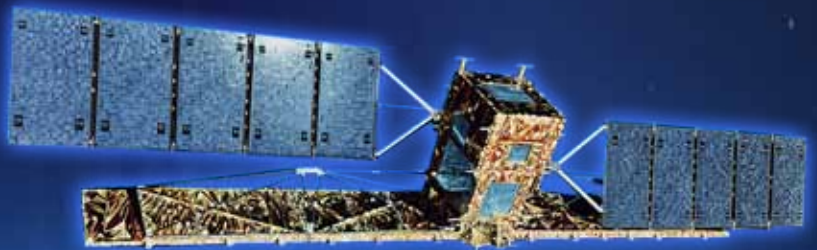


STAR WARS^{eh.?}

*A Case Study of Canada's Role
in the Militarization of Outer Space*

By Raymond Kenneth Mackinnon



Humankind has recorded only 52 short years in space since the launch of Sputnik 1 on 4 October 1957. More poetically, the late astronomer Carl Sagan claimed, “Man has only waded in the shores of the cosmic ocean.”¹ In this brief period, the exploration and exploitation of space revolutionized how both space faring and non-space faring states worked, played, and conducted war. Civilian advancements in the “Final Frontier” proved a remarkably uniting endeavour after the cold war. Communication satellites bolstered notions of a global village, of cultures and economies connected over vast distances. Above, the International Space Station is the most ambitious international collaborative effort human civilization has ever attempted. American space exploration during the Mercury, Gemini, and Apollo programmes inspired a generation of youth to explore the infinite expanses of outer space. The lunar plaque enshrined on the Apollo 11 Lander claimed the United States (US) went to the moon “in peace for all mankind” and stands as a testament to the ostensibly peaceful paradigm of outer space exploration.² Yet, the Apollo programme also serves as a reminder of space exploration that emerged from the cold war. For the United States to claim peaceful intentions in a space race born of competition between two superpowers ignores entirely the struggle for international prestige and control of outer space during the conflict between the East and West.³

With all the attention garnered by the United States and Soviet Union, it is little known that Canada played a significant role in the exploration of space. In an effort to contribute to this underdeveloped historiography, this paper explores the military initiatives that provided the impetus for Canadian efforts in space, arguing that the cold war was a significant factor in Canada’s space exploration. Further, adherence to the popular belief that outer space is a “sanctuary” ignores significant historical

evidence to the contrary. The 2007 anti-satellite demonstration by the People’s Republic of China and the 2008 response by the United States suggests that failing to acknowledge outer space as a potential arena for war may prove detrimental to military forces that rely on space-based assets in future conflicts.

The cold war fear of exchanging nuclear salvos with the Soviet Union had an important impact on Canada’s space exploration and continental defence. Canada adopted a niche role fulfilling both domestic and international goals by focusing on technology that benefited the Canadian public and often synchronized with American research objectives. Canada’s Defence Research Board (DRB) worked alongside the US Army and Air Force, providing significant contributions toward ballistic missile research. It was DRB scientist R. J. Sutherland who first articulated the concepts of “first strike” and “second strike,” a significant contribution to the cold war strategic lexicon.⁴ American initiatives linked to Canadian national defence necessitated collaboration between the two countries. North American Air Defence (NORAD), the strongest example of the Canada-United States (CANUS) relationship, was formalized in 1957–58. As the relationship grew during the post-Second World War era, Canada was not completely subservient to the demands of the United States in regards to continental defence.

Canada-US relations did not ignore Canada’s strategic and political objectives. Canada declined full partnership in investments deemed too expensive, or those that proposed to alter the nuclear status quo, namely the space transport system (also known as the STS or space shuttle) in 1972, and President Ronald Reagan’s 1983 Strategic Defense Initiative (SDI) respectively.⁵ Canadian space research and technology frequently involved projects that resulted in the militarization of outer space, including three shuttle missions that used the Canadarm for placing US military satellites into space. Further, Canadian politicians feared the US might use Reagan’s



proposed space station Freedom as a testing lab for SDI research. Considering also the military capabilities of the 1982 search and rescue satellite aided tracking (SARSAT) system and the 1995 radar satellite (RADARSAT-1), these projects offer significant indications that Canada supported the militarization of outer space.⁶

In addition to Canada's partnership with the United States, Canada supported several international treaties regulating military activity. Canada ratified the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (better known as the Outer Space Treaty) and protested the SDI's transgression of the 1972 Anti-Ballistic Missile (ABM) Treaty. Although these documents suggest international agreement on limiting the militarization of outer space, a cursory examination reveals limited adherence to documents with little real coercive power.

