National Defence Défense nationale

Canadian Forces College

Collège des Forces Canadiennes

CANADIAN UNMANNED AERIAL SYSTEM PROCUREMENT: URGENT FOR THE RIGHT REASONS

Maj A.E. Ambrosini

JCSP 39

Master of Defence Studies

PCEMI 39

Maîtrise en études de la défense

Canada

CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES
JCSP 39 – PCEMI 39

MASTER OF DEFENCE STUDIES – MAÎTRISE EN ÉTUDES DE LA DÉFENSE

CANADIAN UNMANNED AERIAL SYSTEM PROCUREMENT: URGENT FOR THE RIGHT REASONS

Maj A.E. Ambrosini

Word Count: 16 186

Compte de mots: 16 186

CONTENTS

ABSTRACT

History has demonstrated that perpetual technological improvements are a steadfast certainty. Improvements in automation are making every day human life both easier and at the same time more dangerous such as the self-driving cars designed to save lives contrasted with the self-flying machines designed to kill with ease. While the human race has the ability to develop solutions to human challenges, it also has the propensity to develop innovative military applications first such as the nuclear bomb preceding nuclear power production. In the current period of rapid innovation, the world is witnessing a semi-autonomous robotic revolution that is changing the nature of warfare. The latest versions of Unmanned Aerial Systems (UAS) are increasingly capable and becoming pervasive in their use, creating growing security challenges for Canada. The systems' many positive attributes such as their ease of use, stealth, endurance and precision strike capabilities have made them highly attractive to entities that will use them for both security enhancing and, for far more troublesome, destabilizing reasons. Canada urgently needs the Royal Canadian Air Force (RCAF) to acquire long-range long-endurance UAS capabilities and expertise. The acquisition would allow Canada to capitalize on the exploitation of their positive effects to better protect Canada and to avoid being overwhelmed by belligerent entities that have aggressively attained the capabilities. However, the acquisition is currently mired in a vulnerable, complex, and slow procurement process that is not meeting the urgent need. In addition to being overwhelmed by other entities, Canada's uniqueness in its very large land mass and social values that are highly compatible with peace building are important reasons why the systems are urgently needed. Accepting the slow status quo procurement system is leading us to failure as each day that goes by is making the capability gap larger and more difficult to mitigate and overcome. Immediate alternative actions are required by the RCAF to promptly start to grow their UAS capability and expertise such that it will be well developed by

the time a permanent UAS system is finally procured through the Joint Unmanned Surveillance and Target Acquisition System (JUSTAS) procurement initiative.

CHAPTER ONE – INTRODUCTION

> People often go through three stages in examining the impact of future technology: awe and wonderment at its potential to overcome age old problems, then a sense of dread at a new set of grave dangers that accompany these new technologies, followed, finally and hopefully, by the realization that the only viable and responsible path is to set a careful course that can realize the promise while managing the peril.[1]
>
> -Randy Kurtzweil, *The Law of Accelerating Returns*

As members of the military profession it is necessary to attain the right knowledge, skills, and capabilities to perform the duties assigned using the tools afforded by the political leaders. This applies at all levels, from the infantryman using his or her service weapon, to the highest levels where politicians are advised what tools are needed to best accomplish the missions tasked. The means of realizing the ideal procurements, such as Unmanned Aerial Systems (UAS), is wrought with risks. The Canadian political landscape, citizenry, and history of failed and lagging acquisitions suggests that the military and civil leadership have failed to properly communicate the needs effectively. Or that navigating the Canadian military procurement process has somehow failed to deliver as it was intended. These failures provide the reasons to change some of the Canadian Armed Forces' (CAF) methods. The Royal Canadian Air Force (RCAF) is the organization that is needed to take the lead in beginning to grow the Unmanned Aerial System capabilities that will meet the requirements unique to Canada.

Suggesting that Canada chase the latest most innovative UAS technological solution is both expensive and doomed to fail since the pace of developments will invariably outpace any procurement system. However, delaying the acquisition of a capable UAS would be like trying to catch a falling knife; it will only get more perilous as its speed increases. Technological advances

[1] Ray Kurzweil, "The Law of Accelerating Returns," Accelerating Intelligence. Essays, 7 March 2011, Internet last accessed 25 April 2016, http://www.kurzweilai.net/the-law-of-accelerating-returns.

have been, and will remain, a constant as time moves forward. However, just as the accelerating knife, the *pace* of innovation is increasing as will be explained in chapter two. Consider that for many human challenges such as securing of clean water, food and shelter there have been continuously improving solutions. This is the pattern of history. Technology has helped the human population to exponentially increase, and especially over the past 200 years. At year zero, over 2000 years ago, there were less than 300 million people. It took until the 1800 to grow to one billion, and in only the last 200 years or so, it has drastically increased to well over seven billion.[2] That exponential growth was in large part made possible by increasingly capable technology. Technology is used it to supply safe water, produce vast amounts of food and medicine to help people live longer and healthier. Technology is incorporated into homes to keep people safe and comfortable from the elements. It has also made austere areas of the world habitable with imported food and shelter thus expanding yet again the population potential. Technological innovation surrounds Canadian society from the clothes worn to the aircraft used to circumvent the globe. The constant stream of innovations has also augmented humanity's ability to wage war against one another in the pursuit of resources to sustain populations. Canada is a natural resource wealthy sovereign nation with expansive lands and, thus far, has a low population level. Canadians no doubt have what other nations need to sustain themselves. Protecting the nation will only become more challenging demanding that Canada invest now in technologies that will safeguard the future. Preparing for this challenge will take hard work and effective communication to be properly equipped with the right systems that will provide the civilian benefit while managing the military applications.

[2] Population Reference Bureau website, "Human Population: Population Growth," Internet last accessed 1 July 2016, http://www.prb.org/Publications/Lesson-Plans/HumanPopulation/PopulationGrowth.aspx.

In many cases, the civilian benefit of innovation lags from its initial military purpose. Examples include the personal computer which was germinated from the World War II device used to defeat German encryption, civilian air traffic radar which was first used to extend Allied ability to see German aircraft approaches and nuclear energy which was developed as a result of the nuclear bombs used in Japan to end the war. Technological innovations have two sides. The creations can be used for positive benefit like medicine or for negative reasons such as mustard gas. Stated another way, these tools can create or destroy; give life or take it away. It is best to embrace the duality and study the negative side of technology. This is especially important if the RCAF can learn from another's missteps to avoid making those same mistakes. Chapter three will look at the problematic and unpopular use of UAS by the United States. This will provide contrast between the two nations and help define why Canada should acquire long-range long-endurance UAS and with what capabilities to be consistent with Canadian values. To acquire the right UAS solution, the procurement system must be successfully navigated.

The Canadian military capital acquisitions process is a complex system with vulnerabilities built into every step. There are some examples of very timely and efficient procurements such as the Chinook helicopters, where the request for proposals was issued in 2006 with the end state of 15 helicopters delivered by June of 2014.[3] In contrast, Canada also has a solid history of lagging procurements facilitated by this imperfect system such as the Sea King helicopter replacement. However, the military seems to have received what they needed, on time for when they needed it thus far. The Sea King helicopter is Canada's oldest operational aircraft. Yet it is still successfully flying operational missions in support of Canada. It is old, but it continues to perform although not nearly as competently as a newer more capable system. The

[3] Jane's Defence Industry, "Canada Confirms Boeing Chinook Order," Internet last accessed 26 July 2016, https://janes.ihs.com/Janes/Display/1146846.

replacement project for the Sea King began in 1985. The discussion on the replacement had officially begun as early as 1975.[4] An airframe that continues beyond 20 years past its initial planned life speaks volumes to how broken Canadian procurement process can be. Supporting and contributing to the ineffective procurement system is the Canadian military which has been highly successful in extending the life of its aircraft fleets while continuing to succeed at the missions tasked thus far. It is in the exploration of the '*thus far'* that chapter four will navigate the listless status quo that may not be in Canada's best interest moving into the future. The Joint Unmanned Surveillance and Target Acquisition System (JUSTAS) procurement project is, at present, far too similar to the many large procurement projects that have languished in delay. There is no doubt that a UAS will one day be procured, however the pressing need is different for these systems and a more rapid change is required.

UAS technologies are proven to be reliable and valuable. They are increasing in numbers, complexity and capability. Canada has not yet procured a permanent long-range long-endurance RCAF UAS capability, while a large part of the world has already embraced them. Many of those states are known to be belligerent. There is a lot that can be leveraged in terms of knowledge and experience from Canada's southern neighbours with the benefit of not making many of the same errors ourselves. How the United States has been using UAS is not how Canada would use them. This is good to acknowledge since successful procurement will been found in identifying with Canadian values. With the discussion reframed based on urgency and in a way that the majority of Canadians will support, the UAS capability will naturally follow soon after. This research paper will prove that the pace of UAS innovation, the increasing risk of

[4] Aaron Plamondon, *The Politics of Procurement: Military acquisition in Canada and the Sea King Helicopter*, (British Columbia: 2010), preface x.

other entities' UAS use, and the unique Canadian requirements demand urgent and bold action to acquire and grow a UAS capability without further delay.

CHAPTER TWO – TECHNOLOGICAL INNOVATION

The purpose of this chapter is to explore technological innovations including both civilian and military applications. As was explained in the introduction, the rapid human population growth has been enabled by the exponentially evolving technologies that support that growth. This exponential perspective which will mainly be based on the highly visible civilian applications will better capture the present pace of innovation from which point we can consider where the technology is going. From that understanding, semi-autonomous and autonomous robotic systems, the proliferation of robotics, and the various places they are used will be explored. This chapter will discuss on UAS available now with consideration on when the technology was mature enough for Canada to procure them. The chapter will conclude with the technology of long-range and long-endurance systems that are the stated focus of the Canadian procurement objectives within JUSTAS.

Pace of Innovation

Pace of innovation is a key concept in understanding why it is important for RCAF to urgently engage in UAS capability development. The discussion on pace begins within the context of science fiction with a perspective that anything is possible and that all around us marvelous creations are being dreamed and developed. Science fiction is a place where innovative minds can be expressed, while waiting for the technological tools to create those amazing things catches up. Science fiction is simply future reality possibilities. Of course, not all that has been imagined has, or will come to pass. However, there is a strong precedence to suggest that a lot of it will. With an analysis of this concept, it is no longer a leap of faith but rather a logical deduction. An example often cited is the original Star Trek series and the many innovations that were portrayed aboard the Star Ship Enterprise that had yet to be developed. The

automatically opening doors aboard the futuristic space ship were moved by stage hands on the set. Today in modern society, automatic doors are common place and increasingly an expectation. The wireless communication devices were mere props on the movie set, but there are few today who do not have a smart phone with the additional capability of maintaining a constant connection to the internet. For some users, many of its functionalities are voice activated such as the iPhone 6s with the 'always on hey Siri' function.[5] The phone is continuously listening to the user's profiled voice ready to comply with directions. As well, there is a developmental version of smartphone voice interaction which has an element of artificial intelligence called 'Viv'. This 'bot' will be able to answer much more complex questions such as "[w]ill it be warmer than 70 degrees near the Golden Gate Bridge after 5 p.m. the day after tomorrow?"[6] When Star Trek was first aired with these futuristic innovations it was the year 1966. The basic cell phone was first used in 1973 and it is now common place.[7] Another example is the helicopter which would certainly seem alien to anyone living before the time of Leonardo DaVinci and alien to likely all but Leonardo himself 500 years ago. So too will the technological inventions that will be conceived and built in the next several, but far fewer, years. Is Star Trek's warp drive and 'beaming' personnel and equipment impossible? Not according to Steven Hawking. However he does concede that human time travel is improbable anytime soon.[8] Leonardo DaVinci's helicopter with a corkscrew design was realized by rotating individual

[5] Lance Whitney, CNET online, "Apple's "Hey Siri" voice activation can work in battery mode with iPhone 6S," Internet last accessed 30 June 2016, http://www.cnet.com/news/apples-siri-expands-capabilities-to-rival-microsoft-cortana/.

[6] Sara Ashley O'Brian, "Siri creator wants to make the World's best bot," CNN money website 9 May 2016, Internet accessed 10 May 2016, http://money.cnn.com/2016/05/09/technology/dag-kittlaus-siri-viv/index.html.

[7] Nicole Mortillaro, "How Start Trek changed the World (really)," Global News Science and Weather, 26 Sept 2014, last accessed 25 April 2016, http://globalnews.ca/news/564452/how-star-trek-changed-the-world-really/

[8] Casey Kazan with Luke McKinney via The Daily Mail, "Stephen Hawking: Time Travel to the Future is Possible," Internet last accessed 30 June 2016, http://www.dailygalaxy.com/my_weblog/2010/07/stephen-hawking-time-travel-to-the-future-is-possible.html.

airfoils. Perhaps the 'warp drives' and 'beaming' devices will look different, but have the same effects of moving faster through space, moving personnel and equipment almost instantaneously through space or solid matter. World renowned inventor Elon Musk's dream of the supersonic people transporter called the 'Hyperloop' is moving closer to reality with the May 2016 successful test. This prototype propelled a metal sled with an acceleration of two and a half times the acceleration due to gravity to a speed of 116 miles per hour in 1.1 seconds. The development team plans to be moving people at a speed of 700 miles per hour by the year 2021.[9] People can accept today what many in the not too distant past could not. Humans have landed on the moon and have harnessed the power of nuclear energy and its companion the nuclear bomb. Currently it is not inconceivable to have a manned mission to Mars. In fact, additional unmanned missions are planned for 2018 with the intent of manned missions to follow perhaps by the year 2030 once the technology is reliable.[10] To blaze the trail for the fragile humans to inhabit Mars will be humanoid robots such as the NASA developmental autonomous robot called Valkyrie.[11] What is worthy of further exploration is the pace at which technological advancements are made, how it is actually increasing exponentially, and why it is important to discuss this with respect to Canada's timing of UAS capacity building considerations.

Randy Kurzweil is a renowned inventor with perhaps his greatest strength in predicting the pace of advancements in technology. In his 2001 landmark work called "The Law of Accelerating Returns", he describes and quantifies the exponential pace of technological advancement. He often cited 'Moore's Law'. Gordon Moore was an inventor of the integrated

[9] Heather Kelly, "The Hyperloop just got one step closer to reality," Internet accessed 12 May 2016, http://money.cnn.com/2016/05/11/technology/hyperloop-test-run/index.html.

[10] Stephen Clark, "SpaceX announces plan to send mission to Mars in 2018," Space Flight Now, Internet last accessed 12 May 2016, https://spaceflightnow.com/2016/04/27/spacex-announces-plan-to-send-mission-to-mars-in-2018/.

[11] The Associated Press, "NASA builds Valkyrie robots to get Mars ready for humans," Internet last accessed 19 May 2016,http://www.cbc.ca/news/technology/valkyrie-mars-robots-1.3589117.

circuit where he noted that "we could squeeze twice as many transistors on an integrated circuit every 24 months. Given that the electrons have less distance to travel, the circuits also run twice as fast, providing an overall quadrupling of computational power."[12] Moore's Law has held remarkably true since the first computer was developed during World War II. As of 2016, the fastest computer, the Tianhe-2 of China, was running at 33.86 petaflops with 3.12 million cores. A petaflop is a quadrillion or ten to the power 15, floating point calculations per second and there are developments underway for the delivery of a 150 pentaflop computer by the year 2018.[13] This surpasses the human brain which operates at an estimated equivalent to 20 petaflops. The next computer technological leap is in the development of nano computers where the computing capacity will far exceed that of the human brain, but in a fraction of the volume consistent with "the persistent trend toward miniaturization".[14] Overlay the innovations in artificial intelligence such as the computerized chess game and the robot surgeon in development, and it not just conceivable to have machines more capable than humans but an accepted fact. There are "…gaming programs, which have already surpassed human ability. Even if the computer starts off a game of chess with fewer pieces than the best human opponent, the odds are still in its favor.[15] The supervised autonomous surgeon robot can "…perform soft-tissue surgery, stitching together a pig's bowel during open surgery - and doing so better than a human surgeon".[16] Linking the computer's exponential growth to the historical military technological developments, we see that military innovation has also experienced an exponential growth of power. From the

[12] Ray Kurzweil, "The Law of Accelerating Returns," Accelerating Intelligence. Essays, 7 March 20011, Internet last accessed 25 April 2016, http://www.kurzweilai.net/the-law-of-accelerating-returns.

