CANSOFCOM EDUCATION & RESEARCH CENTRE

L'UNION FAIT LA FORCE

FUTURE TRENDS SHAPING THE INTEROPERABILITY BETWEEN CANSOFCOM AND THE ROYAL CANADIAN AIR FORCE

MAJOR DAVID JOHNSTON

THE CANSOFCOM EDUCATION & RESEARCH CENTRE

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FOREWORD

It is my great pleasure to introduce the latest monograph, *L'Union Fait La Force: Future Trends in Shaping the Interoperability Between CANSOFCOM and the Royal Canadian Air Force*. This publication represents Major David Johnson's thesis for the Masters of Defense Analysis degree from the Naval Post Graduate School in Monterey. His work was deemed outstanding and as a result, is permanently housed in the Dudley Knox Library's Calhoun Institutional Archive, Theses and Dissertations collection.

Major Johnson's monograph addresses the importance of a dedicated CANSOFCOM requirement for airpower. Significantly, his work qualitatively analyzes eight trends that Canada should address to optimize SOF airpower, namely: remote piloting; artificial intelligence and machine autonomy; processing, exploitation, and dissemination (PED); Intelligence, Surveillance, and Reconnaissance (ISR); SOF mobility; precision strike; Alternative Service Delivery; and fuel sources. His study of these trends produces a number of noteworthy implications for Canada and allied like-minded nations. Not surprisingly, Major Johnson's study calls for greater interoperability between CANSOFCOM and the Royal Canadian Air Force, arguing that both are stronger together.

As always, our intent at the ERC is to provide interesting educational material that will assist individuals in the Command, as well as those external to it, learn more about human behaviour, special operations, and military theory and practice. I hope you find this publication informative and of value to your operational role. In addition, it is intended to spark discussion, reflection and debate. Please do not hesitate to contact the ERC should you have comments or topics that you would like to see addressed as part of the CANSOFCOM monograph series.

Dr. Emily Spencer
Series Editor and Director CANSOFCOM ERC

L'UNION FAIT LA FORCE: FUTURE TRENDS SHAPING THE INTEROPERABILITY BETWEEN CANSOFCOM AND THE ROYAL CANADIAN AIR FORCE

A mature Special Operations Forces (SOF) capability requires dedicated fixed- and rotary-wing resources, yet, the Royal Canadian Air Force (RCAF) has arguably not fully responded to the deepening operational relevance of Canadian SOF. In its 2014 guiding document, *Air Force Vectors*, the RCAF clusters SOF with Space and Cyber activities, both significantly more niche and less mature than Canadian Special Operations Forces Command (CANSOFCOM).[1] Similarly, recent airpower articles from the *Canadian Military Journal* and the Canadian Global Affairs Institute mention CANSOFCOM in passing only.[2] With more than ten years of domestic and expeditionary SOF operations in support of Canada's national interest, CANSOFCOM has emerged as a key component of the Canadian Armed Forces (CAF). Nevertheless, CANSOFCOM has also emerged as an organization that lacks the requisite airpower.

Current indicators show no likely end to the requirement for SOF. The CAF Chief of Force Development characterizes the Future Security Environment (FSE) as one where "state and non-state actors alike will seek to combine conventional, irregular and high-end asymmetric methods concurrently, often simultaneously in the land, sea, air, and space environments and the cyber domain to gain advantage in future conflict."[3] Some Canadian politicians agree. According to Jason Kenney, former Minister of National Defence (MND), there is "strategic consensus around the world about the versatility and relevance of special operations forces."[4]

For irregular and asymmetric threats, the irregular and asymmetric solutions provided by SOF are essential. As U.S. Admiral and former Commander of U.S. Special Operations Command (USSOCOM) Eric Olson stated, "most conflicts involving NATO in the future will require broadly capable and skilled SOF."[5]

The projected future shows no end to the relevance of SOF, something that the RCAF must acknowledge and endorse. SOF has a crucial role to play in promoting and addressing this recognition as well. CANSOFCOM must formulate a coherent assessment of the future that steers the development, generation, management, employment, and sustainment of SOF-specific airpower. The problem then, and the specific research focus of this study, is: What future trends in airpower must CANSOFCOM and the RCAF consider to optimize Canadian SOF airpower?

EXPANDING THE QUESTION

While conventional forces are capable of power projection and warfighting of significant magnitude as seen in history, CANSOFCOM is especially well-poised to respond to the irregular and asymmetric threats of the future. To do so effectively, it requires support from all elements of the Canadian military, including an increase in joint interoperability and capability development between CANSOFCOM and the RCAF. Thus far, dedicated support from RCAF has been limited to light utility helicopters. CANSOFCOM's 427 Special Operations Aviation Squadron (SOAS) provides "dedicated special operations aviation effects as part of high-readiness Special Operations Task Forces for domestic and international operations."[6] At the same time, most CANSOFCOM operations require more than precision SOF mobility and must therefore look outside of dedicated support to the CAF, allies, and Alternative Service Delivery, for the other core capabilities in the air domain, as shown in Figure 1.

RCAF Core Capabilities	**1. Control of the Air** **2. Air Attack** **3. Air Mobility** **4. ISR**

FIGURE 1. RCAF Core Capabilities[7]

Due to the lack of dedicated assets aside from Air Mobility, CANSOFCOM is obliged to form *ad hoc* composite task forces to achieve the other core capabilities, which in most cases, focus primarily on Air Attack and Intelligence, Surveillance, and Reconnaissance (ISR). These task forces are made up of non-dedicated assets from the RCAF, other federal government agencies, and publicly contracted civilian companies. This *ad hoc* approach results in degraded operational effects stemming from a lack of shared cultural understanding, divergent priorities, and decrease of interoperability, among a host of other complications. Clearly, CANSOFCOM and the RCAF can do better.

