptcy[16]. The two steadfast allies approached the entire Middle East with similar desired outcomes, namely a peaceful and Western friendly region, with entirely different game plans. Their approaches to the problems of the rest of the world can be no less diversified.

The ebb and flow of the larger NATO alignment is not new, and is, as could be expected, exacerbated by the number of participants. The organization existence is challenged by the actions, or lack thereof, of individual member states fairly regularly. Most recently, the President of the USA has taken to task all NATO partners who have not met the two percent of gross domestic product contribution numbers. Not long ago, the European Union expressed frustration with the USA's activities in Iraq and a lack of interest to fund it[17]. One of the newest of westernized alliances, called the FIVE EYES, has been downgraded to four eyes and come back to five again after a dispute between the USA and New Zealand occurred and was resolved. The point of this is that alliances are fickle, and the Canada USA relationship cannot be viewed any differently.

In a 1969 Washington Press Club speech, Prime Minister Pierre Trudeau famously said about the USA that *"Living next to you is in some ways like sleeping with an elephant. No matter how friendly and even-tempered is the beast, if I can call it that, one is affected by every twitch and grunt,"* It should be very clear to any who pay any attention to current affairs that there have been significantly more grunts and twitches since the 2016 USA Presidential elections than during the previous three or four administrations.

What then must we make of the ongoing reliance of Canada on her allies, especially the USA, for access to military aviation assets and SBSS data? In the case of military hardware, it is generally a contractual commercial concept under the authority of government agreements.

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[16] Mumford, A. *Counterinsurgency wars and the Anglo-American alliance : the special relationship on the rocks*. Washington, DC: Georgetown University Press, 2017. Pg 21.

[17] Hay, W. Sicherman, H. *Is there still a west? : The future of the Atlantic alliance*. Columbia, Missouri: University of Missouri Press, 2007. Pg 183.

When it comes to accessing nationally owned or controlled SBSS data, such commercial interactions are less prevalent. Canada, as a Middle-Power, participates in group activities (alliances, coalitions, UN missions) in part to influence the other participants towards Canada's worldview, and in part to be a solid global citizen[18]. This is entirely in line with the thought that middle powers cannot act effectively by themselves[19], but does not support the optics if not reality of Canada taking a fare reduced or free ride. While Canada does contribute within the bilateral through multilateral partnership spectrum, often 'punching above its weight', the prospect of being viewed as a net debtor in the relationships cannot be shrugged off. When it comes to contributions of SBSS data to bilateral and multilateral missions, Canada is not currently in a position to contribute much substance. This is a relationship negative from our allies' perspective. Should Canada's views on global affairs diverge too strongly from those of key allies, our ability to provide value to that relationship will come under increased scrutiny. It is not a great mental leap to imagine a strongly opinionated and 'nation first' ally leader to take punitive action by limiting access to their resources, including SBSS.

**Capabilities Maintained**

This paper does not claim that Canada has relegated itself to complete incompetency in the aerospace domain. There are commercial aerospace ventures such as Bombardier or MacDonald, Dettwiler and Associates (MDA) to name just two, which have global markets and expertise. Canada has an effective track record with its astronaut program and maintains government sponsored expertise in the field of space robotics (the CANADARM series have gained some renown). Satellite building potential in general has been maintained through the various communications systems built by Canadian firms in concert with government, and especially RADAR Satellite expertise. Research and Development within industry, the Canadian

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[18] McLin, J. *Canada's changing defense policy, 1957-1963 : the problems of a middle power in alliance*. Baltimore, Maryland: John's Hopkins Press. 1967. Pg 213.

[19] Haglund, D. *New NATO, new century : Canada, the United States, and the future of the Atlantic alliance*. Edited by Haglund, D. Kingston, ON: Queen's University, Centre for International Relations, 2000. Pg 191.

Space Agency and defence research spheres also have been fostered along primarily scientific lines, and a clear acknowledgement that placing any of these technologies in space requires either commercial agencies or allied assistance. Our ability for and commitment to collaborative efforts in the USA Lunar Gateway in the provision of another version of the CANADARM is therefore within our expertise, however its contribution to mutual security is a stretch of imagination. It should not be considered as any form of alliance contribution so much as a desire to have some claim to use of the proposed space station and further access to future lunar and space exploration.

**The path to our future**

The RADAR Satellite Constellation Mission (RCM), an unclassified system, that has a planned launch date sometime in 2019 (currently June) is a step in the right direction. This three vehicle SAR constellation will be completely owned by the Government of Canada, thereby allowing the full sharing with our allies. It answers an important requirement for Maritime Domain Awareness, especially when combined with the international vessel Automated Identification System (AIS) data. It will also be useful for domestic terrestrial elevation modelling and land use determination, and can be used in coherent change detection procedures that assist with some expeditionary intelligence requirements. However, the primary regions that RCM was designed to focus on do not cover all the regions Canada can expect to conduct expeditionary operations in, nor the vast areas where our allies have ongoing concerns. Further, to be truly useful in a detection and surveillance role, it needs companion electro-optical (multi-spectral/hyper-spectral/ Infra Red/Near Infra Red) sensors. While these sensors exist in the capabilities of some of our allies, access to another nation's asset is never guaranteed in a timely fashion, or at all. In the same vein that our allies continually asses their own ability to provide independent sources of SBSS data that compliment their own requirements as well as the various alliances' needs, Canada should not be complacent in the belief that the niche of RADARSAT data can satisfy the growing appetite for SBSS sources.

Prime Minister Justin Trudeau announced the commitment of approximately two billion dollars over 24 years toward the Lunar Gateway, which will undoubtedly have some spill over benefits in the space development fields. While space exploration is a laudable goal, and could lead to a future refuge for humanity, it does not contribute directly to our ability to identify and manage challenges here on Earth. With RCM costing roughly half of the Lunar Gateway investment, albeit over a much shorter time, Canada could be well served to at least consider the construction of electro-optical small satellite constellations that compliment RCM to address the here and now.

**Conclusion**

This paper has explored the impacts of decisions Canada has made regarding its investments in the realm of aerospace assets to argue that the continued focus on the niche market of RADAR satellite is placing its ability to exercise sovereignty in jeopardy through a lack of forward thinking investments in nationally owned, operated and controlled multi sensor SBSS.

The impacts of decisions during the 1950s and 1960s in the aeronautical field have created a scenario where Canada is entirely dependent on allies for fighter aircraft production capability. While Canada is not unique in this respect, relying on the USA (and others) for equipment puts the nation at a distinct disadvantage.

Similar decisions in the realm of SBSS, would have similar implications towards dependence on allies for critical intelligence derived from such systems. The ability to leverage allies' data is an excellent cost saving measure until such time as payment is demanded or the data assets are otherwise unavailable. Reluctant allies are not the only possible impediment to SBSS data access, and relying on only one type of Canadian owned source (RCM) is the very essence of placing all of one's eggs in a single basket. Future SBSS investment decisions must be made with a view to national asset independence and alliance asset redundancy.

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