[13] Jamie Lendino, "China's Tianhe-2 still the fastest supercomputer in the world, but the US is catching up," Internet accessed 10 May 2016, http://www.extremetech.com/extreme/209704-chinas-tianhe-2-still-the-fastest-supercomputer-in-the-world-but-the-us-is-catching-up.

[14] Ray Kurzweil, "The Law of Accelerating Returns…, 44.

[15] Sam Wallace, "The proposed ban on offensive weapons is unrealistic and dangerous," Kurzweil AI Accelerating Intelligence. Blog, 5 August 2015, 1.

[16] Meera Senthilingam, "Would you let a robot perform your surgery by itself?" Internet accessed 12 May 2016, http://www.cnn.com/2016/05/12/health/robot-surgeon-bowel-operation/index.html.

time humans started making tools approximately 2.5 million years ago, it took humans well over two million years to develop the bow and arrow. That was 64,000 years ago.[17] From then, gun powder was invented 1,200 years ago. The nuclear bomb was invented 70 years ago and today precision-strike semi-autonomous systems fly a hemisphere away without pilots such as the General Atomics Predator UAS. At every step, humans are using the new tools and the latest technology to develop and improve the future technologies. The abacus assisted with slightly more complex counting. The electronic calculator expanded this capability. Today supercomputers solve problems that no human could in a normal life time. At this point, one should have the appreciation that technology is advancing rapidly but more important, that the pace of advancement is exponential demanding RCAF act urgently to engage in UAS capabilities. This discussion will be explored further in chapter four when arguing the timing and strategy of Canada's integration of capable UAS and why delaying may not be in the best long term interest. The discussion now continues with the types of systems available to continue along towards the military applications of the systems.

Autonomous Systems

The definition of a semi-autonomous system is any non-human technological creation that operates independently to a certain degree. Semi-autonomous systems are all around. They are so common place that they are nearly invisible. They have built the cars we drive, assembled the intricate computer chips we use in devices, run power plants, and have been washing clothes for a long time. These robots and devices typically perform tasks that are *dull* or repetitive, *dangerous* or *denied* such that it cannot be done by a human, or *dirty* in some way that humans

[17] Rob Waugh, "Why we stuck with sticks and stones: Inventing the first Bows and Arrows took early humans TWO MILLION years," Internet accessed 10 May 2016, http://www.dailymail.co.uk/sciencetech/article-2170895/Inventing-bows-arrows-took-early-humans-TWO-MILLION-years.html.

would rather not perform the given task.[18] What all semi-autonomous systems have in common is that they require human guidance, supervision and intervention to accomplish the desired task. Where the variations occur is in the level of guidance, supervision and intervention on the part of the human operators. For example 'Curiosity', the Mars semi-autonomous robot rover, will stop progressing towards its assigned goal when a difficulty is encountered. The rover was programmed to enter into a safe mode while the human operators formulated a revised plan to mitigate and overcome whatever obstacle it encountered to then allow 'Curiosity' to continue with the mission.[19] 'Curiosity' clearly fits into the dangerous, and presently denied, task category. Technology has not yet solved a way to bring a human safely to Mars. The Roomba vacuum, while not nearly as intricate or capable as 'Curiosity' is also a semi-autonomous system that will move about independently, navigating obstacles to accomplish its assigned task of vacuuming a floor. Vacuuming would be a dull and potentially dirty task that humans are more than content to have done by robots. This device however is not able to climb stairs or navigate past closed doors to finish cleaning all the floors in a home, yet!

The recent developments in technology have been heavily concentrated in the area of enhanced automation where systems are capable of increased levels of autonomous operation. Enhanced automation is becoming the norm, from the cars driven with the numerous features such as rain-sensing windshield wipers, lane departure assistance, and collision-avoidance systems that will stop a car even if the driver does not. Refrigerators have been self-regulating their internal temperatures from early on and are becoming increasingly intelligent. They are able

[18] Matthias Maass, "From U-2s to Drones: U.S. Aerial Espionage and Targeted Killing during the Cold War and the War on Terror, Comparative Strategy," Published online 15 May 2015, Routledge Taylor & Francis Group, last accessed 12 April 2016, 226.

[19] Building Strong Semi-Autonomous Systems, Shlomo Zilberstein, School of Computer Science University of Massachusetts Amherst, Internet last accessed 27 June 2016, https://www.aaai.org/ocs/index.php/AAAI/AAAI15/paper/viewFile/9920/9686, 4090.

to manage grocery lists and advise on the freshness of the food within it while advising the owner wirelessly on a mobile device.[20] In aviation, levels of automation are available to pilots where automatic landings can either be allowed or denied or whether the aircraft is allowed to self-fly programmed routes or profiles. Automation allows humans to be removed from less desirable tasks thus allowing the human to focus on other preferred tasks or tasks that have yet to be automated. The rain-sensing windshield wipers allows the driver to concentrate on driving without needing to move his or her hands from the wheel to activate the wiper system. The Roomba will not only amuse house pets, but will also allow the human owner to use that saved time in a more productive or enjoyable manner. Automation is especially useful to aviation where there is often a dynamic and rapidly changing environment for the pilots to manage. If automation is flying the aircraft, and in most cases better than the pilot, then the pilots are able to divert more of their attention to other tasks such as managing malfunctions, managing communications or planning new courses of action in response to changes. When a human is no longer required, the machine will exhibit fully autonomous behavior.

Fully autonomous systems will be intelligent and able to perform an assigned task without human intervention, even if presented with unforeseen obstacles or barriers. The system will react and make a new plan to achieve its objective. [21] This is where automation is headed and perhaps you will be driven by your own self-driving car in the near future. Google's Self-Driving Car project has 1.5 million miles travelled and is currently operating in four American cities. The project seeks to reduce traffic accidents and deaths by eliminating the human errors

[20] Sam McNerney, "Smart Fridge Manages Your Grocery List And Monitors Food Freshness," 28 January 2012, internet last accessed 27 June 2016, http://www.psfk.com/2012/01/samsumg-smart-fridge.html.

[21] Shlomo Zilberstein, "Building Strong Semi-Autonomous Systems," School of Computer Science University of Massachusetts Amherst, Internet last accessed 27 June 2016, https://www.aaai.org/ocs/index.php/AAAI/AAAI15/paper/viewFile/9920/9686, 4088.

that account for 94 percent of them.[22] In fairness, the development of this innovation is not without risk such as the May 2016 fatal crash of the prototype autonomous car built by Tesla.[23] Of course, automation is particularly valuable for military applications where many of the most dangerous tasks would be better suited to robots. This would be highly advantageous to the technologically advanced country. However as Stephen Hawking stated in 2014, "[o]ne can imagine [artificial intelligence] outsmarting financial markets, out-inventing human researchers, out-manipulating human leaders, and developing weapons we cannot even understand." He then continues to warn us that "[w]hereas the short-term impact of [artificial intelligence] depends on who controls it, the long-term impact depends on whether it can be controlled at all."[24] There have been numerous science fiction movies on this very topic of self-aware and self-preserving intelligence that will wage war on its creator. The movie 'the Matrix' is perhaps the best depiction of this danger. In this futuristic film, humans had developed Artificial Intelligence that became self-aware and beyond human control. The 'machines' then dominate and exploit the human race to power themselves. The plot is focused on how the remaining free humans attempt to fight the very machines they helped create. With warnings considered, innovation and developments in fully autonomous weapons systems continues despite the United States' Department of Defense Directive 3000.09. In November 2012 the U.S. became the first nation to adopt an official public policy on autonomous systems. This policy placed a ten-year moratorium on the development of lethal autonomous systems, allowing only for the development of non-lethal autonomous systems. "[T]his directive, however, is for a limited period, and it can be

[22] Google Self-Driving Car Project, Internet last accessed 27 June 2016, https://www.google.com/selfdrivingcar/.

[23] David Shepardson and Bernie Woodall, "Tesla Crash Raises Concerns About Autonomous Vehicle Regulation," Reuters on-line 1 July 2016, Internet accessed 2 July 2016, http://www.reuters.com/article/us-tesla-autopilot-idUSKCN0ZH4VO.

[24] Amitai Etzioni and Oren Etzioni, "Killer robots won't doom humanity–but our fears of AI might," Quartz.com, 24 May 2016, Internet accessed 31 May 2016. http://qz.com/691286/ethics-bots-could-soothe-fears-about-ai-taking-control-of-humanity/.

waived by senior DoD officials."[25] Of note is that this directive only applies to automated targeting of human targets and as such fully autonomous targeting of non-human targets is permitted. Fully autonomous war machines are where the world of technology is headed.

An autonomous weapons system, once activated, can select and engage targets without further human intervention or control.[26] The trend towards military automation began in World War II with the German Goliath Tracked Mine. This system was operated by a 2,145 foot three-wired remote control to move close to a target and then could be detonated. It destroyed bridges, tanks, and infantry formations.[27] In the last seventy years, the automated military systems have indeed progressed. A lethal example includes the robots along the de-militarized zone between North and South Korea. "In 2006, the government of South Korea began installment of the Techwin SGR-A1 Sentry robots along the [demilitarized zone] with North Korea. These systems are capable of fully autonomous tracking and targeting, although human approval is still required before firing."[28] If the fail-safe human intervention was removed, this system would detect, track and purposefully destroy its human targets in a fully autonomous manner. Other examples of highly automated lethal systems include the United States X-47B unmanned combat air system (UCAS) and the nEUROn which is in development by France, Greece, Italy, Spain, Sweden and Switzerland.[29] The X-47B and nEUROn are the latest iterations of UAS technology

---

[25] Daniel Sukman, "Lethal Autonomous Systems and the Future of Warfare," *Canadian Military Journal* on-line, last accessed 8 March 2016, http://www.journal.forces.gc.ca/vol16/no1/PDF/CMJ161Ep44.pdf.

[26] Jeffrey S. Thurnher, "The Law That Applies to Autonomous Weapon Systems," The American Society of International Law Website, 18 January 2013, last accessed 25 April 2016 https://www.asil.org/insights/volume/17/issue/4/law-applies-autonomous-weapon-systems.

[27] Jon Guttman, HistoryNet, May 5, 2011, "Goliath Tracked Mine: The Beetle That Started the ROV Craze," Internet last accessed 27 June, 2016, http://www.historynet.com/goliath-tracked-mine-the-beetle-that-started-the-rov-craze.htm.

[28] Daniel Sukman, "Lethal Automous Systems and the Future of Warfare," *Canadian Military Journal* vol. 16, no.1, last accessed 8 March 2016, http://www.journal.forces.gc.ca/vol16/no1/page44-eng.asp.

[29] Michael Carl Haas "Autonomous Weapon Systems: The Military's Smartest Toys?" The National Interest, November 20, 2014, last accessed 25 April 2016, http://nationalinterest.org/feature/autonomous-weapon-systems-the-militarys-smartest-toys-11708.

incorporating stealth technology. Both aircraft are large between 30 and 40 feet long and look similar to the B2B stealth bomber. The X-47B operates at altitudes of 40,000 feet covering a distance of 2,100 nautical miles and most impressively can carry up to 4,500 pounds of payload.[30] On 22 April 2015, the X-47B successfully "conducted the 'first ever' autonomous aerial refueling…" proving that the march towards fully autonomous operation continues. [31] However, at this time, these and "… other autonomous systems can be compared somewhat to 'benign psychopaths,' lacking a frame of reference to understand or make moral or ethical decisions, based upon consequence."[32] Military operations fought in this way would have been alien to Carl von Clausewitz who theorized that emotion was a key part of fighting.[33] This would indeed be a change to the nature of conflict. Although the image of killing machines operating intelligently without human input is troubling, this is where UAS are headed. This statement should not be surprising, however, if looked at within the context of actual technological developments. Some of the ethics of automation and its ease of use will be discussed in chapter three. Most important to this study are the semi-autonomous Unmanned Aerial Systems that the RCAF is planning to incorporate into the CAF. As we move toward the study of procurement, exploration of the robot proliferation is needed to again emphasis that the RCAF needs to urgently address the UAS issue to avoid being overrun by the surrounding UAS operating entities.

---

[30] Janes's IHS, "All the World's Aircraft: Unmanned", Internet last accessed 26 July 2016, https://janes.ihs.com/Janes/Display/1318245.

[31] *Ibid.*

[32] Daniel Sukman, "Lethal Autonomous Systems and the Future of Warfare," *Canadian Military Journal* vol. 16, no.1, last accessed 8 March 2016, http://www.journal.forces.gc.ca/vol16/no1/page44-eng.asp

[33] Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret, (Princeton, Princeton University Press, 1976), 138.

Proliferation

The proliferation of robotic systems is in lock step with the pace of robotic technological advancement. This multiplying of systems is of particular concern to this discussion. The gap of systems in operation and the gaps in Canadian knowledge to develop, employ and manage these systems are getting larger at an exponential pace. This is making the RCAF's eventual leap into the UAS realm more challenging with every day that goes by. Consider the difficulty in embracing new technologies for *some* older members of society. Further aggravating this limitation is the military structure where those in high leadership positions are almost always older, due to the progression requirements, than the younger and more adaptable recruits. It will be difficult for those in command to fully comprehend and manage the new systems and the subordinates that will employ them. We must be mindful of trying to educate the leadership "… when they are well past the age of agile and innovative thought" which would occur if a new transformative technology was abruptly introduced.[34] With the exponential pace of advancement, the gaps in expertise and adaptability will grow, making the transition to UAS that much more difficult. Sooner is clearly better with respect to the timing of the RCAF's engagement in these innovative systems that remain absent from their core equipment and skill sets. Benefit would be realized even if it is on a small scale with only a few UAS. Perhaps a leased solution should be pursued as long as it had permanent personnel and equipment structure, and it was set-up to maintain and grow the RCAF expertise. Further delay will come at a higher price as the gap in ability to embrace the systems grows. The timing issue, and how to mitigate it will be revisited in chapter four.

[34] Paul Wilkins, Group Captain Royal Air Force, "Conceptualizing the Conceptual Component: One Airman's Perspective," *Air Power Review*: A Peer Review Journal by the RAF Centre for Air Power Studies, vol. 18, no. 1, (Spring 2015), 15.

There is a proliferation underway of semi-autonomous robots in all areas of human existence and most visibly in civilian applications. As of 2010, the Roomba robotic vacuum had over five million in operation and by 2015; 14 million iRobot devices have been sold around the world.[35] Micro UAS are now common place children's toys with more capable ones with built-in cameras are available on Amazon for less than one hundred dollars, such as the Syma X8C 2.4 Ghz 6-Axis Gyro RC Quadcopter Drone.[36] The availability of these systems and how easy they are to operate are reasons for concern. With just about anyone able to own and operate these devices, there is increased risk that they will find nefarious uses for them whether intentional or not. There have already been incidents of small UAS impacting aircraft in flight and they are on the rise causing both damage to aircraft and making the skies less safe.[37] A staggering 300,000 flying systems were registered during the first 30 days of the United States' Federal Aviation Authority's on-line civilian UAS registration program.[38] This number continues to grow.