PREVIOUS RESEARCH

In a review of literature regarding this focus area, examination of prior work in four broad categories finds additional room for analysis. First, there is a significant body of study about the future of warfare in a general sense and the future of airpower more specifically. As a guiding document, the CAF Director of Force Development published *FSE 2040*. This document examines current and past trends to provide context to CAF long-term Force Development activities and is a guide for future planning in procurement and other capability planning.[8]

International sources are also noteworthy for the study of future warfare. In 2014, the United States Air Force (USAF) published both the *Air Force Future Operating Concept* and the *USAF Strategic Master Plan*. According to the latter, the USAF intends to provide "consistent direction across all Air Force portfolios and brings year-to-year coherency to our plans and programs."[9] These documents provide a more detailed, Air Force-specific guideline for future concepts and planning. Other nations have similar documents, but they are less relevant to Canadian future SOF airpower.[10] As a whole, this category provides broad ideas to frame general planning without specificity. Further analysis is therefore necessary to determine the design of future SOF airpower specific to Canada.

The second broad category of published writing is more explicit about future Canadian airpower, albeit without a particular SOF nexus. The RCAF has published three guiding documents for future capability development. The first, *Air Force Vectors*, discusses how the RCAF will maintain and strengthen multi-role, combat-capable land, sea, air, and special operations forces.[11] *Vectors* acknowledges SOF, yet CANSOFCOM is not specifically prioritized or acknowledged requisite to current and future strategic utility. This theme is carried on in two other RCAF capstone documents, the 2013 *RCAF Future Concepts Directive* and the 2009 *Projecting Power: Canada's Air Force 2035*.[12] While all of these publications provide specific future capability development for the RCAF, they still miss the mark vis-à-vis SOF.

The next broad category includes five CAF officers that have written about separate and distinct capabilities that are relevant to CANSOFCOM. All of these works are theses from the Canadian Forces College. For example, Major Steve Gillis wrote a service paper in 2016 that focused on the area of tilt rotor technology.[13] Gillis developed a coherent justification for the future utility of these platforms, including CANSOFCOM in the general discussion. In detail, he shows that without employment of tilt-rotor platforms, SOF aviation may lack the capacity and capability to operate in both domestic and expeditionary contexts.[14] Additionally, Lieutenant-Colonel J.C.J.P. Gagnon wrote a similar thesis discussing the domain of Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR). Gagnon once again develops sound recommendations for the requirements of future C4ISR, which is certainly a requirement for SOF, yet his paper is dated.[15] Most of the defence industry has added the concept of cyber and rebranded the entire area of study as C5I. Other papers examine similar themes, including ones on technical costs for helicopter fleet procurement, light kinetic strike from ISR platforms, and manned airborne ISR in general.[16]

While these papers are excellent sources of select information, they lack two key features. First, they are specific rather than general, thereby stove-piping their relevance to Canadian SOF airpower. Next, they often lack a SOF-specific focus. Nonetheless, one particular RCAF officer bridges this gap. Major Tim Streek wrote a thesis in 2013 that addresses future SOF airpower in Canada and makes numerous key recommendations.[17] Nevertheless, Streek fails to address significant emerging technologies, such as autonomy and artificial intelligence, which will significantly alter the landscape of both fixed- and rotary-wing platforms. This collective body of knowledge is more precise than the first two yet fails to apply broad future concepts to specific capability requirements in a holistic manner.

The last category is reflective of the international SOF community that has answered questions specific to their own organizations. In one useful work, Major Eivind Johansen, of the Royal Norwegian Air Force, published a paper discussing how Norway should organize a SOF-specific Air Wing. Johansen concluded that with the key ingredients of "political will, a long-term perspective and a selection of dedicated and willing SOF airmen, Norway will be capable of building up a creative, innovative and adaptive [Air Wing] in order to optimize NORSOF for further success."[18] Similarly, in 2012, the North American Treaty Organization (NATO) SOF Headquarters

(NSHQ) sponsored a Naval Postgraduate School capstone project to answer this same question for NATO SOF. Although the program did not come to fruition, the analysis in the publication provides justification for a SOF Air Warfare Center.[19] These two publications are specific to their parent organizations and are useful benchmarks for a subsequent study of Canadian Future SOF Airpower.

Despite all of these prior publications addressing SOF airpower, a gap in the literature persists. The flagship documents from Canada and the USAF provide a guide for the future operating environment, while the RCAF has its future strategic plans documented. Previous research delved into particular capabilities in depth, and allied nations and organizations have proposed particular solutions to particular needs. What is lacking for Canada is a body of analysis that incorporates significant future trends in airpower to determine Canadian SOF airpower for years to come.

SCOPE AND RESEARCH DESIGN

This study analyzes broad trends in airpower as they relate to CANSOFCOM and the RCAF. It clarifies the need for SOF airpower in a qualitative manner. To build the research question into valid claims, it begins with significant background and basis for SOF. The inclusion of future trends in airpower technology and information processing follows, but simply to the degree necessary to provide practical and realistic applications for CANSOFCOM. As a result, the technology and information processing sections remain outside of a purely technical realm. Ultimately, this study presents implications for CANSOFCOM in order to advocate for optimized future SOF airpower.

This study begins with a brief history of Special Operations in Canada, the current CANSOFCOM force structure, missions, and employment concepts. The source material for this chapter is primarily unclassified work published in Canada, most of which is available on the Internet. The author's personal knowledge and experience augment this chapter, along with interviews with CANSOFCOM personnel. Chapter One ends with evidence for the future prominence of SOF.

Subsequently, SOF is analyzed in a global context, relating CANSOFCOM to near-peer and like-minded nations as members of the global SOF network. The scope of this analysis is limited to the United States, the United Kingdom, and Australia for specific reasons explained in detail in the chapter itself. Chapter Two is based on a review of open source documentation from these three countries along with personal interviews conducted by the author.

Chapter Three analyzes and validates SOF airpower, based on conclusions drawn by the author. It describes the cultural and theoretical development of airpower throughout history. It then reviews three examples of failure caused by sub-optimal fixed- and rotary-wing assets. Although Canada has not yet suffered the same failures as other nations, it should still learn from their mistakes. This chapter provides historical examples of failures from which CANSOFCOM and the RCAF may learn from and opt not to replicate.