The United Nations attempted to regulate the conduct of space-faring nations during the cold war, most notably the United States and Soviet Union. In particular, the Outer Space Treaty prohibited weaponization, yet it had loopholes and inconsistencies that allowed both the United States and Soviet Union to pursue activities directly related to national security during the cold war. Important to note is the clause which "called upon States to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction."⁷ This statement first appeared in the United Nations General Assembly adoption of the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space in October 1963 and eventually formed Article IV of the Outer Space Treaty. Article IV also forbade "the establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies,"⁸ but noticeably did not apply these restrictions to outer space itself; the testing and placement

was illegal, but not the use of these weapons.⁹ The varying interpretation of treaties during the cold war was most notable in US space policy; however, it also affected Canadian cooperation with the US on issues that threatened to move away from the treaty. These are discussed below in relation to their corresponding projects. First, it is crucial to outline Canada's earlier contributions to outer space security and how they benefited both military knowledge and capabilities during the cold war.

The Canadian government formally supported early research efforts in space science and technology through the National Research Council (NRC) and the DRB. The DRB was created in 1947 and led by Chairman Omond Solandt until 1956. The DRB focused on defence research previously conducted by the NRC during the Second World War and focused on aspects at which Canadians excelled and that were directly applicable to Canada.¹⁰ In what became defining characteristics of civilian space policy, it was clear to Solandt that a widely varying climate and vast geography necessitated respective developments in meteorology and communications.¹¹ These research areas had civilian objectives but also supported military needs, including anti-ballistic missile weapon systems and studies of missile re-entry into the upper atmosphere.

A DRB subsidiary based in Valcartier, Québec, the Canadian Armament Research and Development Establishment (CARDE), actively pursued research in "the counter-[inter-continental ballistic missile] ICBM problem"¹² and focused on developing an understanding of ballistic missile re-entry signatures.¹³ In the words of Chief Superintendent, Brigadier D. A. G. Waldock, "The primary problem we are concerned with today is defence against the ballistic missile."¹⁴ CARDE also studied "aerodynamics, ballistics, electronics, physics, chemistry, explosives and mechanical engineering."¹⁵ CARDE did not work in isolation; the United States invested several million dollars per year into CARDE's research. American capital invested in joint CANUS projects

funded collaboration between the DRB and the American Department of Defense (DoD) at CARDE, Fort Churchill, Manitoba, and other installations.¹⁶

The first stage of the relationship was from 1955 to 1960 when the DRB and United States Air Force (USAF) collaborated on ballistic missile defence research. It was recognized as early as the 1960s that ABM programmes were vulnerable to multiple independent re-entry vehicles. These warheads were designed to fool ABM missiles into destroying decoys and allowing nuclear warheads to slip through defences. Scientists noted that the decoys presented different re-entry wakes compared to actual warheads because of difference in weight. Dr. Gerald Vincent Bull, known for his work on "superguns," headed CARDE's Aerophysics Department and directed the research. At CARDE, he managed the development of experiments designed to simulate missile re-entry and to study the wakes of varying ICBM models.

Termed "gas guns," these experiments used a low-pressure vacuum to mimic atmospheric conditions whilst firing varying miniatures resembling ballistic missiles.¹⁷ They were fired on a range 780 feet (238 metres) long. Ultimately, CARDE tested 25 different ICBM replicas at speeds approaching Mach 5.¹⁸ CARDE excelled in this research, with both experience and infrastructure. From 1964 to 1971, CARDE made "observations of gaseous radiation, ablation and wake phenomena exhibited by projectiles travelling at hypersonic speeds through the controlled atmospheres of the tanks."¹⁹ This research developed an understanding of the characteristics of missile re-entry into the atmosphere because the ability to distinguish between decoy and real warheads was critical in establishing a credible second-strike capability.