When examining the proliferation of the larger military UAS and especially those able to carry weapons a similar expansion trend which is not likely to reverse course is observed. The proliferation of semi-autonomous systems is not just with the 'friendly to Canada' nations and entities. Belligerents of all forms are jumping ahead of the RCAF in their use such as China's UAS flights over the Antarctic in February of 2016.[39] China is also fully engaged in the military drone market for export where "… its willingness to export the technology to other countries has

[35] iRobot home webpage company information, Internet last accessed 13 May 2016, http://www.irobot.com/About-iRobot/Company-Information/History.aspx.

[36] Ebay listing downloaded 30 June, 2016, http://www.ebay.com/itm/Syma-X8C-2-4Ghz-6-Axis-Gyro-RC-Quadcopter-Drone-UAV-RTF-UFO-2MP-HD-Camera-/141677602860.

[37] Stephan Pope, "FAA Investigating Reported UAV Collision with Piper Twin," Internet last accessed 30 June 2016, http://www.flyingmag.com/technique/accidents/faa-investigating-reported-uav-collision-piper-twin.

[38] Martin Streetly, Executive Overview: HIS Jane's All the World's Aircraft: Unmanned, 11 March 2016, Jane's, last accessed 14 April 2016 2016, https://janes.ihs.com/Janes/Display/1317973.

[39] *Ibid*.

serious implications for combat in the future."[40] One of China's systems very closely resembles the Predator and Reaper series of UAS but at one million dollars per aircraft compared to the American Reaper which costs 30 million. The cost differential is not likely to make China wealthy in arms sales, however it will lead to further proliferation by non-friendly nations and will certainly increase China's influence and "… diplomatic toolkit, giving it an additional way to extend its reach into the Middle East, Latin America and Africa as it builds these security relationships."[41] Since the proliferation of UAS began, there are now more than "…50 countries [that] are developing UA[S]"[42] Of the countries that produce the systems, many export them with over 70 countries owning and operating UAS of various sizes and capabilities and for their own different purposes."[43] A statistic that is cause for concern is the "…23 countries reportedly developing armed UA[S]." "Israel is the largest exporter of UA[S], with sales to more than 42 countries as of February 2010."[44] "In 2000, the US had fewer than 50 drones, mostly for surveillance. Just over ten years on the US Department of Defence (DoD) has more than 7,000 unmanned aircraft in its inventory."[45] This number increased to 10,000 in July of 2013.[46] Russia has also been actively developing and improving their Medium Altitude Long Endurance (MALE) UAS. "According to industry sources a USD 9 billion programme is currently underway to enhance Russia's unmanned capabilities." Their 'UGAV' UAS is powered by a 11,000 pounds in thrust Kilmov RD-5000 engine and capable of a top speed of 430 kt and a

---

[40] Sara Kreps, "China swooping in on military drone market," CNN on line news, last accessed 25 April, 2016, http:///www.cnn.com/2016/04/01/opinions/china-drone-sales-kreps/index.html

[41] *Ibid.*

[42] Lynn E. Davis, Michael J. McNerney, James Chow, Thomas Hamilton, Sarah Harting, and Daniel Byman, Rand Corporation, "Armed and Dangerous? UAVs and U.S. Security", 7.

[43] *Ibid*.

[44] *Ibid*, 10.

[45]Chris Woods, "Ten Years Since First Deadly Drone Strike, Industry Gather is London," The Bureau of Investigative Journalism, 21 November 2011, Internet last accessed 19 April 2016, https://www.thebureauinvestigates.com/2011/11/21/drone-manufacturers-in-london-on-10th-anniversary-of-1st-strike/

[46] Lynn E. Davis, Michael J. McNerney, James Chow…, 7.

range of 2,500 miles and maximum operating altitude of 40,000 ft."[47] There is no shortage of UAS in development and no sign of slowing the improvements being made to these systems. The systems will continue to evolve rapidly with stealth being the next significant leap such as the X-47B and nEUROn.[48] This discussion continues with timely discussion of systems that would be of greatest interest to Canada.

State of UAS technology

When considering *when* Canada should obtain a UAS, a discussion on the maturity of present day MALE UAS demonstrates that there is no better time than the present. Just as the well-known Chinese proverb goes; 'the best time to plant a tree was 20 years ago, the second best time is now'. This also applies to the timing of Canada's use of a proper UAS. To play on these words, China has been planting their UAS trees for quite some time now. The spectrum of UAS systems are built in all different sizes with different purposes and capabilities ranging from the very small such as to mimic insects to the very large full sized fighter aircraft. An example of a nano or small system is Norway's 40,000 dollar, 18 gram, 2.5 by 10 centimeter Prox Dynamics PD-100 Black Hornet Nano UAS with streaming regular and thermal cameras.[49] An example of the very large or High Altitude Long Endurance (HALE) is Northrup Gruman's 32,250 pound Global Hawk capable of flying at altitudes up to 60,000 feet with a speed of 310 nautical miles per hour while carrying a 3,000 pound payload for 12,300 nautical miles or over 34 hours.[50] There would be obvious differences in how each of these systems would be employed. Both of these flying devices could be easily employed within the Canadian Armed Forces. The

[47] Andrew White, "Unmanned evolution in the Middle East," *Jane's Defence Weekly, Aerospace, Defence &Science*, last accessed 14 April 2016, https://janes.ihs.com/Janes /Display/1763341.

[48] Lynn E. Davis, Michael J. McNerney, James Chow…, 4.

[49] Edgar Alvarez, "US military tests a Tinker Bell-sized drone," Internet last accessed 13 May 2016, http://www.engadget.com/2015/05/29/us-military-micro-drone/.

[50] US Air Force on-line fact sheet Global Hawk, internet last accessed 13 May 2016, http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104516/rq-4-global-hawk.aspx.

examination will concentrate mainly on the MALE UAS as these systems would fill the current and foreseeable void within the Canadian context and is closest matched to the intended procurement objective that will be discussed in chapter four. The MALE UAS are the area to focus the effort. Not only is there a void in this area, the procurement process demands a high level of effort and risk, and is where the process could use the most assistance.

One of the most recognizable and certainly most used UAS is the General Atomics' Predator. The first version which dates back to 1996 was called the RQ-1 where the 'R' was for reconnaissance, the 'Q' to designate unmanned and the '1' for the first version. It is part of the MALE category. There can be no doubt as to this aircraft's successful use with the militaries around the world and no country more than the United States. The initial Predator platforms were used only for surveillance. "It was not until the 1999 NATO Kosovo campaign; however, that someone came up with the idea of equipping these planes with missiles, transforming them from spy planes into killer drones."[51] In February of 2001, the Predator was the first UAS to successfully incorporate a strike capability where it took aim and fired a "…Hellfire laser-guided missile: it struck and destroyed an unmanned stationary target (an Army tank)."[52] In August of 2004, Canada trialed a version of the Predator called the Altair which was leased from General Atomics.[53] It was painted with a Canadian insignia and was provisionally certified for use in Canadian airspace. The Atlantic Littoral ISR Experiment (ALIX) was conducted from Goose Bay Labrador where the Harper Conservative government had pledged to position a UAS

[51] Medea Benjamin, *Drone Warfare; Killing by Remote Control*, (New York: Verso, 2013), 15.

[52] Gerry Yarrish, "The Predator UAV," Model Airplane News 130, no.3 (03, 2002): 28-29, IRC on-line reference 12 May 2016.

[53] Canadian American Strategic Review, Internet last accessed 28 April 2016, http://www.casr.ca/id-justas-project-timeline.htm.

squadron as part of his 2006 election campaign promises.[54] Just as with the intended procurement of permanent UAS capability from the JUSTAS project, this did not occur. The trial involved a ground move of the UAS from California by truck over some of the roughest roads to Goose Bay. Within a day, the aircraft was assembled and ready for flight. The experiment proved the technology for Canadian use and was a success.[55]

Currently, General Atomics is best known for three versions of UAS. The MQ-1 Predator, the MQ-9 Reaper, and the Predator XP which is the unarmed version intended exclusively for export to US friendly countries. These systems incorporate the aircraft, the Ground Control Stations (GCSs), and a satellite link system. They have a Beyond Line of Sight (BLOS) capability where they are remotely controlled once in flight via satellite link from almost anywhere in the world. The United States most often controls them from GCSs located in Nevada. In 2002, the RQ-1 became the MQ-1 where the 'R' for reconnaissance was replaced by the 'M' to designates multi-role when it was equipped with strike capability in the form of the Hellfire missile system. The 2015 on-line published fact sheet for the US Air Force states sensors aboard their 150 MQ-1 Predators include as a minimum the Multi-spectral Targeting System (MTS). This package developed by Raytheon has an infrared sensor, a colour/monochrome daylight TV camera, an image-intensified TV camera, a laser designator, a laser illuminator, and can manage the use of two precision Hellfire missiles. There are over 2,000 MTS in use on

[54] Rob Antel, "MacKay hints Labrador base promises might not be kept," CBC news on line 17 May 2012, Internet last accessed 30 June 2016, http://www.cbc.ca/news/canada/newfoundland-labrador/mackay-hints-labrador-base-promises-might-not-be-kept-1.1203744.

[55] In August of 2004, the author of this paper was one of the pilots tasked to ensure Canadian airspace compliance by the General Atomics civilian contractor pilots. There were only two deviations, both as a result of computer input errors which resulted in air traffic control violations. Despite these minor events, the aircraft trial missions were all successfully flown according to plan. The author has also followed a career path that diverged from UAS until this self-directed study which will be discussed in Chapter four.

varying platforms and are flying on average 50,000 flight hours per month around.[56] Each UAS is discussed as a unit which consists of four aircraft, a GCS, and a Predator Primary Satellite Link.[57] They have a service ceiling of 25,000 feet, a range of 770 miles, a cruise speed of 70 nautical miles per hour and is capable of a maximum speed of 135 miles per hour. The improved version called the Reaper, which was added in 2007. It is capable of operating at altitudes up to 50,000 feet at a speed of 240 miles per hour while carrying precision munitions such as the very effective two Hellfire missiles configuration.[58] However, these awesome weapons have contributed to negative reaction and sentiment from a large part of the world.

[56] "Aerospace and Defense Companies; Raytheon Delivers Industry-First 2000th Multi-Spectral Targeting System," *Defense & Aerospace Week* (Nov 06, 2013): 101. http://search.proquest.com/docview/1446969783?accountid=9867.

[57] US Air Force on-line fact sheet, MQ-1B PREDATOR, Posted 1/5/2012, Internet last accessed 13 May 2016, http://www.webcitation.org/66idKJIvU.

[58] U.S. Air Force Online Fact Sheet, Internet accessed 1 July 2016, http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104470/mq-9-reaper.aspx.

CHAPTER THREE – UAS IN PRACTICAL USE

This chapter will explore the use of UAS and specifically the United States' use of armed UAS. For the most part, these operations involving UAS are considered highly unpopular except to those that either employ them or sell them. Secrecy, conflicts with international laws, and the negative effects on the populations that endure the strikes all contribute to an overwhelmingly negative sentiment towards armed UAS. This likely contributes to the RCAF's reluctance and outright inability thus far to procure them given the unpopularity of the systems. It is far more difficult to gain support and procure a system that is seen as overwhelmingly negative. However, in the study of the darker side of armed UAS, we can better define a Canadian solution that will both meet the county's needs and solve the challenges of negative perception to achieve a well thought-out procurement of the needed capability.

Use of UAS

Without a doubt, the United States of America is by far the leader in UAS development, production, and use around the globe. This provides Canada a great deal of information to study and evaluate the subject when considering a Canadian solution. The American UAS programs gained incredible pace after the 11 September 2001 terrorist attacks on the United States. Soon after this event, "… the U.S. Congress authorized the use of 'all necessary and appropriate force' in order to prevent future acts of terrorism against the United States." This authorization set off a flurry of activity to spend, build, seek and destroy the terrorist enemies of the United States. They began to "… scour the world for 'terrorists' as if they were a malignant tumor that needed to be removed surgically, not quite realizing the trauma the operation was creating for the

body."[59] The congressional authority allowed for sweeping Presidential powers to use force and it did not limit where in the world this force could be applied.[60] Since then, they moved to a targeted killing program that began in earnest "in November 2002, when a CIA operated Predator drone was used to target and kill the suspected al-Qaida leader Ali Qaed Senyan al-Harithi, along with five other men, in Yemen."[61] The Congress also authorized immense amounts of financial resources to source the new weapon systems that were ideally suited to seeking and destroying targets in remote and difficult to reach places such as in the Middle East. Since 2001, armed UAS have been employed at levels that have made the UAS discussion highly charged and scrutinized. There are many reasons that have significantly contributed to armed UAS proliferation and widespread use.

First and foremost, an unmanned system does not place a human operator in harm's way. When soldiers die, the population will first become angry or scared; then they will begin to question and withdraw support for the conflict.[62] With a UAS, this problem is mitigated. Without a human in the combat aircraft there is no chance that a pilot or crew member, in this case an American operator, can be harmed or killed. Although these systems are considered 'risk-free' to operators, further along in the discussion the concept of risk will be explored proving that this notion is misleading and that these operations are not without potential peril.

---

[59] Akbar Ahmed, *The Thistle and the Drone: How America's War on Terror Became a Global War on Tribal Islam",* (Washington D.C.: Brookings 2013), 259.

[60] Stephanie Carvin, "Getting Drones Wrong," The International Journal of Human Right, Routledge Taylor &Francis Group, 2015, last accessed 12 April 2016, http://dx.doi.org/10.1080/13642987.2014.991212 , 373.

[61] Craig Martin, "A means-methods paradox and the legality of drone strikes in armed conflict," The International Journal of Human Rights, Published online: 24 Feb 2015, Routledge Taylor & Francis Group, last accessed 12 April 2016 via IRC, 145.

[62] Gary Schaub Jr, "JUSTAS for all? Innovation and UAVs in the Canadian Forces" Defence Studies, Routedge 5 June 2015, Downloaded from CFC IRC 20 April 2016,

A UAS can be much "smaller, lighter and more fuel efficient" than an aircraft with the required life support systems involved in a manned aircraft.[63] Their smaller size also allows for the ability to operate without detection. This is especially true at night where a UAS would be difficult to detect unless the enemy had advanced air defence radars. UAS operating throughout the night would also not be afflicted by the human limitation of fatigue. In most cases, the size and efficiency of the aircraft would also contribute to cost reduction over a similarly capable manned aircraft.[64]

The UAS does not require a physical ground-based foot-print in the area where it is being employed. As such, the system can be launched from a friendly location and flown into the area of operations without the need for any ground support and especially no requirement for 'boots on the ground'. Predators that are operated in Afghanistan are controlled from Ground Control Stations in Nevada. Although the non-stealth UAS would be "…generally easy to shoot down" in airspace with air defence, they can operate almost freely with reduced risk in airspace with either no air defence or is conducive to UAS operations such as in Afghanistan, Yemen and Iraq.[65] The UAS are launched and landed from a friendly protected area close to the area of operations by a local team. But once in flight, the control of the weapon system is handed over to another agency located, in most cases, in the United States. The benefits of this include, reduced risk to ground personnel, as well as an immense reduction in cost because there is no requirement to support a ground element. These benefits have tremendous advantage in both the financial realm and the flexibility realm since the systems only need flight time to operate as remote control assassins almost anywhere in the world.