With a strong argument established for future CANSOFCOM airpower, this study turns to the eight future trends that will shape its composition.

1. **Remote Piloting.** A mixture of traditionally piloted and Remotely Piloted Aircraft (RPA) will achieve all future effects in the air domain. The use of these systems is certain, to the point where a better question is whether manned assets will continue to fly in their current numbers.

2. **Artificial Intelligence and Autonomy.** The world of artificial intelligence (AI) and autonomy is burgeoning as it

relates to airpower. Humans may not remain intimately connected to future platforms, and will recede further and further as technology advances.

3. **Processing, Exploitation, and Dissemination of Data.** The sheer depth and breadth of data requiring processing, exploitation, and dissemination (PED) is a daunting challenge for any military element now and into the future. CANSOFCOM must turn data into decisions.

4. **Intelligence, Surveillance, and Reconnaissance.** These first three trends directly influence future ISR platforms. These platforms are increasingly capable, omnipresent, and unbounded by altitude, range, or payload.

5. **SOF Mobility.** Future mobility may trend in two separate directions, toward compound helicopters, personified in the Sikorsky *SB-1 Defiant*, or the tilt-rotor class of aircraft platforms, most notably the Bell *V280 Valor*. Regardless of the path, it appears evident that the payload and range differences between helicopters and fixed-wing assets will continue to coalesce in the tactical realm.

6. **Precision Strike.** The future of fixed-wing strike platforms also has a looming divide between highly complex, expensive, and scarce fifth- and sixth-generation stealth fighters, and simple, *down-teched* observation-attack platforms in the U.S. *OA-X* program. Benefits and tradeoffs exist between high-end and low-end assets, and an optimized air force possesses a mix of both.

7. **Alternative Service Delivery.** Resources employed in or supporting the air domain may increasingly use contractor owned and operated platforms involving civilian companies instead of traditional military units through the

mechanism of Alternative Service Delivery (ASD). Current examples, in Canada as well as abroad, show that air support from non-traditional sources is a viable option in the Canadian context.

8. **Fuel Sources.** Fuel sources will continue to develop and enable greater range and payload capacity across the spectrum of platforms in the air domain. However, the goal of perpetual fuel is likely unreachable in the near-to-medium term.

These eight trends will affect the CAF well into the next several decades and beyond. The significant and valuable implications for CANSOFCOM and the RCAF can guide capability and technology development.

Following trend identification and analysis the study furnishes the implications of these trends for CANSOFCOM. Specifically, this study builds on the material that has been covered and puts forth relevant, practical, and reasonable propositions upon which CANSOFCOM should base its future airpower. Namely:

1. The Enduring Need for Human Involvement;
2. Human-Machine Teaming;
3. Joint by Design;
4. Modular by Design;
5. Alternative Service Delivery;
6. Fuel Sources;
7. Processing, Exploitation, and Dissemination;
8. Intelligence, Surveillance, and Reconnaissance;

9. SOF Mobility; and

10. Precision Strike.

By way of conclusion, the trends implications for CANSOFCOM, the RCAF, and the CAF are summarized succinctly. A number of other areas for further research are proposed along with several final thoughts on the importance of optimized SOF airpower in Canada.

CHAPTER ONE
CANSOFCOM PAST, PRESENT, AND FUTURE

SOF are an important component of the military dimension to Western states' instruments of national power, today and into the foreseeable future.[20]

Lieutenant-General Mike Rouleau
Former Commander CANSOFCOM

HISTORY OF SOF IN CANADA

Canada has a long and storied connection with SOF dating back to before Confederation. The Seven Years' War saw irregular raids involving both colonial and aboriginal fighters on both sides.[21] These irregular troops began a long history of disproportionate effects garnered by Canadian SOF units. Then, during the Second World War, Canadian involvement in the British Special Operations Executive (SOE) and the combined U.S.-Canadian First Special Service Force (FSSF) gained merit. In the SOE, hundreds of personnel were involved in training and support at Camp X in Oshawa, Ontario, and 227 Canadian operators deployed into Europe and Asia, often behind enemy lines and in direct support of Allied operations.[22]

Unlike the clandestine SOE, the FSSF gained significant notoriety and were nicknamed the Black Devils by the Germans they targeted. In a single year of the War, the FSSF killed 25 and captured 235 enemy soldiers for every corresponding FSSF commando lost.[23] The FSSF experience was not, however, without its failures. Historian Sean Maloney noted that friction with the British Royal Air Force (RAF) resulted in sub-optimal employment of the FSSF. In perhaps an interesting foreshadowing, he notes that "RAF Bomber Command viewed the existence and use of such a force as being contrary to its own interests."[24] Nevertheless, the FSSF found a way to achieve disproportionate effects. The storied legacy of the FSSF lives on with CANSOFCOM today, and CANSOFCOM Operators often wear the FSSF patch indicating that lineage.

Modern Canadian SOF took shape in the mid-1990s. Until that time, the overall Canadian SOF experience was sorely lacking, as Maloney summarizes: "until the formation of JTF 2 [Joint Task Force 2] in the 1990s, it was *ad hoc*, reactive, and sporadic in its execution."[25] Beginning in 1992, the Canadian Department of National Defence assumed the national counterterrorism role from the Royal Canadian Mounted Police. This new role saw the creation of JTF 2 and its pairing with the *CH-135 Twin Huey* light utility helicopters of the RCAF's 450 Tactical Helicopter Squadron. 450 Squadron was eventually replaced by 427 SOAS and the *CH-146 Griffon* superseded the *CH-135*. JTF 2 saw slow but continual growth in size, capability, and reputation until the powder keg of September 11, 2001. With that watershed moment, Canada and other like-minded nations identified a greater need for SOF. JTF 2 saw involvement in Afghanistan on a continuous basis between 2001 and 2011. In doing so, admirably, it established itself as a top-tier SOF Unit. In 2012, then-Colonel and not yet Commander of CANSOFCOM, Mike Rouleau wrote that "although a very secretive force, JTF 2 was becoming firmly established as a premier Western SOF unit alongside other Western Special Mission Units."[26] 427 SOAS saw equal growth in employment and reputation in Afghanistan, eventually joining JTF 2:

> The Squadron was eventually forced into a paradigm shift that saw it innovating and adapting to develop a significant expeditionary lift capability. By 2010 and continuing throughout the end of Canadian combat operations in

Afghanistan, 427 SOAS aircrew flew full-spectrum combat operations on MI-17 V5 HIP helicopters in direct support of the CANSOFCOM SOTF in theatre.[27]

This growth, however, was temporary. Upon the drawdown of Canadian involvement in Afghanistan, 427 SOAS returned to sole employment of the light-utility *CH-146 Griffon*.