The DRB also studied the medium through which the missiles would pass: the aurora borealis. The DRB's Director of Weapons Research Dr. Gordon Watson observed that

the newly established Prince Albert Radar Laboratory (PARL) under the jurisdiction of the Defence Research Telecommunications Establishment had the capability to study the aurora borealis and was able to follow rockets launched from Fort Churchill and satellites passing overhead. From its origin, PARL was defence focused. Watson noted, "The unit has been instrumented primarily to obtain extensive data on aurora reflections at high levels and at ranges comparable with those required for the detection of ballistic missiles and satellites."²⁰ Without a full understanding of the aurora borealis, scientists feared that it could be used to mask or screen incoming missiles.²¹

Defence research was not limited to understanding the variables associated with Soviet missiles; CARDE actively pursued research directly related to anti-ballistic missile defence. CARDE worked closely with the USAF at Fort Churchill while testing the DRB's Black Brant rocketry programme.²² Although the sounding rockets carried experiments that were often civilian in nature, CARDE's research into solid-state fuel was a crucial military development for northern missile defence. Solid-state fuel was preferred over liquid primarily because "immediate readiness is the keynote in any defence against ballistic missiles. This weighs heavily in favour of solid propellants, which can sit on launchers for long periods of time."²³ In addition, solid-state fuel was more reliable in arctic temperatures.²⁴

The military-civilian relationship functioned well. In cooperation with the Bristol Aircraft Company based in the United Kingdom, CARDE developed the rocket propellant while the Bristol plant in Winnipeg manufactured the rockets. Early successes in 1959 led to collaboration with Canadair Limited, redesigning and perfecting the rocket. After years of collaboration, CARDE withdrew from the programme in 1964 and turned over full responsibility to the Canadian branch of Bristol Aerojet Limited, who in turn became Bristol Aerospace Limited and sold rockets to the National Aeronautics

and Space Administration (NASA) and others around the world.²⁵

Interestingly, CARDE's research was not limited to defence scientists. Civilian university programmes also assisted defence-related projects. The *Centre de Recherches sur les Atomes et les Molécules* (CRAM) was created in 1967 and allowed CARDE scientists to supervise theses from Université Laval students in Québec. As Alain Gelly noted, military-civilian cooperation had occurred since the DRB's founding and further, "[i]n 1967, DRB delegated responsibility to its defence research laboratories for awarding research grants and contracts to industry and academia."²⁶ Defence research in Canada was therefore not exclusive to the DRB but extended into both corporations and universities.

In the spirit of defence cooperation, Canadian defence scientists collaborated with the US Advanced Research Projects Agency (ARPA) and made valuable contributions to cold war research that received significant praise

south of the Canadian border. The United States acknowledged CARDE's expertise in ballistic missile studies. This fostered a working relationship between Canadian defence scientists and the USAF. As a member of the Tripartite Technical Cooperation Program alongside the United States and United Kingdom, CARDE and the Royal Canadian Air Force (RCAF) collaborated with ARPA in a multi-stage research endeavour called Project Lookout. Lookout I conducted research into radiation given off by ballistic missiles launched from Cape Canaveral, and after the completion of Lookout I, research began on Operation TABSTONE (LOOKOUT II in Canada).

TABSTONE was designed to investigate "measurements of the launch phase characteristics of ballistic missiles"²⁷ for the US Missile Infrared Decoy and Ship Engagement Model. In the summer of 1961, 28 launches were made from Patrick Air Force Base in Florida. Successes led to collaboration on Lookout III where CARDE and ARPA monitored emissions from the new Atlas and Titan rockets.²⁸



In retrospect, Canadian and American rocketry and space science collaboration during the 1950s and 1960s supported many projects relating to defence while simultaneously promoting pure science.

Although rocketry proved immensely successful for both countries, the CANUS defence relationship today has become nearly synonymous with continental defence. Perhaps the most popularized defence relationship between the United States and Canada is the joint effort in North American Air Defence, responsible for safeguarding the sovereign airspace of North America.²⁹ Eminent political scientist Joseph Jockel noted that prior to NORAD's founding in 1957–58, Canadian and American air defences were becoming “increasingly intertwined, both geographically and operationally.”³⁰ The Pinetree Line (operational in 1954), Distant Early Warning (DEW) Line (operational in 1957), and Mid-Canada Line (operational in 1958) were designed to detect incoming Soviet aircraft, facilitate command and control of CANUS air assets, and monitor North American air space.³¹

US interests did not dominate the air defence of North America. The organization's official mandate was to “provide National Command Authorities (NCAs) in Ottawa and Washington with timely, reliable and unambiguous attack warning and attack assessment.”³² As Joel Sokolsky observed, “It has been a cornerstone of Canadian defence policy that the United States would not undertake the air defence of North America unilaterally.”³³ NORAD is a clear example of Canadian military involvement in continental defence, exemplifying both the CANUS relationship and cold war nuclear paradigm.