---

[63] Walter A. Dorn Dr, *Keeping Watch: Monitoring Technology and Innovation in UN Peace Operations,* (United States: United Nations University Press 2011), 68.

[64] *Ibid*, 70.

[65] Lynn E. Davis, Michael J. McNerney, James Chow…, 3.

MALE UAS are marvelous in their ability to be persistent. Without a pilot onboard there is no need for rest, feeding, relief, or in the domain of surveillance, even blinking. These systems have long-range and long-endurance. They carry highly capable optical, infrared, and radar systems that are constantly gazing upon an area of interest. There are of course, humans at the other end of the system controlling, monitoring and viewing the imagery and data being collected. However, these humans can be relieved by rotations of fresh crews and instead of one pilot managing the entire platform and associated sensors such as in a fighter jet, there can be several systems' operators. This would be similar to having several humans on board the aircraft all performing their specific tasks. Add to this the high levels of automation which removes the requirement for even the UAS pilot to actively fly the aircraft and there is yet again capacity and capability added to the team effort. There are systems in place to accurately fly the platform without any pilot input beyond telling it where and what to do. The UAS and associated support system has the highly desirable "…ability to linger undetected for protracted periods of observation over a potential target, feeding detailed visual and other sensory intelligence back to an operations team that is able to engage in a targeting decision-making process under little stress, at a relatively leisurely pace."[66] The unblinking quality is made possible by further automation where the cameras and sensors are aimed at areas of interest and from there they do not require continued human aiming, rest or relief. No one pilot in a manned aircraft would be able to match the UAS' abilities to remain airborne longer and see far better than any human day or night, capture video images and then relay its electronic data for use by its human operators.

The ability to remain undetected is clearly an advantage. They can operate undetected either because the enemy does not have the ability to track them, or because the UAS is equipped

[66] Craig Martin, "A means-methods paradox…, 144.

with stealth technology providing invisibility. While unseen, they are able to perform their assigned tasks without direct observation by the intended target. The aircraft are smaller and quieter than fighters with only one engine and operate at an altitude that does not make enemy observation easy. With the sensors available they can operate above meteorological obscuring phenomena and still 'see' through "…hostile environment[s], such as cloud and smoke."[67]

Lethality is a key advantage to the armed UAS. The system "… is highly precise and surgical in the actual delivery of missiles to the target."[68] Of course, this accuracy is only as good as the operator's selection of the appropriate target. After potentially many hours of surveillance, review of data and human authorization, the system can launch a precision munition at a target and destroy it with ease. Just as the bow and arrow allowed a kill from distance, the UAS does the same with greater lethality and with global reach distances thus realizing "[t]he oldest dream of the second-oldest profession."[69] "Surveillance and acting on information are [now] operationally merged when armed drones are used."[70] This has given the United States the ability to fly to remote locations in the Middle East and elsewhere, seek out targets, provide persistent observation and quickly destroy them without ever setting foot in the area of the strike. This advantage is hard to match with most manned platforms and certainly is more efficient in terms of cost and risk to accomplish these types of tasks. Advantages are clear, however there are disadvantages that need exploration since this is where the reasons for the unpopularity of the systems' use are seen. The advantages and ease with which UAS are used makes abuse of the systems probable and negative consequences inevitable. "For the same

---

[67] Andrew White, "Unmanned evolution in the Middle East," *Jane's Defence Weekly, Aerospace, Defence &Science*, last accessed 14 April 2016, https://janes.ihs.com/Janes /Display/1763341.

[68] Craig Martin, A means-methods paradox…, 144.

[69] Stephanie Carvin, "Getting Drones Wrong," The International Journal of Human Right, Routledge Taylor &Francis Group, 2015, last accessed 12 April 2016, http://dx.doi.org/10.1080/13642987.2014.991212 , 366.

[70] Matthias Maass, "From U-2s to Drones…, 225.

human progress that gives us the technology to strike half a world away also demands the discipline to constrain that power – or risk abusing it."[71]

Abuse of UAS

The United States has indeed lacked discipline to constrain their newly developed power embedded into the modern technological innovation that a UAS represents. The main areas of concern are centered on secrecy, accountability, and credibility. This combination has stressed relations with the United States and many of its allies. "None of the United States' chief allies has publicly supported the targeted killing; many of them privately question the administration's claim that it comports with international law and worry about the precedent it sets for others who inevitably will acquire the same technology."[72] This in turn has led to a decidedly negative sentiment towards their use by many around the world and none more than the populations that have been under constant surveillance and threat of destruction. The region that has been the most targeted by UAS is the region of North Waziristan bordering Pakistan and Afghanistan. "This small area would be the target of one of the most concentrated [UAS] campaigns on earth."[73] This is where the 'terrorists' were believed to be training, operating and acting from. It is also a region that is difficult to occupy with its rocky impassable terrain and difficult to traverse mountainous passages. Or stated in another way; it is the "ideal" place for a UAS to operate.

Secrecy is a double-edged sword. Operations that are not visible are also not subject to review, scrutiny, or accountability. If the public at large does not know of the operations, then there is no one needed to be responsible for them. Yet despite the secrecy, evidence of what is

[71] *Ibid*, 218.
[72] *Ibid*, 227.
[73] Akbar Ahmed, *The Thistle and the Drone…,* 48.

occurring cannot be completely hidden. If a missile strikes, there is evidence of it. The secrecy then raises doubt that what is occurring is right or within the law. Where this discussion becomes complicated is in determining of who conducted the strike, and who or what was destroyed. The United States *may* acknowledge that they conducted a strike and state that it was a terrorist, but with the person or several people dead, there is no way to confirm it. Lives have been taken without a trial or any kind of verifiable review since the intelligence is also most often hidden. The lack of resolution offers immense opportunity for others to fill in 'the facts'. An example of this occurred "in Afghanistan, in February 2002, when a Predator drone was used by the Central Intelligence Agency (CIA), in a Hellfire missile strike targeting a tall man and two other men who were acting deferential towards him." The UAS operators believed it had been Osama Bin Laden. It was not him yet the officials maintain that they were "not innocent… [and the] …insurgents had most likely been high level." Soon after the strike the *New York Times* stated the victims were peasants looking for scrap metal.[74] It is this type of event that draws high levels of scrutiny. And it should. This is in essence assassination which by the United States' own admission is not permissible. "[O]n 4 December 1981, President Ronald Reagan signed Executive Order 12,333, which stated, '[n]o person employed by or acting on behalf of the U.S. Government shall engage in, or conspire to engage in, assassination." Yet in another example, the American Hellfire missile that killed Abu Ali Al-Harithi in Yemen in 2003 proved otherwise.[75] While the name of this individual was known, most names are not. Within order 12,333 however, the definition of assassination was not given and the United States has since

[74] Craig Martin, "A means-methods paradox…, 145.

[75] Daniel Sukman, "Lethal Autonomous Systems and the Future of Warfare," *Canadian Military Journal*, vol. 16. No. 1.

changed its interpretation from the order's initial issue in 1976.[76] One distinct way in which the legalities are mitigated is by calling the strikes 'targeted killing' vs 'assassination' thus lowering the legal burden.[77] Further to this, if there is a state of war, then the targeted killing is further seen as permissible under International Humanitarian Law (IHL).[78] Despite this amended legal interpretation, strike after strike is made without official reporting or transparent oversight causing concerns from international partners and deteriorating world security.

A drawback to this secrecy, concealed covert activity, and continued conduct in this fashion is the impact to the way other entities operate. It has led other "… governments [to] use technological advances in modern warfare to make violence less visible and more acceptable to the public."[79] As mentioned above, there is no real accounting of who exactly is targeted and killed or whether they were indeed terrorists since it "… is impossible while a shroud of official secrecy hangs over these CIA activities."[80] In 2012, the United Nations Mission in Afghanistan "…reported that in 2012 there were 506 drone strikes in Afghanistan which resulted in only five incidents of civilian casualties, involving 16 deaths and three injured, which included the killing of four children through an apparent targeting error."[81] Civilian death reporting understandably varies given the different political objectives of those involved. It is dependent on the source in that they would be potentially underreported by the United States and over reported by Al-Qaeda with the truth somewhere in between the two figures given. A report by the New America Foundation discussing drone strikes in Pakistan from 2004 to 2011 estimated the civilian

---

[76] Mark V. Vlasic, "Assasination &Targeted Killing – A Historical and Post-Bin Laden Legal Analysis," *Georgetown Journal of International Law*, 43.2 (2011-2012): 261.

[77] *Ibid*, 268.

[78] *Ibid*, 275.

[79] Doga U. Eralp, "The Role of U.S. Drones in the Roboski Massacre," *Peace Review*; A journal of Social Justice, Routledge Taylor and Francis Group, last accessed 12 April 2016, http://dx.doi.org/10.1080/10402659.2015.1094325 , 453.

[80] Stephanie Carvin, "Getting Drones Wrong…, 377.

[81] Craig Martin, "A means-methods paradox…, 146.

casualty rate at 18 percent and suggested that the rate has dropped since then.[82] The July 2014 CENTCOM data reported "… that there have been over 1,000 drone strikes in Afghanistan since 2008, but noted that there is no public record of these strikes or their effects."[83] The lack of transparency on the UAS strikes has led to doubt that the activities are legal, ethical or even effective. This doubt, whether well founded or not, is again a drawback to secrecy and has had an impact on how other entities have, and will conduct themselves in the future with UAS capabilities.

Accountability has been clearly lacking from the CIA where secrecy is paramount to the way they operate. That is not to say they are not accountable. It is just to emphasize that they are not accountable to anyone that can be verified in a transparent fashion. This logically leads to doubt and many to deduce they may not be fully accountable for their actions. Further to this, "[t]he CIA is not, as a matter of both domestic US law and international law, part of the armed forces engaged in hostilities in Afghanistan."[84] Their nebulous position has also led to allegations that "… the CIA interprets certain provisions of its domestic enabling legislation to mean that it is not bound or limited by principles of international law."[85] This too cannot be verified due to the level of secrecy. There is however a consequence to not being part of an armed force. "[S]uch civilians do not enjoy the protections and privileges of combatants under International Humanitarian Law, and so are themselves targetable (for such time as they are taking direct part in hostilities), and they could theoretically be prosecuted for murder for their actions." Civilian

[82] Mark V. Vlasic, "Assasination &Targeted Killing…, 297.
[83] Craig Martin, "A means-methods paradox…, 146.
[84] *Ibid*, 155.
[85] *Ibid*.

UAS operators would be in this category.[86] The culminating consequence of secrecy and apparent lack of accountability is the damage done to the United States' credibility.

An American proponent of the armed UAS program with the contention that it is a tremendous success at combating terrorism is Capt Joseph Chapa, a member of the United States Air Force. However, even he concedes that the United States has failed to adequately disclose information about its UAS activities where he stated;

> The cost of lives and property are immense, and major damage is done to America's international reputation, U.S. foreign relation, especially with key partners in the War on Terror, and America's perception as a committed proponent of International Law is challenged. In short, the United States is paying significant price across the board for its military successes in its counterterrorism campaigns.[87]

Additionally, secrecy prevented the international community from determining the "United States' degree of responsibility."[88] Polls support these negative sentiments such as those conducted in 20 countries from "… Germany to Mexico to China, [where] the world said no to US drones. In US-friendly Muslim nations such as Egypt, Jordan and Turkey, the disapproval rates were enormous, ranging from 81 to 89 percent."[89] This decidedly negative sentiment has had the unintended consequences of fostering support for terrorism and contributing to other nations such as China racing to develop their own UAS capabilities. The many drawbacks to how the United States has operated UAS would be mitigated with a stronger more transparent legal backing.

---

[86] *Ibid*, 156.

[87] Matthias Maass, "From U-2s to Drones…, 219.

[88] Joseph O. Chapa, Captain United States Air Force, "Remotely Piloted Aircraft and War in the Public Relations Domain," *Air & Space Power Journal*, September – October 2014, 39.

[89] Medea, Benjamin, *Drone Warfare Killing by Remote Control*, (Verso New York, 2013), 9.

Legal discussion

Following the laws and demonstrating that they are respected would go a long way to restoring credibility for the United States. Perhaps the laws *are* being followed. The main challenge is that there is no easily verifiable proof either way due to the level of secrecy. There is nonetheless truth to the 'might makes right' saying. This study will explore some contributing legal reasons for the unpopularity of the UAS programs.

Spying and attaining a bird's eye view of the enemy offers highly desirable advantages from a warrior's perspective.[90] This has been true since the times of Sun Tzu and certainly before. The earliest forms of overhead spying included observation from hill tops followed by observation towers, balloons, aircraft, satellites and now UAS. The 1919 Paris Convention relating to the Regulation of Aerial Navigation stated "… that in peacetime every power has complete and exclusive sovereignty over the airspace above its territory."[91] Modern interpretations of this convention have further determined that in order to be airspace there must be air and thus limited a nation's airspace to "… around 60 miles above ground"[92] The MALE UAS platforms including the Predator and Reaper operate within this airspace.

Spying is clearly an illegal activity under certain circumstances such as flight through another nation's airspace for the purpose of collecting information. Space–based satellite spying is under a different set of laws and is exempt.[93] Spying is an acknowledged core activity of powerful nations. The United States spies on both its enemies and allies as well known from the

---

[90] Sun Tzu, *The Art of War*, (London, 2012), 90.

[91] John C. Cooper, "United States Participation in Drafting 1919 Paris Convention," *Journal of Air Law and Commerce*, 18.3, (1951), 268.

[92] Matthias Maass, "From U-2s to Drones…, 221.

[93] Matthew J. Kleiman, "Space Law 101: An Introduction to Space Law," American Bar Association, Internet last accessed 29 June 2016, http://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/space_law_101_an_introduction_to_space_law.html.

recent wiretapping scandal between the United States and Germany's Chancellor Angela Merkel.[94] There have been many well documented cases of high-level spying through airspace such as the U2 and SR-71 spy plane activities over what was then the Soviet Union. These innovative aircraft were designed to fly high enough to avoid being shot down by Soviet air defence or airborne assets. In these cases, aircraft technology provided the safe "… prize of breaking International Law". [95] Both aircraft were unique in their ability to fly high enough to be out of reach. "The U-2 operated at 70,000 feet or 13 miles, the SR-71 at 85,000 feet or 16 miles"[96] Only one U-2 spy plane was successfully shot down on 1 May 1960 and its pilot Francis G. Powers was captured and imprisoned by the Soviet Union.[97] However "…even with advanced technology, U.S. aerial surveillance remain[s] illegal."[98] This illegality is also true of unwelcomed UAS in other nation's airspace. Beyond spying and surveillance, the UAS's ability to destroy the targets it is observing has ushered in another discussion on assassination.

The 'targeted killing' UAS program is at the core of this UAS abuse examination. As discussed above, it is known that the US continues to perform 'targeted killing' while insisting that the actions are legal, arguing that there are differences between these actions and assassination such that "…the ban on assassinations did not apply."[99] President Obama stated that after the terrorist strikes of 11 September 2001, force in accordance with domestic and international law against Al-Qaeda, the Taliban and associated forces was authorized. In direct response to hostilities he stated "… this is a just war – a war waged proportionally, in last resort,

---

[94] Reuters, "U.S. spy agency tapped German chancellery for decades: WikiLeaks," 9 Jul, 2015 6:21pm EDT, Internet last accessed 28 June 2016, http://www.reuters.com/article/us-germany-usa-spying-idUSKCN0PI2AD20150709.