Along with JTF 2 and 427 SOAS, Canadian SOF grew with two other manoeuvre units and a Strategic Headquarters equal in influence to the other services. Today, it comprises those elements as well as a SOF Training Centre, as depicted in Figure 2.

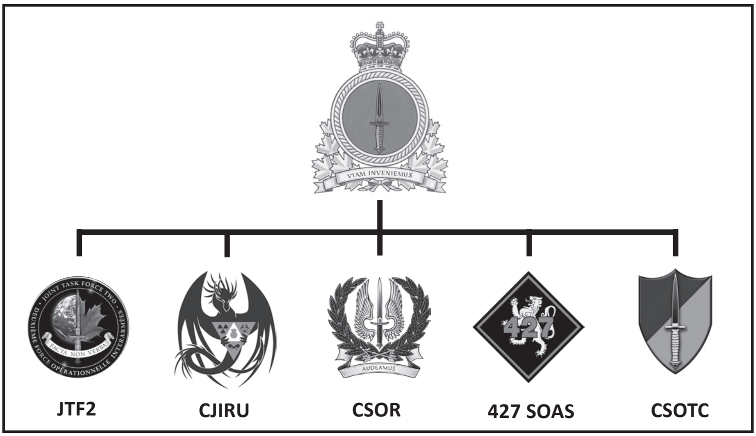

FIGURE 2. 2018 Structure of CANSOFCOM[28]

Different from other Level-1 elements in the CAF architecture, CANSOFCOM today acts as both a Force Generator – similar to the other CAF services – and as a Force Employer – similar to the Canadian Joint Operations Command. Disproportionately small in both stature and funding compared to these others, today, CANSOFCOM is in an unprecedented position of strength as an institution and is firmly established as a high reliability organization.[29]

CURRENT SOF MISSIONS AND CAPABILITIES

The mission of CANSOFCOM is to "provide the Government of Canada with agile, high-readiness Special Operations Forces capable of conducting special operations across the spectrum of conflict at home and abroad."[30] Although closely aligned with U.S. SOF counterparts and often employed alongside allied nations abroad, CANSOFCOM has an additional remit for domestic crisis response in support of the Canadian Minister of Public Safety. These roles, both domestic and expeditionary, allow CANSOFCOM to meet the Government of Canada's 2017 Defence Policy Review vision of employment "in situations that pose an imminent threat to national interests, where the use of larger military forces is inappropriate or undesirable, in operational environments where access is limited, and against high-value targets."[31] Each CANSOFCOM unit has a specific mission, as listed in Table 1.

UNIT	MISSION
Joint Task Force Two (JTF 2)	Protect the Canadian National Interest and combat terrorism at home and abroad.
Canadian Joint Incident Response Unit (CJIRU)	Provide specialized, timely and agile Chemical, Biological, Radiological, and Nuclear Defence (CBRN) response to the Government of Canada.
Canadian Special Operations Regiment (CSOR)	Provide high readiness SOF capable of force generating for, and conducting, integrated Special Operations Task Forces to execute operations on behalf of the Government of Canada.
427 Special Operations Aviation Regiment (427 SOAS)	Provide dedicated special operations aviation effects as part of high-readiness Special Operations Task Forces for domestic and international operations.
Canadian Special Operations Training Center (CSOTC)	Provide CANSOFCOM with common SOF-specific training, designing and delivering a wide range of academic and practically orientated courses.

TABLE 1. 2018 CANSOFCOM Units and Missions[32]

Beyond these mission statements, a great deal of what CANSOFCOM units are capable of achieving remains in the classified realm. Information in the public domain makes it clear that they are expected to operate in all environmental conditions, around the globe and with a multitude of partners in both the global SOF network and the government of Canada's security and intelligence community.

FUTURE RELEVANCE OF SOF

> *Given the contemporary and widely anticipated future dominance of irregular over regular warfare, it is not surprising that SOF around the world appear to be entering a golden era*.[33]
>
> Colin S. Gray
> Strategist

The future relevance of SOF in general, and CANSOFCOM in particular, is based on three general focus areas. First, the characteristics of the FSE; second, the disproportionate effects of SOF; and third, SOF and conventional force synergy.

CHARACTERISTICS OF THE FUTURE SECURITY ENVIRONMENT

> *The primordial driver of change, technology, will advance in unexpected ways and rates, but the nature of human interaction, punctuated by war, will remain the same.*[34]
>
> *CANSOFCOM Future Operating Environment Handbook*

To begin, the characteristics of the Future Security Environment call for a continuation and, arguably, an increase in the asymmetric solutions provided by SOF. Disorder and competition within and between states and non-state actors is expected to continue at pace. New powers will pursue influence at the regional level, often via proxy warfare. Similarly, the decline of the nation state in a classic sense will see individuals and groups search for identity and culture. The U.S. *Joint Operating Environment 2035* summarizes these characteristics into two overarching challenges, *Contested Norms* and *Persistent Disorder:*

> Contested norms will feature adversaries that credibly challenge the rules and agreements that define the international order. Persistent disorder will involve certain adversaries exploiting the inability of societies to provide functioning, stable, and legitimate governance. Confrontations involving contested norms and persistent disorder are likely to be violent, but also include a degree of competition with a military dimension short of traditional armed conflict.[35]

Government of Canada policy documents echo this perspective. Both *FSE 2040* and the 2017 Defence Policy Review discuss the imbalance between adversaries and the continuation of small, disorderly wars.[36] Whether we refer to the FSE as a competitive world order, a multi-polar era, or as just simply disorderly, the trends seem clear.