Canada's position in the northern hemisphere was the primary reason for this agreement: the US anticipated Soviet aircraft and missiles following a trajectory over Arctic territory and passing through Canadian airspace. Moreover, Soviet bombers carrying nuclear weapons over Canada presented a

clear risk to Canadian territory.³⁴ Although the bomber threat was a concern during the 1960s, it never took precedent over the fear of intercontinental ballistic missiles. The Soviet Union deployed less than 200 Bison and Bear bombers, but by 1972 maintained over 2,000 operational missiles pointed towards North America.³⁵ When the Soviet threat shifted from bombers to ballistic missiles, NORAD's responsibility shifted respectively from airspace to aerospace.

Canada's satellite programmes maintained military use during and after the cold war, exemplifying a duality in civilian and military usage noted by Dr. Andrew Godefroy.³⁶ Launched in 1982 and declared operational in 1985, SARSAT supports the duality of space assets with the capability of tracking military beacons on 243.00 megahertz.³⁷ SARSAT is used for aiding downed civilian aircraft and also supports search and rescue operations within the Canadian Forces. Although not referencing the satellite specifically, the 1995 SAR doctrine demonstrates the militarized aspect of Search and Rescue. Section 4.2.1 states: “The primary task of the SAR system in wartime is to support air operations of our own and allied forces with the aim of recovering downed aircrews. In addition, the service is used to recover other armed forces personnel during and after combat activities.”³⁸

The duality of Canadian space programmes is also evidenced in the civilian and military interests derived from the global positioning system (GPS). While today it is utilized often unknowingly in everyday life, the GPS is a converted military project from the 1980s that was designed to land aircraft in remote areas, assist naval vessels in rendezvous and recovery missions, and assist ground forces in using indirect fire.³⁹ Despite limited Canadian assets, the Canadian Forces nevertheless occasionally benefit from the dual usage of the SARSAT and GPS satellites. The use of RADARSAT-1 in Afghanistan demonstrated strategic implications for the deployment of space-based assets in the battlefield.⁴⁰

RADARSAT-1 significantly reduced the impact of the “fog and friction of war” by mapping the mountainous terrain.⁴¹

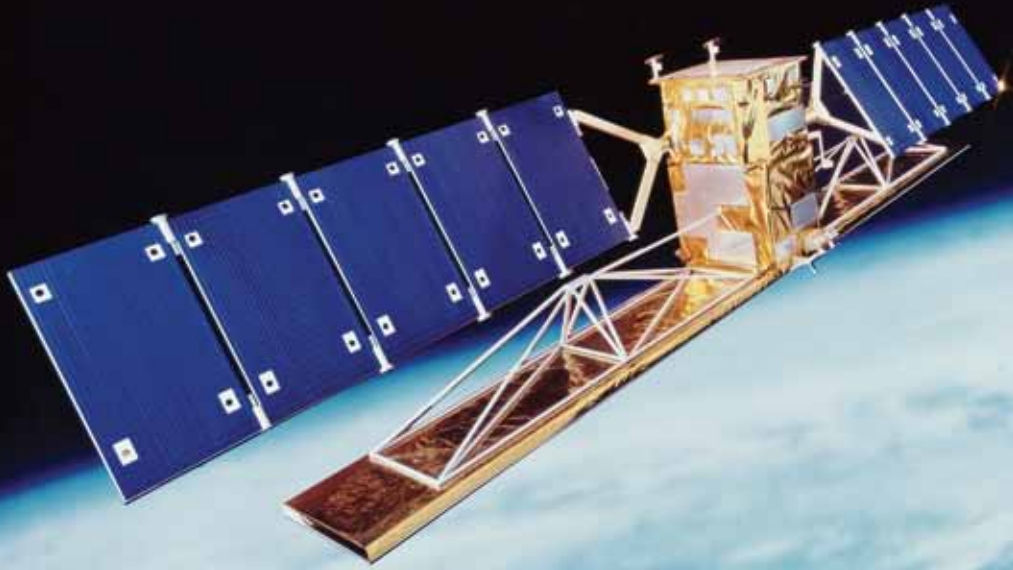
Closer to home, RADARSAT-1 has also assisted Canada’s sovereign claims over the Arctic. In a report presented to parliament in 1987, Member of Parliament (MP) William Tupper suggested that a programme such as RADARSAT-1 would be able to “over-fly the Canadian Arctic every 24 hours, [and provide] detailed information on sea-ice and sea-state conditions, on surface-ship movements in the region, and on the geology of the Arctic land areas.”⁴² Satellite assets will likely continue to play a crucial role over this contested territory as traffic through the Northwest Passage increases. RADARSAT-1 exemplifies the duality of Canadian space technology by utilizing its capabilities to fulfill both military and civilian objectives. As opposed to “swords into ploughshares,” the SARSAT, RADARSAT-1 and GPS satellite programmes with limited budgets maintained civilian and military capabilities simultaneously, and produced relevant, beneficial programmes in both spheres.