[95] Matthias Maass, "From U-2s to Drones…, 224.

[96] *Ibid*.

[97] *Ibid*.

[98] *Ibid*.

[99] *Ibid*, 228.

and in self-defense."[100] Yet, "… [s]ince his inauguration on January 20, 2009, President Barack Obama has killed more people with drones than died on 9/11."[101] As a new President, he was most certainly "… enamored with the Central Intelligence Agency, because they are offered a covert fix for [his] complex problem."[102] The 'Jus in bello' principle requires that "military force, including that conducted by armed drones, satisfy the principles of necessity, proportionality, distinction, and humanity."[103] Of the thousands killed, very few were reported as innocent or collateral damage. A large reason for this was in the definition of those that could be targeted. The Obama administration loosely defined "… all military-age males in a strike zone combatants… unless there is explicit intelligence posthumously proving the innocent."[104] So in the case of men collecting scrap metal, they too are legitimate targets by this definition since it cannot be known for certain that they were innocent. In many reported cases, the CIA has gone on to launch a 'double tap' in which a [UAS] kills those trying to rescue the wounded from the first strike."[105] These interpretations, definitions and practices are problematic and it follows easily that nations both allied and enemy would take issue with it. With respect to CIA strikes, there are two categories. The first is a personality strike, and the second which is far more contentious is the signature strike. In the first category, the name and identity of the person being targeted is known. The challenge in a personality strike is the process by which one finds himself on this 'kill list' is questionable. There have been reports that these names were provided to the CIA by operands in the theatre of operations to target their own enemies and thus used the

[100] *Ibid*, 226.
[101] Marjorie Cohn & Jeanne Mirer, "Armed Drones Violate the Right to Peace," *Peace Review*, A Journal of Social Justice, Routledge, downloaded from IRC 12 April 2016.
[102] Matthias Maass, "From U-2s to Drones…, 228.
[103] Doga U. Eralp, "The Role of U.S. Drones in the Roboski Massacre…,450.
[104] Stephanie Carvin, "Getting Drones Wrong…, 373.
[105] Marjorie Cohn & Jeanne Mirer, "Armed Drones Violate…

American aggression to further their own aims and not those of the United States.[106] Add to this the reward money that is offered by the United States for identifying 'terrorists'. Thus the quality and legitimacy of those named are justifiably questioned.[107] "There are said to be as many as six different 'kill lists' in existence for Afghanistan alone, with thousands of names among them, maintained by different agencies."[108] These lists are "constantly restocked" to ensure a steady and unending supply of names and targets for the UAS.[109] More problematic still are the signature, or pattern of life, strikes where individuals were targeted because of their conduct. If a person meets with a large group, that action could be considered hostile intent and thus become a 'legitimate' target. When this type of strike proves to be an error there is a tremendous amount of backlash. An example of unwanted backlash are the "… calls made in March 2011 by local North Waziristan tribal leaders to wage jihad against the United States after a [UAS] killed forty elders who were meeting to discuss chromite prices in the agency earlier that month."[110] In effect when the CIA "… mounts a signature strike, it does not even know who it is killing."[111] If in truth these are errors, then the backlash is justified and should be expected. This may further deteriorate the security situation by enraging populations and states which will create additional risks in the future.

The use of American UAS in the Middle East and in the war against terrorists has been conducted under the argument of "preemptive self-defense." The United Nation's Charter Chapter VII Article 51 states that self-defence is permissible after an attack. Legal interpretations

---

[106] Akbar Ahmed, *The Thistle and the Drone…,* 83.
[107] *Ibid*, 274. Medea Benjamin, *Drone Warfare Killing by…,* 27.
[108] Craig Martin, "A means-methods paradox…, 159.
[109] Akbar Ahmed, *The Thistle and the Drone…,* 276.
[110] Vahid Brown and D. Rassler, *Fountainhead of Jihad,* India: (Oxford University Press, 2013), 149.
[111] Marjorie Cohn & Jeanne Mirer, "Armed Drones Violate the Right to Peace," *Peace Review*, A Journal of Social Justice, Routledge, downloaded from IRC 12 April 2016.

of this article include discussions of limitations that include "proportionality" and "necessity".[112] Proportionality was discussed above. Necessity can be captured in the United States' desire to deter and repel future terrorist attacks. In the case of UAS use in the Middle East, the law could justify the attacks in that they would both repel "armed attack and take the war to the aggressor state in order to effectively terminate the attack and prevent a recurrence".[113] The manner in which the United States has navigated this legal limitation is by emphasizing that their 'targeted killings' were directed towards individuals that posed "an imminent threat" and thus were conducted in self-defence. However, "[o]nce defense has been stretched to include defense against *theoretical* future threats, is ceases to credibly distinguish itself from aggression."[114] As can be seen from the discussion above, the United States' use of UAS for targeted killing using the methods described above can easily be seen as going too far into this legal obstacle. To complete the discussion on the darker side of armed UAS use, we will explore some additional unintended consequences.

Many UAS "… hover overhead for hours, emitting a buzzing sound that terrorizes the children below and causes serious problems, including posttraumatic stress disorder (PTSD)."[115] This risk cannot be understated. An entire generation of youth has learned to hate these systems. They will seek vengeance on the perpetrators and operators of them. This could lead to additional security threats for the United States. If the strikes were indeed surgical and only those guilty of terrorism were targeted, then the local population could continue to live confidently knowing that they would be safe as long as they were not actively planning to attack the United States. As demonstrated above, the strikes while surgical in hitting what they are aimed at, are

[112] Mark V. Vlasic, "Assasination &Targeted Killing…, 271.
[113] *Ibid.*
[114] Marjorie Cohn & Jeanne Mirer, Armed Drones Violate…
[115] *Ibid.*

far less than perfect at targeting the actual enemies of the United States in a manner that would stand up to legal scrutiny. "Their use has enhanced local resentment of the United States and broadened the organizational pool of militant actors who now seek revenge, problems which will likely endure and need to be managed."[116] The most troubling aspect to this is when retaliation is conducted within the United States "where Americans live".[117] There are examples of this occurring. The horrific 2016 'Orlando Shooting' which resulted in 49 deaths was perpetrated by a single individual pledging allegiance to the Islamic State of Iraq and Syria. This is the same enemy that has been targeted by the United States' UAS program.[118]

It appears that UAS are seen as having less of an ethical implication which in turn has added risk to the world's security. UAS appear to violate sovereignty less than 'boots on the ground' despite the fact they operate in violation of the law as discussed above. It is due to the reduced appearance of violation that leads to further abuses.[119] If these actions taken by a state are less provocative, then it follows that they will be used more often in a '*vis perpetua'* or form of perpetual force.[120] Further, if it is acceptable for the United States to act this way, then it also follows that other nations could act in the same manner making the overall challenge to world security an increasingly complex issue. It will be far more likely that other countries will use these systems to intervene in areas where, without them, they would not have.[121] The United States acknowledges that their actions and conduct will lead to the "… inevitable proliferation of

---

[116] Vahid Brown, and D. Rassler, *Fountainhead of Jihad*, 149. Medea Benjamin, Drone Warfare Killing by…, 29.

[117] Daniel Sukman, "Lethal Autonomous Systems and the Future of Warfare …

[118] Ralph Ellis, Ashley Fantz, Faith Karimi and Eliott C. McLaughlin, Orlando shooting: 49 killed, shooter pledged ISIS allegiance, CNN Online, Internet Accessed 1 July 2016, http://www.cnn.com/2016/06/12/us/orlando-nightclub-shooting/.

[119] Rand Corporation, "Armed and Dangerous? UAV's and U.S. Security," Rand.org. Downloaded 10 May 2016. http://www.rand.org/pubs/research_reports/RR449.html 12.

[120] Christian Enemark, "Drones, Risk, and Perpetual Force," *Ethics and International Affairs*, 28, no. 3, 2014, 365.

[121] Lynn E. Davis, Michael J. McNerney, James Chow…, 15.

remote weapons" as was explored in chapter two.[122] Add to this the ease with which a remote control UAS can kill from afar and"… reasons to stop might be hard to find."[123] With ease of use, the UAS is both safer for the soldiers and the politicians, thus it follows that they are likely to be a destabilizing force and an ongoing cause for concern.

Finally, the idea of world leadership for which the United States has acted over the past many years will be difficult to achieve with respect to UAS given their abuse and lack of credibility and responsible use of them. This impact may be experienced by the many other nations with the technology and capability to use them in a highly destabilizing manner. It would be difficult to put a price on this loss of control. Despite President Obama's message, "[i]f we want other nations to use these technologies responsibly, we must use them responsibly", it may already be too late for this level of constraint.[124] Other governments and entities are acquiring and operating armed UAS in ways that are likely to threaten "… regional stability, laws of war, and the role of domestic rule of law in decision[s] to use force."[125] With all of the above noted consequences to UAS use, the toted 'zero-risk' concept is easily challenged as being categorically wrong. UAS have increased risks to global security through proliferation and counter reaction. Responsible use of UAS could have the reverse effects. This is where Canada's timely building of an RCAF UAS capacity could demonstrate responsible world leadership while concurrently better fulfilling the CAF's role for Canada.

---

[122] Joseph O. Chapa, "Remotely Piloted Aircraft and War in the Public Relations Domain," *Air and Space Power Journal*, (Fall 2014): 39.

[123] Stephanie Carvin, "Getting Drones Wrong…, 379.

[124] Lynn E. Davis, Michael J. McNerney, James Chow…, 19.

[125] *Ibid*, 21.

CHAPTER FOUR - PROCUREMENT

Chapter four will highlight the reasons why the RCAF should acquire a UAS capability. It will also go into detail on the CAFs procurement challenges. The JUSTAS procurement program was initiated in the year 2000. It has yet to produce a procurement of any permanent UAS. The JUSTAS program's missed timelines and delays are similar to the Sea King replacement attempts where the first Sea King replacements were planned to arrive in the early 1990s.[126] The CAF procurement process is vulnerable to changing political winds and in some cases to the CAF's choices which lead to an overall sluggish system. Because of the failed attempts to procure UAS and the implications to Canadian industry, a different course of action will be suggested. Despite Canada's procurement missteps, the CAF has managed to get what it needs when it needs it and have been remarkably successful in accomplishing their assigned tasks. However, with respect to UAS, there is an underlying consequence to delay that may be more difficult to overcome. As discussed in chapter two, technological advancement is exponential. As well, the delta between current CAF expertise and the UAS skill sets that are required will lead to a more difficult transformational change. The CAF needs to seriously begin preparing immediately.

Reasons for UAS

The Canada First Defence Strategy is the current CAF guiding document. Written within that document are the three roles of the military. The roles are "defending Canada, defending North America and contributing to international peace and security."[127] Embedded in the first role is the first priority of "surveillance of Canadian territory and air and maritime approaches".

[126] Aaron Plamondon, *The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter*, (British Columbia: 2010), xi.

[127] Government of Canada, Canada First Defence Strategy, Canada.ca website, Internet last accessed 1 July 2016, http://www.forces.gc.ca/en/about/canada-first-defence-strategy.page.

Canada has the world's second largest land mass at 9,984 million square kilometers and has the world's longest coastline at 202,080 kilometers.[128] Patrolling and protecting that land mass is an immense task! It is also a task that would clearly become *dull* after the first few thousand kilometers. None of the current RCAF aircraft in use can perform this task the way a small fleet of capable UAS could. New technological tools, such as the MALE UAS, can help solve this challenge and fill this security capability gap to fulfill the essential and primary role. As discussed in chapter two, the proliferation of other countries' UAS platforms including belligerents such as Russia and China will require that we too have a stronger presence to deter their presence in Canadian territory. A capable UAS would act in a manner similar to a marked police car patrolling the highways. When motorists see a police car they tend to operate more cautiously while trying harder to prevent driving infractions to avoid consequences. By Canada demonstrating a persistent presence over the territory, aggressors would certainly be deterred far more than they are now. The presence would offer significant deterrence and the ability to capture data for later use to hold belligerent violators accountable. If there is no one to monitor, the illegal or unwanted act will be much more likely to occur. This presence is of utmost importance in the Arctic where the sparse population and lack of reconnaissance resources contributes to an environment where other entities could operate in manners contrary to Canadian wishes.

Satellite data has shown that "Arctic sea ice has shrunk 2.7% per decade since 1978; faster in the summer months (7.4% per decade)." [129] Also of note is that "… upwards of 50 per

[128] Maps of the World, Top Ten Countries with the Longest Coastlines, Website, Internet accessed 1 July 2016, http://www.mapsofworld.com/world-top-ten/world-top-ten-longest-coastline-countries-map.html.

[129] Svein Vigeland Rottem, The Arctic Council and the Search and Rescue Agreement: the case of Norway, Polar Record 50 (254): 284-292 (2014) Cambridge University Press 2013, last accessed 28 April 2016, http://www.fni.no/pdf/SVR-PR-2013.pdf, 285.

cent of the world's undiscovered resources are estimated to lie in the Arctic."[130] Those two factors coupled with the increasing population, which will need to be supported with resources, would lead to the common sense deduction that there are 'other' interests in the Canadian North. With greater access from retreating ice, commercial fishing, shipping, tourism, and resource development activities will be on the rise.[131] There should be no doubt in anyone's mind that the RCAF's lack of persistent presence will most certainly be filled by those countries most in need. The Arctic is also a very dangerous place to operate. The extreme cold and unpredictable weather would make survival difficult for any aircrews that found themselves in a survival situation. A UAS would not have this issue. It would clearly fulfill the *dangerous* role of patrolling the Canadian North. The greater access afforded by receding ice will also increase traffic in the North West Passage of all types. This will lead to "…more accidents and make search and rescue operations in the Arctic more hazardous and complex."[132] In addition to capability in the Arctic as was demonstrated during the 2004 ALIX experiment, UAS have already proven effective by Canada on deployed operations.

The Canadian Army (CA) has used small UAS such as the *ScanEagle* and *Raven B* for tactical purposes in Afghanistan. They also "surprised the air force" when they acquired the larger systems beginning with the *Sperwer* and then the *Heron* UAS, in the same theatre of operations.[133] Although the RCAF engaged in the larger UAS operations to assist the CA, it was not before the *Sperwer* experienced two hard landings and three crashes within the first 60 sorties.[134] Operational control of the larger systems was appropriately transferred from the CA to

---

[130] Daniel, Lachance, LCol, Arctic Alternative Futures, RCAF Journal vol. 4 summer 2015
[131] Svein Vigeland Rottem, The Arctic Council and…, 285-286.
[132] *Ibid*.
[133] Gary Schaub Jr, and K. Kristensen. "But Who's Flying the Plane? Integrating UAVs into the Canadian and Danish Armed Forces," *International Journal* 70, no. 2 (06, 2015): 250-267.
[134] *Ibid*.

the RCAF in 2009.[135] The Royal Canadian Navy currently uses the smaller *ScanEagle* systems aboard their frigates to assist in the search for pirates.[136] The Sperwer were bought as an urgent operational need for operations in Afghanistan. The fleet was incrementally built until there were 25 with 4,270 flight hours and over 1,300 sorties.[137] The Israeli Heron systems were leased with assistance from the JUSTAS project office for 30 months with 837 successful missions flown and no aircraft losses.[138] The Sperwer have since been sold off leaving no MALE UAS capability for Canada. The CAF knows from past experience that UAS are invaluable in the capabilities they provide. These systems reduce the risk to service members and improve operational effectiveness. There is also a positive psychological effect that could be gained by a capable UAS fleet.