Many other military officers, historians, and educators agree. For example, recently, retired USAF pilot Michael Buck wrote, "counter-insurgency and irregular warfare operations in low threat environments will persist for the foreseeable future."[37] This reality does not presume that future inter-state conflict has disappeared. Indeed, the U.S. *2018 National Defense Strategy* indicates that "States are the principal actors on the global stage, but *non-state actors* also threaten the security environment with increasingly sophisticated capabilities."[38] This strategy later refers to the "changing character of war," which is echoed in the Government of Canada's 2017 Defence Policy Review.[39] Professor John Arquilla's paradox, which furthers this opinion, is adapted and presented in Table 2.

SINCE SEPTEMBER 11, 2001:	
Number of irregular wars	40
Number of violent Jihadi groups	50
Number of U.S. government organizations focused on Intel and Counterterrorism	1,271
Number of successful bombing campaigns	0*

TABLE 2. Arquilla's Paradox: Which Wars Really Are Irregular?[40]

*If there was a win, it was Kosovo, but it was an "ugly win."[41]

This paradox brings several observations to light. First, it confirms that irregular war and terrorist threats are significant and growing. Indeed, Arquilla wonders whether perhaps we have inverted the terminology, since irregular warfare has become a regularity over the last 17 years. Next, it offers an opportunity to counterargue the ascendance and employment of SOF. With the statistics showing no end to simmering conflicts in spite of the ascendance of both SOF and counterterrorism and intelligence organizations, perhaps SOF are less effective than currently thought. If the world situation is worsening, or at least is remaining persistently disorderly and contested, has the employment of SOF been effective? One American general officer wondered the same: "as impressive as the targeting process is, an incredible, agile and effective engine for dismantling and destroying terrorist organizations, how is it we can't succeed?"[42] Introspection is certainly valuable on occasion. Nevertheless, the simple reality is that since 2001, SOF has been the force of choice and, arguably, the best possible force available due to declining military budgets and continued high operational tempo for conventional forces.[43]

A final thought regarding Arquilla's paradox is about the efficacy of bombing campaigns. His view clearly supports a more comprehensive approach to military engagement. Yet, airpower advocates believe otherwise. One claim supporting this perspective is that airpower may have decisively won the First Gulf War. Early effects from the air campaign undoubtedly achieved strategic advantage by reducing the Iraqi Air Force, command and control structure, and logistics backbone to ineffectual levels.[44] Air campaigns, however, achieve very little on their own. Inevitably and enduringly, military action requires the deployment of *boots on the ground,* in various scope and scale, to achieve long-term effects. As renowned military analyst Fred Kagan has said, "When it comes to reorganizing or building political, economic, and social institutions, there is no substitute for human beings in large numbers."[45] Moreover, if we need to pick one winning factor from the First Gulf War, it is not the air campaign – it is information: "information is as important as firepower in modern war, as we learned in the Persian Gulf."[46] Bombing does not win wars, particularly ones that are irregular.

In summary, Canada and its allies expect to remain in a protracted long-slow-indirect series of small wars against non-state actors hedged often by state entities. This conflict environment requires joint, combined, and interagency solutions. It requires airpower that directly supports ground forces in general and CANSOFCOM in particular. It has done so on an increasing basis since 2001.

DISPROPORTIONATE EFFECTS

As part of the analysis of SOF relevance, one must also consider the disproportionate effects SOF have in relation to their size and cost. SOF units are typically small in size and significantly less resourced than their conventional counterparts. For example, the increase of 605 CANSOFCOM personnel included in the 2017 Defence Policy Review represents only 0.8 percent of the CAF, which is miniscule in number, yet, will have disproportionate effects.[47] Former military officer Jamie Hammond has observed that "SOF create military, diplomatic and political successes out of all proportion to their numbers. They are cost-effective. They operate across the spectrum of conflict, understand the requirements of other government departments and are comfortable with tactical, operational and strategic goals."[48]

Canadian Brigadier-General and SOF officer Steve Boivin has a similar perspective. According to Brigadier-General Boivin, CANSOFCOM brings valuable flexibility to the range of military capabilities available to the Government of Canada, combining adaptable military profiles, very high readiness, and ability to deliver on intent.[49] The relatively cheap, disproportionate, and popular employment of SOF has military and political value. CANSOFCOM, however, can only achieve this value when adequately enabled with a full complement of assets, airpower included.

SOF AND CONVENTIONAL FORCE SYNERGY

At the same time, one should not see the increased relevance of SOF in general, and CANSOFCOM in particular, as a replacement for conventional deterrence. Nothing in the FSE discounts the significant deterrent effect provided by a large conventional military force. Professor Colin S. Gray agrees. "There will be much terrorism and insurgency to blight the future, especially the near-term future," he asserted, "But the mischief promoted by irregular conflict pales into near insignificance when compared with the potential for harm that resides in great power antagonism."[50] Notwithstanding the continued need for conventional deterrence, SOF are highly useful elements of national power. Part of the basis for this perspective is the effective synergy between SOF and conventional forces. One of the five "SOF Truths" is that *most special operations require non-SOF assistance*.[51] SOF need support from the rest of the military services (Army, Navy, and Air Force) and, indeed, other departments of the government as well. The concurrent employment of SOF and conventional forces is a synergistic relationship. While SOF need conventional help, the inverse is also true. Historian Mark Moyer points out that “in the event of a conventional conflict, large numbers of special operations forces could be needed to help organize resistance movements, conduct strategic reconnaissance, guide bombs, serve as combat advisers to allied forces, or raid targets in the enemy’s rear.”[52] CANSOFCOM and the other CAF services concurrently provide asymmetric solutions and conventional deterrence, each one complementary and vital.