Canadian space achievements went beyond satellite programmes. Canada’s contribution to the space transport system (STS) included the Canadarm, the robotic arm used on the shuttlecraft that has proven to be a major source of Canadian international recognition and prestige. Heralded as a triumph of peaceful exploration, the shuttle’s USAF origins are not often acknowledged. Although no longer used exclusively for military launches, the space shuttle programme initially maintained a working relationship between NASA and DoD.

Missions flown for DoD were referred to as “Designated National Security Missions” and included “space activities peculiar to, or primarily associated with national security programmes, associated research and development activities or space operations involving national security objectives.”⁴³ Of note is the 1980 understanding between NASA and DoD

that “the DoD will have priority in mission preparation and operations consistent with established national space policy.”⁴⁴ This was codified in the 1981 National Security Decision Directive 8 that ordered, “in coordination with NASA, the Department of Defense will assure the Shuttle’s utility to defense and integrate national security missions into the Shuttle system.”⁴⁵ The use of the Canadarm in three of the ten military missions from 1985 until 1992 necessarily associates Canada with the militaristic origins of the shuttle system.⁴⁶ Further, primary documentation of the STS programme demonstrates again the military-civilian duality of space exploration and Canada’s contribution through niche-role participation.

The United States also looked to Canada for contributions during the research and development phases of President Reagan’s proposed space station Freedom. Canada joined this project in 1985, a year before the 1986 Challenger explosion delayed the programme until 1993 when the Russians joined during Bill Clinton’s presidency. At that time, the name of the station was changed from Freedom to the International Space Station.⁴⁷ The underlying irony of Freedom’s political overtones is that the United States also considered the station for military use. During negotiations with participating countries, the US delegation required that “any foreign participants recognize and agree that the United States may use the U.S. elements of the space station and the Canadian-provided Mobile Servicing Center for National Security purposes, consistent with U.S. Law and U.S. international obligations, without their consent or necessarily their review.”⁴⁸ The Canadian Standing Committee on Research, Science and Technology expressed deep concerns over this position, recommending to the House of Commons that “Canada proceed with its participation in the Space Station project, provided that agreement be reached with the United States on military use of space station. A minimum acceptable agreement would be the exclusion of weapons or weapons prototype testing from [the] space station.”⁴⁹



The Tupper Report further stated that “overt military use of the space station is unacceptable to the Committee,” and specifically targeted any potential for SDI “experimentation” conducted on the station.⁵⁰ The committee delineated between weaponization research, and programmes related more specifically to militarization, finding that “[o]ne such possible use of [the] space station could be for testing of arms-control verification technologies.”⁵¹ Canadian support for such a use resonates strongly with the American interpretation of “peaceful purposes” that includes defensive uses and national security interests. In this case, Canada supported militarization that fell under the umbrella of peaceful purposes according to US space policy. Canada confronted the issue of stability rather than to militarize or not, a trend also apparent in the decisions made regarding the SDI in 1983.