A permanent RCAF UAS capability would easily embrace and exploit the positive psychological effects of airpower by providing overhead cover to operations on the ground.[139] This has already been proven valuable by the Sperwer and Heron systems that were used in Afghanistan to search the area of operations for threats. This bird's eye information no doubt saved many lives. This could be projected further to include Search and Rescue scenarios where the UAS would stay overhead for an extended period of time providing support to those in need on the ground. This is especially true in the Arctic where operations are by definition remote and dangerous. By using unmanned systems to work in this dangerous environment there would be reductions in risk to manned Search and Rescue personnel and platforms. With fewer manned

---

[135] *Ibid*.
[136] Gary Schaub Jr, "JUSTAS for all? Innovation and UAVs, 124.
[137] *Ibid*, 131.
[138] Ibid, 133.
[139] Richard Goette Dr, "The Positive Psychological Effects of Air Power," The Royal Canadian Air Force Journal vol. 1, no. 1, Winter 2012, last accessed 28 April 2016, http://www.rcaf-arc.forces.gc.ca/en/cf-aerospace-warfare-centre/elibrary/journal/2015-vol4-iss3-07-the-positive-psychological-effect-of-air-power.page, 80.

flights this would further reduce costs and risks.[140] A properly equipped aircraft would also be able to drop lifesaving equipment such as a Survival Kit Air Droppable (SKAD) which is currently part of the requirements of the JUSTAS project's intended capabilities.[141] A capable system could quickly deliver essential parts, equipment or supplies to remote locations improving operational effectiveness. The list of benefits of a UAS is expansive and further reason to navigate the acquisition of the capability in a manner that is not vulnerable to the many pitfalls of the Canadian procurement process.

Continuing with the positive potential of a UAS, there are many peacekeeping roles which Canadians value and support. Just as with the analogy of the marked police car, a surveillance craft could be watching for international human rights violations and preventing them from occurring. The UAS could deter "… dangerous movements of arms and fighters … truce violations, large-scale atrocities or clandestine smuggling of weapons or humans."[142] A well-equipped and capable UAS would be the ideal platform for persistent, detailed, and day or night observation to better protect the lives below. Peacekeepers have traditionally operated in daylight. Not so with belligerent fighters who exploit the night time. With the use of night vision goggles this has changed. However, a UAS would eliminate almost entirely the night advantage to the hostile actors. A UAS would also be able to provide this support with less intrusiveness, which is in contrast to the aggressive use as seen in chapter three. The benefits and utility of

[140] Lynn E. Davis, Michael J. McNerney, James Chow…, 11.

[141] Public Works and Government Services Canada, "JUSTAS RFI 2016," Downloaded from Internet 10 April 2016, https://buyandsell.gc.ca/procurement-data/tender-notice/PW-BL-298-25611, 13.

[142] Walter A. Dorn Dr, *Keeping Watch: Monitoring Technology and Innovation in UN Peace Operations*, (United States: United Nations University Press 2011), 2.

UAS are clearly desirable, which is motivating Canada to actively seek a solution through the JUSTAS program. [143]

JUSTAS Program Delay

The 2016 Canadian Air Force General Order (CANAIRGEN) issued discussing UAS stated, "Unmanned Aircraft Systems (UAS) are becoming increasingly prevalent in military and civilian domains in Canada and around the world. UAS capabilities continue to grow at a rapid pace and the RCAF needs to remain fully engaged in this continuously evolving domain."[144] This has been a steadfast sentiment of the CAF since the inception of its omnibus procurement project. The JUSTAS project was initiated in September of 2000 with its first operational capability to follow within the decade. There is nothing fundamentally wrong with any of its stated goals or requirements. The latest 2016 Letter of Interest to industry identifies that it can be one UAS or a mixed fleet of different types and does not specify it as a MALE system but rather a Long Range Long Endurance platform. This is consistent with Canada's most prominent characteristic: its size. The system or systems are intended for operations domestically including the Arctic and deployable with or without weapons capabilities. The document proposes a staged implementation to achieve the full JUSTAS objectives, beginning with an interim capability that may span up to five years. The sensor package is expansive and includes Synthetic Aperture Radar, Sense and Avoid System, De-Icing and Anti-Icing systems, Beyond Line of Sight Command Link with back-up link, Traffic Collision Avoidance System, Electro-Optics/Infra-Red Turret with Laser Range Finder and of course weapons, to name a few.[145] The document identifies possible base locations, the need for the systems to be flexible and allow for growth of

[143] *Ibid*, 32.

[144] Canadian Air Force General Order, "CANAIRGEN 15/16," Internet last accessed 18 May 2016, http://barker/Admin/Canairgen/2016/cag16015-eng.html.

[145] Public Works and Government Services Canada, "JUSTAS RFI 2016," Downloaded from Internet 10 April 2016, https://buyandsell.gc.ca/procurement-data/tender-notice/PW-BL-298-25611, 6.

sensors and potential missions that include air dropping of survival kits. Also included are seven detailed scenarios that the system or systems would need to be capable of achieving. They include maritime security challenges off both East and West coasts, Arctic, overland, training and two expeditionary scenarios, including the strike capability. The document is detailed, well thought out and well communicated to allow industry to help the CAF identify the right solution or solutions. Clearly communicating the desired Canadian UAS capabilities has not been the obstacle to procurement. There are other factors that have prevented the CAF from attaining the ideal permanent solution.

The challenge is that the Canadian procurement structure cannot support JUSTAS as intended. This can be seen in the timeline of events as follows. The JUSTAS plan stated that the first operational UAS was to be flying missions by 2009.[146] As has been the case in many of Canada's procurements this date has come and gone. In 2006, 500 million dollars was allotted to begin procurement beginning with six MALE UAS for overland operations domestic and abroad with contracts to be awarded beginning in 2007. In early 2007, the project implementation phase was 'put on hold'. In March 2007, a proposal was initiated to purchase sole-source nine General Atomics Predator B UAS which was very quickly rejected by the Harper government cabinet due to non-competitive concerns.[147] In January 2008, the Honorable John Manley produced for Prime Minister Steven Harper the 'Independent Panel on Canada's Future Role in Afghanistan'. Within this report was a recommendation on the procurement of drones where he specifically outlines the need for "high performance Unmanned Aerial Vehicles for intelligence, surveillance, and

[146] Canadian American Strategic Review, "The Joint Uninhabited Surveillance Target and Acquisition System (JUSTAS) Project," http://www.casr.ca/id-justas-project-timeline.htm.

[147] *Ibid*.

reconnaissance before February 2009."[148] After numerous Letters of Intent with the most recent one in January 2016, reviews, changes and political interference there remain no procurement solutions. The one billion dollar and 20 year service contract project is grinding through iteration after iteration of change, and lacking commitment on the part of the government and in some cases the CAF. This was seen when personnel intended for JUSTAS were "… being turned over for staffing of a new Chinook helicopter squadron to be located in Petawawa."[149] A further example of the CAF's lack of clarity and commitment includes the statement by Lieutenant General Blondin, as commander of the RCAF, where he stated "if you commit yourself too early with a very expensive program, there are new ones coming in that are not far behind that will give you different capabilities and could be much cheaper."[150] The CAF cannot shoulder entirely the responsibility for procurement failures. Politics are by far the greatest threat to successfully acquiring a UAS capability.

Politics and Procurement

The impact of politics on Canadian military hardware procurement is substantial. To begin with, military expenditures are vast, discretionary and decided upon proportional to the political popularity among the electorate. In its most basic sense, if the idea is popular the political party will support it in order to secure their political future. During times of no conflict, low security threat, and a struggling economy, it would not be popular to buy billions of dollars' worth of military hardware despite the 'need'. Large capital procurements usually take a long

[148] Independent Panel on Canada's Future Role in Afghanistan, January 2008, Internet Accessed 28 July 2016, http://publications.gc.ca/collections/collection_2008/dfait-maeci/FR5-20-1-2008E.pdf, 38.

[149] David Pugliese, "Unmanned vehicles: the long, slow, costly process of bringing JUSTAS to the Canadian Forces," Esprit de Corps, Published 1 Sept 2012, Internet accessed 22 April, 2016, http://www.thefreelibrary.com/Unmanned+vehicles%3A+the+long,+slow,+costly+process+of+bringing+JUSTAS...-a0305839762.

[150] Danny Garrett-Rempel, "Will JUSTAS Prevail? Procuring a UAS Capability for Canada," *Royal Canadian Air Force Journal*, vol. 4, no. 1, (Winter 2015), 24.

time to source. For example, the 12 Canadian Patrol Frigates were built and delivered over a five year period.[151] This leads to lengthy procurement processes that once signed and committed to by one political party, can be cancelled by another. These procurements are also highly discretionary. History has proven that "Canada has been incapable or unwilling to properly equip its military."[152] To not be in a state of perpetual war is a great fortune for Canada. Canadian borders are not being threatened by any significant belligerent, and the United States provids immense security as the world's sole superpower. Beyond the barely minimum commitments to the North Atlantic Treaty Organization (NATO), the United Nations (UN), the North American Aerospace Defence Command (NORAD) and providing a basic level of national security, the balance of Canadian military expenses could be delayed or cancelled out right. On the reverse side, it would be highly unpopular for the Canadian government to subject military personnel to tasks in which they are not equipped. This situation could lead to the failure of an assigned mission or worse, fatalities. For example, once Canada committed to fighting in Afghanistan post September 2001, the CAF leadership and political leaders realized there were some clearly identified risks and gaps in equipment that needed to be closed. The *Sperwer* and *Heron* were used to enhance the protection of CAF deployed forces. As such, the political parties spend what they must to prevent failure and loss of life, but very little more until the next crisis where action is demanded to appease the civilian population. When discussing large procurements such as the CF-18 replacement or the procurement of the Canadian Patrol Frigates, the process to compel action is a long and arduous road. Although politics are the main reason of procurement delays, the Canadian military also contributes to extending the process.

---

[151] Wikipedia, Halifax-class Frigate, Internet last accessed 2 July 2016, https://en.wikipedia.org/wiki/Halifax-class_frigate.

[152] Aaron Plamondon, *The Politics of Procurement; Military Acquisition in Canada and the Sea King Helicopter",* (British Columbia: UBC Press, 2010), 1.

The military ethos is built around achieving success. By automotive standards antiques are vehicles that are more than 30 years old.[153] Aircraft do not use the same age measurements however as aircraft age their availability and maintenance costs rise. "Available data shows that availability drops from the 95% range for aircraft up to 15 to 20 years of age to an average of 70% at age 25 and 55% at age 30".[154] As of 2016 the RCAF has nine fleets aged 30 years or more flying operationally in support of the Canadian government. They include the Jet Ranger used for training in Portage la Prairie, the Challenger used for government and CAF personnel transport out of Ottawa, the CF -18 front line fighter, the Aurora which is currently the RCAF's long range patrol aircraft, the Twin Otter which is used in Yellowknife, the Buffalo which is primary SAR in Comox, the 'legacy' Hercules which also flies primary SAR in Trenton and Winnipeg, and finally the Sea King which began flying in 1964 a full 52 years ago![155] "The fact that attempts to replace the Sea King necessitate a book-sized study reveals that there is a procurement problem in Canada."[156] However, they are still flying and achieving success and that is an important reason why they are not yet replaced. It places the service men and women who operate the equipment in a tough spot. Their professionalism and dedication, and indeed their job, does not allow for failure at any task. They will therefore do what must be done in order to keep the equipment operational and the tasks on track. Only when faced with limitations that cannot be overcome will the replacement or modernization discussions be meaningfully engaged. However there is at present a risk of failure to the CAF's core missions. The world is changing with a robotics revolution and as we have seen in chapter two the RCAF is not reacting

[153] Joanne Will, "Is my car vintage, classic - or just old?" The Globe and Mail, Internet last accessed 17 May 2016, http://www.theglobeandmail.com/globe-drive/culture/commuting/is-my-car-vintage-classic---or-just-old/article11938943/.

[154] Bill de Decker, "HOW OLD IS TOO OLD," *Conklin and de Decker Aviation Information*, March 2000, Internet Accessed 28 July 2016, https://www.conklindd.com/t-howoldistooold.aspx.

[155] Wikipedia, "List of active Canadian Military Aircraft", Internet last accessed 30 June 2016, https://en.wikipedia.org/wiki/List_of_active_Canadian_military_aircraft.

[156] Aaron Plamondon, *The Politics of Procurement…*, preface.

to this change quick enough. This ushers in an opportunity to identify solutions to the UAS procurement challenges.

Caution is however advised when communicating the CAF's needs to Canadians and the political leaders. Words need to be chosen wisely when discussing military needs. First and foremost as a democracy, it is the civilian political leaders that decide what the military needs and what it will do with what it is given. The Canadian Chief of the Defence Staff can state that "… I am of the view that we need armed UAVs," as did General Johnathon Vance when speaking to a Senate Committee on the 7 March 2016.[157] However, this statement does not wield sway beyond perhaps temporarily influencing public opinion which can be fickle. Even then it may backfire since the military should not be seen as wielding that type of decision power. Worth mentioning again are the negative sentiments towards UAS as discussed in chapter three. The most recent political delay to the JUSTAS project is the initiation of "… an open and transparent defence review process"[158] to replace the Canada First Defence Strategy that is due to be released early 2017 after which a new policy document will emerge.[159] The CAF should advise on how best to achieve the tasks assigned to them by the political powers. We will return to this example with additional impacts in the discussion below and after discussing briefly Canadian procurements and the lack of support to Canadian industry.

Procurement and Canadian Industry

This portion of the exploration will address the efforts Canadian industry has made, only to be frustrated and in many cases abandoned by its own government. A Canadian company was

[157] Tom Parry, CBC News on-line, 7 March 2016, Internet last accessed 1 July 2016, http://www.cbc.ca/news/politics/vance-canada-armed-drones-1.3480278.

[158] Chris Thatcher, Planning for Power, Skies Magazine, News 20 April 2016, Internet accessed 22 April 2016, Http://skiesmag.com/news/article/Planning-for-power.

[159]Government of Canada Website, "Defence Policy Review," Internet last accessed 2 July 2016, http://dgpaapp.forces.gc.ca/en/defence-policy-review/index.asp.

actually a pioneer of UAS technology beginning in 1960 with the Canadair development of the CL-89 Midge. This was a first generation UAS that could be launched, fly a pre-programmed route and return to a location landing under parachute with its imagery and information it had collected, then prepared to fly again.[160] This early effort was followed up by other models including the CL-289 which flew operationally with the British Army in the 1991 Gulf War and the CL-427 Puma which was tested in 2001. "Canadian firms were recognized as leaders in the field of developing state-of-the-art UAS from the 1960s until the 1980s, but a lack of government procurement contracts meant that the technology declined in Canada from the 1980s until the early 2000s."[161] This pattern of Canadian innovation not being supported by Government contracts is similar to the EH-101 project which was intended to replace the aging Labrador Search and Rescue helicopters as well as the Sea Kings. This procurement plan was promptly cancelled by Prime Minister Jean Chrétien as part of his 1993 election promise to take his pen and write "… zero helicopters."[162] The EH-101 had Canadian companies preparing to contribute to the aircraft only to be in a position to lay off workers and stop development of the aircraft. In a quote from the Minister of National Defence Kim Campbell in 1993, the original EH-101 procurement would have netted "… 45,000 direct and indirect person-years of employment over 10 years… [been] more than 50 percent Canadian-made… [and] guarantee that 10 percent of every EH101 sold worldwide [would] be Canadian-made."[163] There were also the technological transfers to Canada that would have enhanced the country's prospects in developing future native technologies. Instead, the cancellation resulted in immediate job losses

[160] Danny Garrett-Rempel, "Will JUSTAS Prevail? Procuring a UAS Capability for Canada," *Royal Canadian Air Force Journal*, vol.4 no. 1 Winter 2015, 19.
[161] *Ibid*, 20.
[162] Aaron Plamondon, *The Politics of Procurement…*, 126.
[163] Aaron Plamondon, *The Politics of Procurement…*, 107.

and 478.3 million dollars in cancellation fees.[164] Most recently, the procurement of the F-35 Joint Strike fighter was sent back to the drawing board by the newly elected Prime Minister Justin Trudeau.[165] He stated that it "no longer makes sense" to buy the Lockheed Martin fighter because Canada would not participate in any first strike missions.[166] "Many Canadian companies have spent years building components for the new plane and stand to lose as much as CDN $11 billion (US $8.3 billion) in work over the life of the jet."[167] From the AVRO Arrow to the F-35, this pattern of not following through with procurement plans is well entrenched in Canada and the JUSTAS program is currently following the same pattern.