CHAPTER TWO
SOF IN A GLOBAL CONTEXT

Thus far, this study has revealed a future environment that calls for a continuation, and perhaps even growth, of SOF capacity and capability. The lack of SOF airpower, as the problem is defined to this point, has remained focused primarily on Canada. But, the question must be asked, what are our peer and like-minded nations doing in the realm of SOF airpower? A specific will demonstrate how CANSOFCOM and the RCAF must emulate the good qualities of our peers, while avoiding their past mistakes, in order to build the SOF airpower that Canada requires.

SCOPE

Canada is a sovereign nation and must chart its path in the world based on its own particular needs. Nevertheless, it has many other partners and allies in the world with whom to compare itself and learn. Naturally, the first country to compare is its neighbor to the south. This comparison is fraught with issues of both scale and perspective on global roles. Notwithstanding these complications, examination of the U.S. SOF experience provides a valuable comparison, and aspirations, for CANSOFCOM and the RCAF.

Next to be examined are our closest military allies, also known as the Five-Eyes partners.[53] The United States, the United Kingdom, Australia, and New Zealand all closely collaborate on defense issues. In particular, the United Kingdom and Australia provide useful comparisons as they are significantly more analogous to Canada's military compared to the other two members. Canada collaborates with others, for example the NATO Alliance members, whom many are like-minded and possess similarly sized militaries. The complexities of the European Union and regional issues –

migrant peoples, considerable domestic terrorism, and a resurgent Russia – mean, arguably, that priorities and future paths are less relevant than the United States and the Five-Eyes partners. For these reasons, the scope of analysis for the Global SOF Network is limited to the United States, the United Kingdom, and Australia.

THE UNITED STATES

> *Our future tasks are unchanged: find stuff, move stuff, kill things. All on behalf of the ground commander.*[54]

Major General William Gayler
U.S. Army Aviation Center of Excellence

USSOCOM is the premier global SOF leader based on sheer size, mixed with significantly advanced capabilities. As of May 2017, the United States boasts 56,000 active duty SOF personnel with approximately 8,000 of these forward deployed in more than 80 countries.[55] The airpower component of USSOCOM is significant, with two entire commands dedicated to the air domain. Figure 3 highlights the air components of USSOCOM.

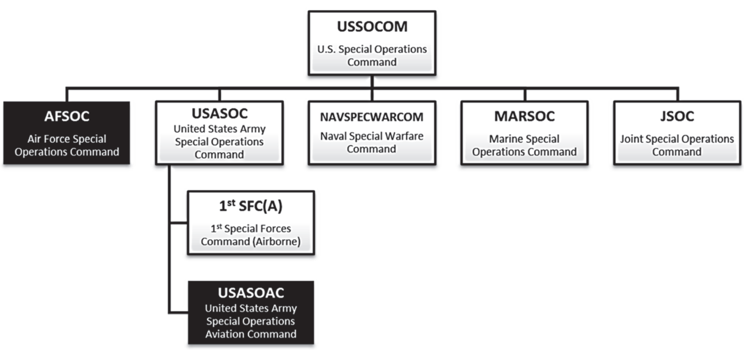

FIGURE 3. 2018 Simplified Structure of USSOCOM[56]

Air Force Special Operations Command (AFSOC), at the farthest left of the figure, is comprised of 19,500 personnel flying a fleet of manned and remotely piloted specially modified aircraft.[57] The mission and tasks of AFSOC are listed in Table 3.

Mission		**Provide our Nation's specialized airpower capability across the spectrum of conflict. Any place, anytime, anywhere.**
Essential Tasks		**Long-range infiltration and exfiltration** **Precision strike** **Intelligence, Surveillance, and Reconnaissance**
Enhancing Tasks		**Aerial refueling** **Military information support operations** **Foreign internal defense** **Command and control**
Supporting Tasks	**Combat Controllers**	**While undetected in combat and hostile environments:** **Air traffic control** **Fire support** **Command and control** **Direct action** **Counter-terrorism** **Foreign internal defense** **Humanitarian assistance** **Special reconnaissance**
	Para-rescue	**Conventional and unconventional recovery operations**
	Special Operations Weather Teams	**While in hostile or denied territory:** **Environmental data assessment** **Environmental special reconnaissance** **Forecast operational impacts**
	Tactical Air Control	**Support ground manoeuver units** **Joint terminal attack control**
	Special Operations Surgical Teams	**Lightweight, mobile, and rapidly deployable casualty evacuation and advanced trauma life support aboard USASOC and/or other opportune air, land or sea platforms**

TABLE 3. AFSOC Mission and Tasks[58]

Table 3 reveals the impressive scope of AFSOC. U.S. SOF in the air domain is even more impressive when additional aviation assets outside of AFSOC are considered. The U.S. Army possesses the U.S. Army Special Operations Aviation Command (USASOAC). As the only unclassified SOF air component outside of AFSOC, USASOAC and its subordinate 160th Special Operations Aviation Regiment (Airborne) (SOAR (A)) are well known inside the SOF community and publicly renowned for involvement in many storied missions. As of April 2017, USASOAC was comprised of 3,750 personnel and 221 aircraft.[59] It is grouped outside of AFSOC and under the U.S. Army based on historical precedent, which will be discussed in more detail in Chapter Three. USASOAC's organizational and cultural alignment with its major client—U.S. Army SOF—assists it in remaining relevant. General James McConville, Vice Chief of Staff of the U.S. Army, speaking at the Army Aviation Association of America conference in 2017, stated, "Army Aviation exists to support troops on the ground. This is how we will remain relevant."[60] This culture prevails in USASOAC.