Canada officially declined to participate in Reagan’s “Star Wars” programme on the basis that it was financially implausible and rendered void the cold war paradigm of nuclear deterrence.⁵² The political, strategic, and technical implications of the Strategic Defense Initiative have been catalogued at length and merit only

brief treatment here in relation to questions of stability and viability. Specifically, “Canadians... concluded that strategic stability and their national security [were] best to be found in the condition of superpower mutual vulnerability.”⁵³ Nuclear strategy specialist Raymond Garthoff observed that scientists on both sides of the Atlantic believed that “a partially effective defense... might be considered adequate against a ragged retaliatory strike.”⁵⁴ The fear that the SDI produced a first-strike threat was central to Soviet distrust of the programme. The Soviet Union’s General Secretary Yuri Andropov stated that defensive weapons, when paired with offensive weapons, produced a first-strike threat; the SDI violated the ABM Treaty; and, finally, the SDI would lead to a renewed arms race.⁵⁵ Union of Concerned Scientists member John Tirman observed that Reagan’s Star Wars speech “was questioning not only the previous emphasis of the US ABM programme, but the whole foundation of post-war nuclear strategy.”⁵⁶

On these grounds, Prime Minister Brian Mulroney stated, “Canada’s own policies and priorities do not warrant a government-to-government effort in support of SDI research”;

however, he continued, “private companies and institutions interested in participating in the program will continue to be free to do so.”⁵⁷ In July 1985, Ronald Purver noted, “Given that most of the work will undoubtedly be done in the US itself, Canada’s share of what remains to be distributed among a dozen or more other countries may not be all that great.”⁵⁸ Purver was correct. The 1990 Report to Congress on the SDI noted that Canada was granted a scarce \$3.48 million and was responsible for research into power systems materials, particle accelerators, platforms, and theatre defence architecture.⁵⁹



Questions of legality plagued the SDI research from its onset. The programme called for the development of technology that,

depending on one’s interpretation, violated Article II of the ABM Treaty. Legitimacy for the SDI hinged on the interpretation of the term “research.” In particular, the phrase “currently consisting of” within Article II of the ABM Treaty determined viewpoints of legitimacy or illegitimacy.⁶⁰ The so-called broad interpretation noted that the SDI did not call for anti-ballistic missile interceptors or launchers as understood in 1972, but technologies purported to become available through SDI research in 1983.

American disregard for the treaty is notable in Reagan’s National Security Decision Directive 192, released on 11 October 1985, which stated, “It is not necessary to authorize the restructuring of the US SDI program towards the boundaries of Treaty interpretation which the US could observe... the issue of where exactly these boundaries should lie is moot even though in my judgment a broader interpretation of our authority in the field is fully justified.”⁶¹ Adherence to the broad interpretation meant that the ABM treaty did not restrict *new* research programmes but allowed the SDI to carry on strictly as a research programme.⁶² Not surprisingly, the Soviet Union and the North Atlantic Treaty Organization (NATO), including Canada, refused to adopt this interpretation.⁶³

Despite the financial, legal, and strategic hurdles, Canada’s refusal to offer official participation in the SDI should not be viewed as advocating for the peaceful use of outer space. Distinguishing between the weaponization and militarization of outer space, Canadian political scientist Douglas A. Ross noted, “It is not in Canada’s interest to encourage the ‘weaponization’ of space in any way. The military use of space for surveillance, early warning and communications has been generally considered stabilizing. To oppose SDI is not to oppose any military presence in space.”⁶⁴ Ross’s implication regarding stabilizing initiatives is crucial: Canadian space exploration (including CARDE’s ballistic missile re-entry research and limitations on



military uses of the space station) emphasized stability in addition to concerns of militarization and weaponization.

Further complicating matters of stability, President Reagan's SDI is an example of high technology vulnerable to low-technology counters. Dr. Elaine Holoboff noted that in 1986 Soviet scientists "estimated [that] counter-measures to the SDI could be deployed for only [five] per cent of the cost of the SDI."⁶⁵ This figure did not include the assumed risks of operating in outer space, including (but not limited to) electronic malfunctions, micrometeorites, harmful radiation, or even collisions with other satellites. Ultimately, debates on the legality or strategic implications pertaining to the SDI became moot with the fall of the Soviet Union in 1991. However, research and discussion on ballistic missile defence remains a realm of ongoing debate within CANUS relations.

The end of the cold war did not transform outer space into a peaceful medium. Although post-cold war developments have been less exuberant, defence research in outer space has continued unabated. Both academic and military literature in the United States and abroad currently debates the question of a fourth service, a space arm to complement the Army, Navy, and Air Force. Deliberation on whether outer space is best understood

from an air, naval, or maritime paradigm is ongoing. While acknowledging the interconnectedness of each service relating to outer space, United States Navy Commander John J. Klein noted that, "Since space is a separate and distinct medium of warfare, military operations and strategy in space should be considered a distinct warfare area."⁶⁶ His recommendation for the eventual establishment of a Space War College

presents several opportunities for CANUS relations: officer education, force development, space-mindedness, and interoperability, to name only a few. In Klein's view, such a programme would include "historical study of strategy and policy, resource allocation, and coalition and joint operations."⁶⁷ Should the US pursue Klein's recommendation, the Canadian Forces would benefit immensely from securing academic positions within such an institute.