Ways of Attaining UAS Capabilities

One of the significant challenges to overcome with the introduction of a revolutionary innovation such as a MALE UAS is that it would be a transformational change and would be disruptive to the present RCAF structure. A structure like the Canadian military places a premium on "… predictability, stability, and certainty."[168] These three attributes help the organization to reliably deliver on its assigned roles without risk of failure. However, as has been discussed above, if the UAS transformative gap is large now it will only get larger with each day that passes. It would be far easier to favour an adaptive type change where it was done incrementally. A way to accomplish this is to grow the capability in a well-organized and well thought-out strategy. For example it would make little sense to stand up a permanent UAS squadron with permanent positions without a UAS available to be employed. Rather, the RCAF should begin to build expertise in the domain with exchange postings, a doctrine cell and

---

[164] Aaron Plamondon, *The Politics of Procurement…*, xv.

[165] Defence News Website, "Canada's F-35 Decision Poised To Shake Up Fighter Jet Market," Website, 15 Oct 2015, http://www.defensenews.com/story/defense/2015/10/25/canada-f35-decision-poised-to-shake-up-market-israel-italy-eurofighter-rafale/74455726/

[166] http://www.cbc.ca/news/politics/stealth-fighter-payment-1.3619469 Internet accessed 7 June 2016.

[167] Defense News Website, "Canada's F-35 Decision Poised…

[168] Gary Schaub Jr, "JUSTAS for all? Innovation and UAVs, 127.

development of a draft force structure that could be incrementally pieced together. The key is to start now and to manage it in a way that ensured long term retention of the expertise. What this would seek to avoid is what occurred after the leased Heron UAS in Afghanistan where the unit was disbanded, "… its personnel disbursed, and its aircraft and systems returned to the contractor."[169] It is of little value to have a pilot fly a UAS in this manner or on exchange then have a career path that never returned to UAS operations. Those Captains will be needed in supervisory roles, and the Majors in the policy and procurement roles at the higher ranks. The cost of lost experience should be fully understood and mitigated.

The most obvious cost to manage is the actual financial commitment to procuring a UAS. Depending on what solution or solutions are chosen, it will be significant and with a long term commitment from industry. As discussed above, large capital procurements that extend past an election cycle are too vulnerable to yield timely results. Such was the case with the recent cancellation of the F-35 Joint Strike Fighter, the EH-101 and all the way back to the AVRO Arrow where "… the longer a defence project goes on in Canada, the more politically vulnerable it becomes."[170] Leased alternatives and longer term trials could be used to navigate this. Leasing can be done in less time; yield quicker results, and would no doubt prove their worth perhaps with the added benefit of expediting a permanent procurement. Even a series of trials with price tags well below the JUSTAS total procurement cost would suit the objective of enabling an adaptive and less expensive transformation. The key is to not wait for an urgent short term conflict-based need, but instead build the case off the core roles of the CAF which begin within Canada.

---

[169] *Ibid*, 134.
[170] Aaron Plamondon, *The Politics of Procurement…*, 29.

Reducing the risk of operational failure is a significant consideration in the discussion of UAS capability. The CAF does not own a capability such as the *Heron* UAS that was deemed as operationally essential and urgent. Canada has the longest coastline in the world, and currently it does not have the right systems managing that expansive task of patrolling it. The void of presence will undoubtedly be filled by some other entity if not mitigated. This is unacceptable and should be considered a failure on Canada's part for defending its territory. In framing CAF's lack of presence as a failure, it is far more likely to gain support for a UAS solution.[171]

[171] Gary Schaub Jr, "JUSTAS for all? Innovation and UAVs…, 127.

CHAPTER FIVE - CONCLUSIONS

The robotics revolution is well underway. This fact demands that Canada engage in that revolution in an equally meaningful way so as not to be overrun by entities operating around Canada. There is no slowing the proliferation of ever more capable systems in all areas of life. From self-driving cars, semi-autonomous surgeons, intelligent robots exploring space all the way to improvements to health and home environments. The key point to this discussion was the military applications of semi-autonomous systems. There will certainly be newer and better technological solutions the longer the RCAF waits. If the RCAF waits long enough, the robots will be fully autonomous and incorporating an entirely new set of concerns for humanity. It is expected that one day soon a machine will be able to pass the 'Turing Test', or as Alan Turing, the inventor of the World War II computer called it, the 'Imitation Game'.[172] The test posits that a machine will demonstrate intelligence when a human judge is unable to determine whether its interactions with the machine are either human or not. Randy Kurzweil believes this test will be passed by the year 2029.[173] This phenomenon of continuous improvement will be true tomorrow, next week, and at every foreseeable point in the future. Using a 'wait and see' approach will invariably result in a dreaded situation where the task of innovating will be that much more difficult.[174] At this time we have witnessed other nations and entities that are actively pursuing their own UAS capabilities at an unsettling rate. Not all of these entities and actors are operating them consistent with Canadian values or in a way that adds to the world's stability and security. Add to this the proliferation of the smaller and increasingly less expensive devices and this will

---

[172] Alan Turing, Computing Machines and Intelligence, Internet last accessed 4 July 2016, http://loebner.net/Prizef/TuringArticle.html.

[173] Randy Kurzweil, "How My Predictions Are Fairing," October 2010, Internet accessed 16 April 2016 http://www.kurzweilai.net/images/How-My-Predictions-Are-Faring.pdf.

[174] Danny Garrett-Rempel, "Will JUSTAS Prevail? Procuring a UAS Capability for Canada," *Royal Canadian Air Force Journal*, vol. 4, no. 1, (Winter 2015), 24.

lead to "... a wider range of actors" further risking safety.[175] The right time to have begun to grow the RCAF's forest of UAS was when the Canadair CL-89 Midge was sprouting. The second best time is now.

As Carl von Clausewitz noted in his impressive book *On War*, "[t]he invention of gunpowder and the constant improvement of firearms are enough in themselves to show that the advance of civilization has done nothing practical to alter or deflect the impulse to destroy the enemy."[176] From rocks, bow and arrows, firearms, missiles through to semi-autonomous military machines designed to seek and destroy, there is no limit to where the military application of technology will be taken in the future. With the latest developments in automation "…the world is approaching a robotics revolution in military affairs that may be on par with the introduction of gunpowder, levee en masse, and the advent of nuclear weapons."[177] It is time to contribute to responsible leadership in the military use of UAS and learn from the missteps of the United States to define and achieve a Canadian solution. World leadership and contrast is needed from the negative sentiments embodied by statements such as UAS "… instill terror in communities, violating their right to peace".[178] The systems offer the ability to protect humans with their many positive attributes. A UAS embodies perseverance through its tireless and emotionless ability to offer persistent aerial operations with increasingly capable sensors and do this far more efficiently than the manned systems. They have already saved many Canadian lives in Afghanistan with the Canadian Sperwer and the leased Heron UAS. Canada's use of a UAS would be in accordance with international laws, with less secrecy and would be accountable for

[175] Paul Wilkins, Group Captain Royal Air Force, "Conceptualizing the Conceptual Component: One Airman's Perspective," *Air Power Review*, Vol 18 no 1, Spring 2015, 11.

[176] Carl von Clausewitz, *On War*, ed. and trans. Micheal Howard and Peter Paret, (Princeton, Princeton University Press, 1976), 76.

[177] Daniel Sukman, "Lethal Autonomous Systems and the Future of Warfare …

[178] Marjorie Cohn and J. Mirer, "Armed Drones Violate the Right to Peace, Peace Review," *A Journal of Social Justice*, Routledge, downloaded 12 April 2016, 417.

its actions. Looking from above does not necessarily need to be spying. Examples include lawful monitoring of security situations below or assisting people below to achieve survival or safety. The world would use Canadian leadership as a contrast to the negative ways that other entities have been using and are likely to continue using them. In contrast to the United States, Canada is not an outwardly aggressive nation that is engaged in combat operations in many locations around the world. Instead, Canada has a history of managing violence when needed, such as the CAF's engagement most recently in Afghanistan. Canada is more in tune with directing resources in accordance with Canadian values towards the establishment of security, peace, and stability.

Canada would benefit immensely from UAS technology especially given the size of its land mass and proximity to the increasingly accessible Arctic. If the RCAF does not have a persistent presence, there will certainly be others using the latest technological innovations to further their own objectives contrary to Canadian wishes. UAS would allow for early detection of dangers, provide surveillance, and if necessary act with force to counter a direct threat.[179] Further to this, the CAF has experience with UAS that have proven their worth as both essential and urgent to best protect the forces on deployed operations. Simply put, there are unending strings of positive effects that can be realized by the responsible use of these technological innovations. The first priority of a Search and Rescue mission is to 'preserve life'.[180] A UAS with a SKAD may be the closest and most capable asset to accomplish this very important first step. Canada would be a world leader in demonstrating these benefits and will balance the military use of UAS. The challenge is acquiring the technology in a manner that reflects the urgency in which it is needed.

[179] Canadian Aerospace Shield Doctrine, B-GA-405-000/FP-001, 20.
[180] Canadian Forces Aerospace Move Doctrine, B-GA-404-000/FP-001, 43.

Navigating the acquisition process for a permanent UAS capability is a responsibility of utmost importance. While the CAF has limited control over changing the political winds, it does control to a large extent their allotted resources. Achieving success begins with a plan that would aim to grow the capability in an adaptive, lower cost manner. Framing the capability gap as a failure needing to be corrected will go a long way to achieving success. A family home can save a great deal of money putting off the purchase of a new car for a few years. However, for a country that survives well past an average human lifetime, money is not the only issue. In contrast to the very lucrative military-industrial complex in the United States, Canada has neglected the Canadian industries that support the CAF. The politically driven cancellation of the EH-101 with all of its impacts to Canadian industry set the Sea King replacement back at least 15 years.[181] Trust should be built with industry to ensure timely and cohesive solutions to Canadian challenges. In addition to supporting industry, effort must be dedicated to recruiting and retaining the right skill sets with the experienced senior leadership able to manage the new technology. By not immediately initiating UAS personnel development, the CAF is missing out on a generation of eager youth with the current skill sets ideal for UAS operations. This is in part due to the video game abilities that meld well with remote controlled aerial vehicle operations. The tremendous new capabilities that can be leveraged for Canada will amount to far more than the dollar savings of delaying the procurement. Watching and waiting on the sidelines while the rest of the world actively integrates military UAS is going to be an increasing challenge that will only become more of an obstacle the longer it is delayed. The CAF has a proud history of making the most of the resources that have been given to achieve success. However in this era of rapid exponential growth, the indulgence of time using a slow procurement process will not facilitate success, but rather exponentially increase the risk of failure. That result would be

[181] Aaron Plamondon, *The Politics of Procurement…*, 125.

inconsistent with CAF professional military ethos. It is time to "pull the trigger"[182] as Chief of the Defence Staff, General Jonathan Vance recently stated and begin watering the budding ideas of UAS operations. It is time to be bold to urgently begin acquiring and using a long-range long-endurance UAS to solve the current pressing Canadian need.

[182] CBC, "*What Canada Needs to Know before Buying Armed Drones Or UAVs,"* Toronto: Canadian Broadcasting Corporation, 2016. http://search.proquest.com/docview/1772678380?accountid=9867.

BIBLIOGRAPHY

Ahmed, Akbar. *The Thistle and The Drone: How America's War on Terror Became a Global War on Tribal Islam.* Washington D.C.: Brookings Institution Press, 2013.

Alvarez, Edgar. "US military tests a Tinker Bell-sized drone". Engadget. 29 May 2015. Downloaded 12 May 2016. https://www.engadget.com/2015/05/29/us-military-micro-drone/.

Benjamin, Medea. *Drone Warfare: Killing by Remote Control.* London: Verso Publishing, 2013.

Canada. *Canadian Forces Aerospace Sense Doctrine.* B-GA-402-000/FP-001. Canadian Forces Aerospace Warfare Centre 1st Edition: 2012.

Canada. *Canadian Forces Aerospace Shape Doctrine.* B-GA-403-000/FP-001. Canadian Forces Aerospace Warfare Centre 1st Edition: 2014.

Canada. *Canadian Forces Aerospace Move Doctrine.* B-GA-404-000/FP-001. Canadian Forces Aerospace Warfare Centre 1st Edition: 2011.

Canada. *Canadian Forces Aerospace Shield Doctrine.* B-GA-405-000/FP-001. Canadian Forces Aerospace Warfare Centre 1st Edition: 2012.

Canada. Department of National Defence CANIRGEN. RCAF OPI for Unmanned Aircraft Systems (UAS) – CFAWC. 4 May 2016. Downloaded 18 May 2016.

Canadian American Strategic Review. "Canadian Forces UAV Procurement: A DND JUSTAS Project Timeline". (July 2013-May 2015). Downloaded 13 April 2016. http://www.casr.ca/id-justas-project-timeline.htm.

Canadian American Strategic Review. "Canadian Forces UAV Procurement: A DND JUSTAS Project Timeline". Internet Last Accessed 28 April 2016. http://www.casr.ca/id-justas-project-timeline.htm.

Canadian Broadcasting Corporation. *What Canada Needs to Know before Buying Armed Drones Or UAVs*. Toronto, 2016. Internet last accessed 25 July 2016. http://search.proquest.com/docview/1772678380?accountid=9867.

Carvin, Stephanie. "Getting Drones Wrong". *The International Journal of Human Rights.* Routledge. 24 February 2015. Downloaded IRC 12 April 2016. http://dc.doi.org/10.1080/13642987.2014.991212.

Clark, Stephen. "SpaceX announces plan to send mission to Mars in 2018". *Space Flight Now*. Internet last accessed 12 May 2016. https://spaceflightnow.com/2016/04/27/spacex-announces-plan-to-send-mission-to-mars-in-2018.

CBC New Technology and Science. “NASA builds Valkyrie robots to get Mars ready for humans”. Associated Press Posted 19 May 2016. Downloaded 19 May 2016. http://www.cbc.ca/news/technology/valkyrie-mars-robots-1.3589117.

Chapa, Joseph O. “Remotely Piloted Aircraft and War in the Public Relations Domain”. *Air and Space Journal.* (September-October 2014). 28-46.

Clausewitz, Carl von. *On War*. Edited and translated by Michael Howard and Peter Paret. Princeton: Princeton University Press, 1976.

Cohn, Marjorie and J. Mirer. “Armed Drones Violate the Right to Peace”. *Peace Review: A Journal for Social Justice.* 18 November 2015. Downloaded 12 April 2016.