Indications for future USSOCOM airpower, along with the U.S. military as a whole, are positive. Secretary of Defense Jim Mattis, speaking during an official visit to USSOCOM Headquarters in October of 2017, remarked that the United States will "strengthen our military, and we can all see the storm clouds gathering, the additional challenges coming, and that means we're going to make the military more lethal."[61] Mattis goes on to emphasize the need for greater work with allies and partners, using the common USSOCOM catchphrase of "By, With, and Through."[62]

The 2017 U.S. National Security Strategy includes the same focus. In particular, it states that the United States will "help our partners develop and responsibly employ the capacity to degrade and maintain persistent pressure against terrorists."[63] It goes on to affirm a focus on counterterrorism and irregular warfare:

> The Department of Defense must develop new operational concepts and capabilities to win without assured dominance in air, maritime, land, space, and cyberspace domains, including against those operating below the level of conventional military conflict. We must sustain our competence in irregular warfare, which requires planning for a long-term, rather than ad hoc, fight against terrorist networks and other irregular threats.[64]

USSOCOM accomplishes much of this fight against terrorist networks and irregular threats with the full integration of AFSOC and USASOAC personnel and airframes.

Beyond U.S. Government and military leadership, academics also believe in the future of USSOCOM. Historian Steven Biddle is one of these proponents. In a 2006 article, Biddle advocated for a greater SOF role. In his opinion, SOF could fill roles beyond those currently defined and could potentially replace conventional forces during major combat operations.[65] This model is based on the early U.S. successes in Afghanistan. Small U.S. Special Forces and interagency teams, partnered with Afghan forces and well supported by airpower, were able to achieve significant success. Although Biddle's perspective is not advocated in this study, it exemplifies the general groundswell of academic support toward smaller, more effective, efficient, and agile military deployments. Biddle also wrote in a subsequent article:

> air-ground interaction is nonlinear and multiplicative, not simple and linearly additive … when both ground and air components contribute fully, the whole vastly exceeds the sum of the parts. But when either component is missing or inept, the result is very different. Ground and air forces are thus powerful together, but are poor substitutes for one another: even twenty-first-century precision airpower cannot replace suitable skills on the ground.[66]

AFSOC has adopted this perspective in its wholesale development and augmentation of its fleet of AC-130 Gunships. This platform, based on the ubiquitous Hercules transport aircraft, combines high-fidelity sensors, precision strike packages, and defensive countermeasures into a single airframe designed chiefly to provide Close Air Support (CAS) to SOF ground operations.[67]

The United States will continue to lead the world in SOF-specific mobility, ISR, and precision strike. Although Canada will likely never need or want to replicate the scale of USSOCOM and its air assets, the comparison provides a useful metric to demonstrate SOF airpower capabilities that Canada could pursue, on a smaller scale, to ensure CANSOFCOM and the RCAF meet the needs of Canada.

THE UNITED KINGDOM

SOF units in the United Kingdom are organized in similar fashion to the United States but on a scale more relatable to Canada. The U.K. Director of Special Forces oversees all SOF units and personnel in the United Kingdom. Although the U.K. government is circumspect about details relating to SOF Units, U.K. Special Forces (UKSF) are reportedly comprised of more than 2,000 personnel in six units.[68] The Joint Special Forces Aviation Wing was created in 2001 to provide dedicated rotary-wing support to UKSF.[69] UKSF airframes include Wildcat, Chinooks, Eurocopter Dauphins, and Gazelles along with a number of fixed-wing airframes.[70] Without having the scale of the material of the United States, UKSF must rely on *ad hoc* support from the RAF for precision strike and for ISR and mobility beyond the tactical realm. Notwithstanding this smaller scale, UKSF airpower is much more well-developed than Canada's, demonstrating greater capability across the spectrum of SOF operations and strong links to the RAF.

Increases in personnel and funding demonstrate a bright future for UKSF. Historian Anthony King wrote in 2009 that "the SAS – and the Special Forces more widely – have increased in relative and absolute size in the past two decades. Reflecting this growth, the post of Director Special Forces has recently been upgraded from one-star to two-star status."[71] The 2015 U.K. Strategic Defence and Security Review indicated that investment in UKSF equipment would increase by ₤2 billion ($3.06 billion USD).[72] Importantly, out of a short two-paragraph section, air assets received specific and repeated mention: UKSF will have "the information they need, including through our investment in advanced high-altitude surveillance aircraft. We will upgrade our helicopters and transport aircraft so that they can deploy further and faster."[73] Once again, in comparison to Canada, the United Kingdom appears to be in a favourable position.

The United Kingdom provides a fitting metric for comparison to CANSOFOM. The similarities between the two SOF commands are discernable. For example, the elevation of rank and influence, which occurred in the United Kingdom for the Director of Special Forces, correspondingly occurred for the Commander of CANSOFCOM in 2016. Nevertheless, the United Kingdom is both better developed and better resourced for the future when compared to CANSOFCOM.

AUSTRALIA

In 2003, Australia created a Special Operations Command (SOCOMD) that fills a similar role to the SOF headquarters of the other Five Eyes partners. It acts as an operational-level headquarters, reports to military and civilian governmental leadership, and oversees all Australian SOF units. In 2014, SOCOMD had a strength of 2,050 full-time personnel across four operational units and three logistics and training units.[74] The components of SOCOMD are depicted in Figure 4.

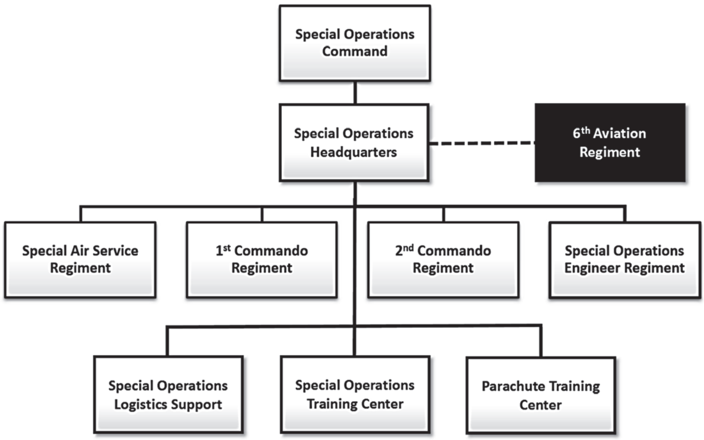

FIGURE 4. 2017 Components of SOCOMD[75]