The 2008 *Canada First Defence Strategy* noted that, "The Canadian Forces will need to be a fully integrated, flexible, multi-role and combat capable military."⁶⁸ In support of the difficulties of "the absence of any clear understanding of the way in which outer space is likely... to revolutionize thinking about war and peace, and strategy"⁶⁹ (as Dr. James Fergusson pointed out), this case study has argued CANUS cooperation in space research and development has yielded immense benefits in both the military and civilian sectors.⁷⁰ Of greater significance is that "the theory, strategic principles, and doctrine of space warfare need to be well understood at all levels within the military before they are actually needed."⁷¹ Although the Canadian Forces maintain institutions devoted to aerospace studies, continued collaboration with the United States would only enhance the exchange of information.

More importantly, the militarization of outer space since the end of the Second World War supports a strong case that ignoring military space technologies and considering space a sanctuary may be harmful to Western security in the future.⁷² As with naval and air power before it, space power has become inextricably tied to national security. Echoing Clausewitz, aerospace engineer James Oberger suggested, "Space power is the combination of technology, demographic, economic, industrial, military, national will, and other factors that contribute to the coercive and persuasive ability of a country to politically influence the actions of other states... or to otherwise achieve national goals through space activity."⁷³ Space power also depends upon a credible deterrent to actions that challenge one's control of outer space, a deterrent that is irreconcilable with the sanctuary school.

Acknowledging the Canadian successes in both military and civilian space exploration is not only an inclusive history but also fosters "space mindedness" towards the inevitability of a challenge to the command of outer space. During the cold war, the control of the air and aerospace theatres was crucial for Canada as a middle power geographically wedged between the United States and Soviet Union. As such, continental defence with the United States was not a corollary of Canada's aerospace expeditions; indeed, this paper has argued it was a prominent characteristic. Canadian efforts fit with American initiatives where fiscal restraints and political policies would allow.

Canadian achievements under the watch of the DRB and its subsidiaries made significant advances in the scientific understanding of the ionosphere as well as its relationship with ballistic missiles. The radar satellite, the global positioning system, and the Sarsat system developed valuable dual roles as civilian and military assets. Adherence to international treaties and stable nuclear strategies affected the Canadian response to President Reagan's Strategic Defense Initiative and concerns over the militarization and weaponization of space as manifested in both the space transport system and space station projects.

The cold war thus shaped Canada's space exploration and defence research into outer space security, even after the Soviet Union dissolved in 1991. Academic and military frameworks, together with successful anti-satellite demonstrations, clearly depict outer space not only as a viable, but also as an indispensable medium to conduct war. As Andrew Godefroy observed, "It is also likely that the next weapons race will occur in space as treaties on the non-weaponization of space lapse, are circumvented, or simply ignored."⁷⁴ With the American abrogation of the Anti-Ballistic Missile Treaty in 2002, and examples throughout the cold war of political and legal manoeuvrings that breached the spirit of both the ABM and Outer Space Treaties, such a claim appears inevitable. To fall into complacency and assume that modern wars will always square the West against technologically inferior enemies seems the surest way to face defeat. ■

A recent graduate of Queen's University, Raymond MacKinnon is attending York University's Master of Arts programme in Science and Technology Studies. An earlier version of this paper was submitted in Dr. Richard Goette's Canadian Military History class at Queen's University. The author is indebted to Dr. Goette for his guidance and support, without which this paper would not have made it beyond an undergraduate assignment. The opportunity to speak at the 21st Military History Colloquium hosted by the Laurier Centre for Military Strategic and Disarmament Studies allowed Mr. MacKinnon to share this work and receive vital direction from leading scholars. This helped the paper evolve into its current form. Raymond has served in both the Royal Regiment of Canada and Princess of Wales Own Regiment reserve units as a non-commissioned member and is currently considering a career with the Air Force.