Cooper, John C. "United States Participation in Drafting Paris Convention 1919." *Journal of Air Law and Commerce.* 18.3 (1951): 266-280.

De Decker, Bill. “HOW OLD IS TOO OLD”. Conklin and de Decker Aviation Information, March 2000. Internet Accessed 28 July 2016, https://www.conklindd.com/t-howoldistooold.aspx.

Defence and Aerospace Week. "Aerospace and Defense Companies; Raytheon Delivers Industry-First 2000th Multi-Spectral Targeting System." *Defense & Aerospace Week* (Nov 06, 2013): 101. http://search.proquest.com/docview/1446969783?accountid=9867.

Dorn, Walter, A. *Keeping Watch: Monitoring Technology & Innovation in UN Peace Operations*. Printed in the United States of America: United Nations University Press, 2011.

Drew, James. “Dubai: UAE’s Predator XP procurement paves way for future sales”. Flight Global. 10 November 2015. Downloaded 12 May 2016. https://www.flightglobal.com/news/articles/dubai-uaes-predator-xp-procurement-paves-way-for-f-418878/.

Ebay. Quadcopter Sale Listing. Downloaded 30 June, 2016. http://www.ebay.com/itm/Syma-X8C-2-4Ghz-6-Axis-Gyro-RC-Quadcopter-Drone-UAV-RTF-UFO-2MP-HD-Camera-/141677602860.

Eralp, Doga U. “The Role of U.S. Drones in the Roboski Massacre”. *Peace Review: A Journal of Social Justice.* Routledge. 18 November 2015. Downloaded IRC 12 April 2016. http://dx.doi.org/10.1080/1040265.2015.1094325.

Erenmark, Christian. “Drones, Risk, and Perpetual Force” *Ethics and International Affairs*. 28, no. 3. (2014). 365-381.

Etzioni, Amitai, and O. Etzioni. “Killer robots won’t doom humanity–but our fears of AI might”. Quartz online. Internet accessed 31 May 2016. http://qz.com/691286/ethics-bots-could-soothe-fears-about-ai-taking-control-of-humanity/.

Garrett-Rempel, Ganny. “Will JUSTAS Prevail? Procuring a UAS Capability for Canada”. *Royal Canadian Air Force Journal.*vol. 4, no. 1. (Winter 2015): 19-31.

Goette, Richard, Dr. “The Positive Psychological Effect of Air Power”. *The Royal Canadian Air Force Journal.* vol.1 no. 1. (Winter 2012): 78-83.

Google. “Google Self-Driving Car Project”. Internet last accessed 27 June 2016. https://www.google.com/selfdrivingcar/.

Hudson. “Budget Reflections”. *Frontline Defence*. (Issue 2, 2016): 6-7.

Independent Panel on Canada’s Future Role in Afghanistan. January 2008. Internet Accessed 28 July 2016. http://publications.gc.ca/collections/collection_2008/dfait-maeci/FR5-20-1-2008E.pdf.

iRobot. Company Information History. Internet last accessed 13 May 2016. http://www.irobot.com/About-iRobot/Company-Information/History.aspx.

Jane’s Defence Industry. “Canada Confirms Boeing Chinook Order”. Internet last accessed 26 July 2016, https://janes.ihs.com/Janes/Display/1146846.

Janes IHS. “Executive Overview: IHS Jane’s All the World’s Aircraft: Unmanned”. Jane’s Unmanned Aerial Vehicles and Targets. 11 March 2016. Downloaded IRC 14 April 2016. http://janes.ihs.com/Janes /Display/1317973.

Kazan, Casey, and L. McKinney. “Stephen Hawking: Time Travel to the Future is Possible”. The Daily Mail. Internet last accessed 30 June 2016. http://www.dailygalaxy.com/my_weblog/2010/07/stephen-hawking-time-travel-to-the-future-is-possible.html.

Kelly, Heather. “The Hyperloop just got one step closer to reality”. Internet accessed 12 May 2016. http://money.cnn.com/2016/05/11/technology/hyperloop-test-run/index.html.

Kreps, Sara. “China Swooping in on Military Drone Market”. CNN.com. 1 April 2016. Downloaded 25 April 2016. http://www.cnn.com/2016/04/01/opinions/china-drone-sales-kreps/.

Kurzweil, Randy. “The Law of Accelerating Returns”. KurzweilAI.net. 7 March 2001. Downloaded 8 April 2013. http://www.kurzweilai.net/the-law-of-accelerating-returns.

Kurzweil, Randy. “How My Predictions Are Fairing”. KurzweilAI.net. October 2010. Downloaded 10 April 2016. http://www.kurzweilai.net/images/How-My-Predictions-Are-Faring.pdf.

Kutryk, Joshua. “To Earth Orbit and Beyond: Discussion Points for a Strengthened Canadian Defence Strategy in Outer Space”. *Royal Canadian Air Force Journal.* vol. 4, no. 4. (Fall 2015): 5-15.

Lachance, Daniel. “Arctic Alternative Futures”. *Royal Canadian Air Force Journal.* vol. 4 no. 3. (Summer 2015): 101-115.

Laird, Robin. “Security, Norway, and the High North”. *Frontline Defence*. (Issue 2, 2016): 50-56.

Maass, Matthias. “From U-2s to Drones: U.S. Aerial Espionage and Tarteted Killing during the Cold War and the War on Terror”. Comparitive Strategy. Routledge. 15 May 2015. Downloaded 12 April 2016. http://dx.doi.org/10.1080.01495933.2015.1017385.

Martin, Craig. “A means-paradox and the legality of drone strikes in armed conflict”. *The International Journal of Human Rights.* Routledge. 24 February 2015. Downloaded IRC 12 April 2016. http://dx.doi.org/10.1080/13642987.2014.998864.

McNerney, Sam. “Smart Fridge Manages Your Grocery List And Monitors Food Freshness”. 28 January 2012. Internet last accessed 27 June 2016. http://www.psfk.com/2012/01/samsumg-smart-fridge.html.

Mortillaro, Nicole. “How Start Trek changed the World (really)”. Global News Science and Weather. 26 Sept 2014. Internet last accessed 25 April 2016. http://globalnews.ca/news/564452/how-star-trek-changed-the-world-really/.

O’Brian, S. Ashley. “Siri creator wants to make the World’s best bot”. CNN money website 9 May 2016. Internet accessed 10 May 2016. http://money.cnn.com/2016/05/09/technology/dag-kittlaus-siri-viv/index.html.

Plamondon, Aaron. *The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter.* Vancouver: UBC Press, 2010.

Pope, Stephan. “FAA Investigating Reported UAV Collision with Piper Twin”. Flying Magazine. Internet last accessed 30 June 2016. http://www.flyingmag.com/technique/accidents/faa-investigating-reported-uav-collision-piper-twin.

Population Reference Bureau. “Human Population: Population Growth”. Internet last accessed 1 July 2016. http://www.prb.org/Publications/Lesson-Plans/HumanPopulation/PopulationGrowth.aspx.

Public Works and Government Services Canada. “JUSTAS RFI-2016”. Solicitation no. 660BL-120002/B. 15 January 2016. Downloaded 10 May 2016. https://unmannedsystems.ca/wp-content/uploads/2016/01/DND_JUSTAS-RFI-2016_Letter_of_Interest.pdf.

Pulgliese, David. “Canada Restarts Attempts to Buy Drones”. Denfensenews.com. 16 May 2015. Downloaded 20 April 2016. http://www.defensenews.com/story/defense/air-space/isr/2015/05/16/canada-restarts-attempt-to-buy-drones/27242059/.

Pugliese, David. “Forces to shut down $250M Drone Fleet; Larger Heron Vehicle to Replace Sperwer”. *Edmonton Journal*. 3 September 2008. Downloaded IRC 22 April 2016. http://search .proquest.com/docview/250636789?pq-orgsite=summon.

Pugliese, David. “Unmanned vehicles: the long, slow, costly process of bringing JUSTAS to the Canadian Forces”. *Esprit de Corps.* (September 2012).

Pugliese, David. “RCAF’s quest for a drone begins again – maybe”. *The Ottawa Citizen.* Published 19 January 2016. Downloaded 22 April 2016. http://ottawacitizen.com/news/national/defence-watch/rcafs-quest-for-a-drone-fleet-begins-again-maybe.

RAND Corporation. “Armed and Dangerous? UAV’s and U.S. Security”. Rand.org. Downloaded 10 May 2016. http://www.rand.org/pubs/research_reports/RR449.html.

Reuters. “U.S. spy agency tapped German chancellery for decades: WikiLeaks”. 9 July, 2015 6:21pm EDT, Internet last accessed 28 June 2016. http://www.reuters.com/article/us-germany-usa-spying-idUSKCN0PI2AD20150709.

Rottem, Svein Vigeland. “The Arctic Council and the Search and Rescue Agreement: the Case for Norway”. Polar Record 50 (254). Cambridge University Press: 2013. http://www.fni.no/pdf/SVR-PR-2013.pdf.

Schaub, Gary, Jr and Kristian Soby Kristensen. "But Who's Flying the Plane? Integrating UAVs into the Canadian and Danish Armed Forces." *International Journal* 70, no. 2 (06, 2015): 250-267. doi:http://dx.doi.org/10.1177/0020702015572765. http://search.proquest.com/docview/1692916486?accountid=9867.

Schaub, Gary Jr. “JUSTAS for all? Innovation and UAVs in the Canadian Forces”. *Defence Studies.* Routledge. Published online: 5 June 2015. http://dx.doi.org/10.1080/14702436.2015.1035941.

Seligman, Lara. “How Swarming Drones Could Change the Face of Air Warfare”. Defensenews.com. 19 May 2016. Downloaded 18 May 2016. http://www.defensenews.com/story/defense/air-space/air-force/2016/05/17/drone-air-force-swarm-mini-uas/84496780/.

Shepardson, David, and B. Woodall. “Tesla Crash Raises Concerns About Autonomous Vehicle Regulation”. Reuters on-line 1 July 2016. Internet accessed 2 July 2016. http://www.reuters.com/article/us-tesla-autopilot-idUSKCN0ZH4VO.

Smith, Megan, and J.I. Walsh. “Do Drone Stikes Degrade Al Qaeda? Evidence From Propaganda Output”. *Terrorism and Political Violence.* Routledge. 10 January 2013. Downloaded 20 April 2016. http://dx.doi.org/10.1080/09546553.2012.664011.

Smith, Josh. “Exclusive: Afghan drone war – data show unmanned flights dominate air campaign”. Reuters. 20 April 2016. Downloaded 22 April 2016. http://www.reuters.com/article/us-afghanistan-drones-exclusive-idUSKCN0XH2UZ.

Streetly, Martin. Executive Overview: HIS Jane’s All the World’s Aircraft: Unmanned, 11 March 2016. Jane’s, Internet Last Accessed 14 April 2016 2016. https://janes.ihs.com/Janes/Display/1317973.

Sukman, David. “Lethal Autonomous Systems and the Future of Warfare”. *Canadian Military Journal.* vol. 16. No. 1. Downloaded 8 March 2016. http://www.journal.forces.gc.ca/vol16/no1/page44-eng.asp.

Thurnher, Jeffrey. “The Law That Applies to Autonomous Weapon Systems”. American Society of International Law. ASIL.org. 18 January 2013. Downloaded 25 April 2016. https://www.asil.org/insights/volume/17/issue/4/law-applies-autonomous-weapon-systems.

Thatcher, Chris. “Planning For Power”. Skiesmag.com 20 April 2016. Downloaded 22 April 2016. http://skiesmag.com/news/article/Planning-for-power.

Tsu, Sun. *The Art of War.* China: Amber Books, 2012.

The Associated Press. “NASA builds Valkyrie robots to get Mars ready for humans”. Internet last accessed 19 May 2016. http://www.cbc.ca/news/technology/valkyrie-mars-robots-1.3589117.

United States. “Guidance for the Domestic Use of Unmanned Aircraft Systems”. Deputy Secrectary of Defence Policy Memorandum 15-002. 17 February 2015.

Vinson, Mark E. and J Caldwell. “Violent Nonstate Actors with Missile Technologies: Threats Beyond the Battlefield”. *JFQ.* National Defense University Press: (1st Quarter 2016). White, Andrew. “Unmanned evolution in the Middle East”. *Jane’s Defence Weekly*. Downloaded 14 April 2016.http://ndupress.ndu.edu/Media/News/News-Article-View/Article/643227/violent-nonstate-actors-with-missile-technologies-threats-beyond-the-battlefield/. 116-123.

United States Air Force. MQ-9 Reaper Fact Sheet. 23 September 2015. Downloaded 12 May 2016. http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104470/mq-9-reaper.aspx.

US Air Force. “On-line Fact Sheet Global Hawk”. Internet last accessed 13 May 2016. http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104516/rq-4-global-hawk.aspx.

Wallace, Sam. “The Proposed Ban on Offensive Autonomous Weapons is Unrealistic and Dangerous”. KuzweilAI.org. 5 August 2015. Downloaded 22 April 2016. http://www.kurzweilai.net/the-proposed-ban-on-offensive-autonomous-weapons-is-unrealistic-and-dangerous.

Waugh, Rob. “Why we stuck with sticks and stones: Inventing the first Bows and Arrows took early humans TWO MILLION years”. Internet accessed 10 May 2016. http://www.dailymail.co.uk/sciencetech/article-2170895/Inventing-bows-arrows-took-early-humans-TWO-MILLION-years.html.

White, Andrew. “Unmanned Ambitions”. *IHS Jane’s Defence Weekly*. vol. 52. Issue 44. (November 2015): 24-32.

Whitney, Lance. “Apple's 'Hey Siri' voice activation can work in battery mode with iPhone 6S”. CNET online. Internet last accessed 30 June 2016. http://www.cnet.com/news/apples-siri-expands-capabilities-to-rival-microsoft-cortana/.

Wikipedia. “List of active Canadian Military Aircraft”. Internet last accessed 30 June 2016. https://en.wikipedia.org/wiki/List_of_active_Canadian_military_aircraft

Wilkins, Paul, Group Captain RAF. “Conceptualising the Conceptual Component: One Airman’s Perspective”. Air Power Review. vol. 18. no. 1. (Spring 2015): 10-26.

Willis, Joanne. “Is My Car Vintage Or Just Old?” Internet last accessed 17 May 2016. http://www.theglobeandmail.com/globe-drive/culture/commuting/is-my-car-vintage-classic---or-just-old/article11938943/.

Woods, Chris. “Ten Years Since First Deadly Drone Strike, Industry Gathers in London”. The Bureau of Investigative Journalism. 21 November 2011. Downloaded 19 April 2016. https://www.thebureauinvestigates.com/2011/11/21/drone-manufacturers-in-london-on-10th-anniversary-of-1st-strike/.

Vahid Brown and D. Rassler. *Fountainhead of Jihad.* India: Oxford University Press, 2013.

Vlasic, Mark V. "Assassination & Targeted Killing - A Historical and Post-Bin Laden Legal Analysis." *Georgetown Journal of International Law* 43.2 (2011-2012): 259-334.

Yarrish, Gerry. “The Predator UAV.” *Model Airplane News.* 130, no.3 (03, 2002): 28-29.

Zilberstein, Shlomo. “Building Strong Semi-Autonomous Systems”. University of Massachusetts Amherst. School of Computer Science. Internet last accessed 27 June 2016. https://www.aaai.org/ocs/index.php/AAAI/AAAI15/paper/viewFile/9920/9686. 4090.