List of Abbreviations

ABM	anti ballistic missile
ARPA	Advanced Research Projects Agency
CANUS	Canada-United States
CARDE	Canadian Armament Research and Development Establishment
DoD	American Department of Defense
DRB	Defence Research Board
GPS	global positioning system
ICBM	inter-continental ballistic missile
NASA	National Aeronautics and Space Administration
NORAD	North American Air Defence
NRC	National Research Council
PARL	Prince Albert Radar Laboratory
RADARSAT-1	radar satellite
SARSAT	search and rescue satellite aided tracking system
SDI	Strategic Defense Initiative
STS	space transport system
US	United States
USAF	United States Air Force

Notes

1. Carl Sagan, *Cosmos*, produced and directed by Adriane Malone, et al., Public Broadcasting Service, 1980.
2. The full inscription on the lunar plaque reads, "Here men from the planet earth first set foot upon the moon July 1969, A.D. We came in peace for all mankind." See William E. Burrows, *This New Ocean: The Story of the First Space Age* (Toronto: Random House Inc., 2000), 426.
3. John J. Klein, *Space Warfare: Strategy, Principles and Policy* (New York: Routledge, 2006), 36.
4. Alain Gelly and H. P. Tardif, *Defence Research Establishment Valcartier 1945–1995: 50 Years of History and Scientific Progress* (Ottawa: Minister of Public Works and Government Services Canada, 1995), 114. As Dr. Andrew B. Godefroy recently observed, Canadians often fail to acknowledge their intellectual achievements in defence studies. Andrew B. Godefroy, "Arguing the Unthinkable: Ideas and Debate on Atomic Warfare in the Canadian Army Journal, 1945–1965," paper presented at 21st Military History Colloquium, Laurier Centre for Military, Strategic and Disarmament Studies, May 2010.
5. Gordon Shepherd and Agnes Kruchio, *Canada's Fifty Years in Space: The COSPAR Anniversary* (Burlington: Apogee Books, 2008), 158.
6. The binary opposition of militarization and weaponization appears through this paper, and is understood to mean the following: "Militarization" refers to activities and systems in space used to support military operations. "Weaponization" refers to the placement or basing of weapons in space, whether for offensive or defensive purposes." See Klein, 181n5.
7. United Nations, "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," October 1967, United Nations Treaties and Principles on Outer Space (January, 2010), 10, <http://www.oosa.unvienna.org/pdf/publications/STSPACE11E.pdf> (accessed February 17, 2011).
8. Ibid., 11.
9. Ibid.
10. Andrew B. Godefroy, "Defence and Discovery: Science, National Security, and the Origins of the Canadian Rocket and Space Program," Ph.D. Diss. (Kingston: Royal Military College, 2004), 18.
11. Shepherd and Kruchio, 114.
12. Bill Rawlings, "Turbulent Wakes: Anti-ICBM Research at the Canadian Armament Research and Development Establishment, 1955–1970," Proceedings, 7th Annual Air Force Historical Conference: Canada in NORAD, Colorado Springs, Colorado, United States, June 4–8, 2001, edited by the Office of Air Force Heritage & History, 13.
13. Ibid.

14. A. T. Patton, "Canadian Armament Research and Development Establishment," *The Roundel* 10, no. 6 (August 1958), 12.
15. Ibid.
16. Rawlings, 16–17.
17. Gelly and Tardif, 126.
18. Patton, 13–14.
19. Gelly and Tardif, 139–41.
20. Gordon D. Watson, "Canada's Contribution to Space Science," *The Roundel* 11, no. 7 (September 1959), 3.
21. Sheppard and Kruchio, 83.
22. Godefroy, 19.
23. Patton, 14–15.
24. Godefroy, 83.
25. Gelly and Tardif, 153–154.
26. Ibid., 150–151.
27. Ibid., 144–145.
28. Ibid.
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31. For maps of the radar coverage, see Joseph T. Jockel, *No Boundaries Upstairs: Canada, The United States, and the Origins of North American Air Defence, 1945–1958* (Vancouver: University of British Columbia Press, 1987), xii–xiv. For operational dates, see R. B. Byers, "NORAD, Star Wars, and Strategic Doctrine: The Implications for Canada," in *Aerospace Defence: Canada's Future Role?*, eds., R. B. Byers, John Hamre, George R. Lindsey (Toronto: Canadian Institute of International Affairs, 1985), 37. See also Gelly and Tardif, 113, for a brief overview of the purpose and responsibilities of the radar systems.
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