SOCOMD aviation support is provided by the 6th Aviation Regiment equipped with Black Hawk and Kiowa helicopters.[76] Other elements of *ad hoc* air support are provided by the Royal Australian Air Force, such as the MQ-4 Triton RPA, and by the Australian Army, such as the Tiger armed reconnaissance helicopter and Shadow 200 RPA.[77] The Australian Defence Force (ADF) also utilizes leased airframes from civilian companies.[78]

In 1996, a tragic training accident involving the loss of 18 personnel and destruction of two helicopters energized the development of SOF-specific airpower in Australia. (Chapter 3 studies this incident in detail.) From this accident, and the more contemporary understanding of the joint nature of warfare, the ADF undertook a modernization initiative beginning in 2013 to increase jointness. The 2013 White Paper confirmed, "Special Forces are, and will continue to be, a critical component of the ADF."[79] While the creation and specialization of the 6th Aviation Regiment has provided similar benefit to Australia as USASOAC has to the United States, Australia did not develop an AFSOC-like equivalent. This is likely due to scale. As a middle-power, similar to Canada, the ADF does not have the economies of scale to do so. The Australian Strategic Policy Institute has stated that this scale:

> tends to argue against organically embedding enabling capability within SOCOMD. That said, given that the SOF are among the ADF elements most likely to be committed to a high-risk operation at short notice, the preparedness and capability of the necessary support elements have to be managed carefully to avoid unnecessary operational risks.[80]

The issue of preparedness and adequate capability is critical to providing optimized SOF air support. Notably, middle-power countries such as Australia and Canada grapple with this issue on a regular basis.

Nevertheless, the future for Australian SOF is bright. In 2016, the Australian government updated its defense White Paper. Specific to SOCOMD, it stated that "Australia's Special Forces will draw on a range of new capabilities from across the capability streams."[81] The Australian Government intends on purchasing a new fleet of SOF-specific multi-mission helicopters as of 2025.[82] These assets will provide mobility, and are expected to possess additional ISR and light strike capabilities.[83] If this multi-mission helicopter emerges with the ability to provide mobility, ISR, and light strike, it will provide SOCOMD with impressive SOF airpower capability.

CHAPTER THREE
THE CASE FOR SOF AIRPOWER

Never confuse enthusiasm with capability.[84]

General Peter Schoomaker
U.S. Army

Thus far the analysis has broadly identified the current and future role of CANSOFCOM in relation to the security challenges of the future and the SOF airpower of Canada's primary allies. It has been demonstrated that the security environment facing us will be violent and uncertain, requiring asymmetric and full-spectrum solutions provided best by a fully enabled SOF capability. In parallel this study has also shown that like-minded nations have already adapted their SOF capabilities to include fully optimized SOF-specific airpower. Nevertheless, none of these factors justifies increasing CANSOFCOM airpower *per se.* It is now opportune to examine how these constituent parts validate the need for Canadian SOF airpower. First, an examination of the historical and cultural development of air forces will consider why SOF airpower has not yet developed. Similarly, two case studies of failure due to inadequate SOF dedicated airpower show how other nations have successfully learned from tragedy, a trend that Canada should emulate.

WHY CANADA HAS NOT CREATED SOF AIRPOWER

> *In both World Wars, the Air Service improvised [close air support] procedures and refined them by the end of the war only to have to reinvent similar procedures in the next war. The reason for this was a cyclical devaluation of close air support in favor of strategic bombing.*[85]

John J. McGrath
Historian

CULTURAL AND THEORETICAL ROOTS

Why did the RCAF not collaborate more fully with CANSOFCOM as SOF gained relevance after 11 September 2001? The answer begins with culture. Historically, air forces around the world are biased toward single-service hard power and the fixed-wing pilot community.[86] This cultural bias is puzzling. Since the outset of military flight, pilots began as observers for ground forces, and in particular, artillery fire. However, it was not long before airpower enthusiasts projected greater roles for pilots. Even before the First World War, Italian General Giulio Douhet believed that strategic bombing would become dominant and exclusive. "All that a nation does to assure her own defence," Douhet proclaimed, "should have as its aim procuring for herself those means which, in case of war, are most effective for the conquest of the command of the air."[87] Douhet believed that strategic bombing could "cut off the enemy's army and navy from their bases of operation, spread terror and havoc in the interior of his country, and break down the moral and physical resistance of his people."[88] British Field Marshal Jan Smuts echoed this perspective in 1917, purporting that aerial operations might become the "principal operations of war, to which the older forms of military and naval operations may become secondary and subordinate."[89] The culture of airpower for airpower's sake became entrenched.

The subjective cultural approach in favor of strategic bombing was, in some ways, a logical and pragmatic attempt to avoid the bloodletting of trench warfare as seen during the First World War. It was the hope that "air power, in the guise of strategic bombing, would return war to the era of short, decisive conflicts."[90] Regrettably, the aspirations of airpower enthusiasts were never achieved in a measurable sense. British RAF Bomber Command continually focused on bombing campaigns during the Second World War despite evidence pointing toward a lack of success. Counter-value targeting – deliberately targeting civilian populations – consumed more than half of Bomber Command's total effort and accounted for almost 70 percent of its aircraft losses," yet, tangible results of either operational or strategic success are questionable at best.[91] Pragmatism aside, strategic bombing did not appear to achieve success on its own.

The greatest benefit of strategic bombing in the Second World War may have been achieved only indirectly. Late in the war, the RAF turned to bombing the German air force while planes were still on the ground and vulnerable. The focus of German airpower was on highly effective joint air-ground close air support (CAS) in support of the German Army. By reducing air support, the RAF decreased the overall effectiveness of the German Army. "The strategic bombing of Germany accomplished most of its results rather too late in the war to be decisive either in itself or in effectively determining the outcome of the ground war," strategist Bernard Brodie concluded, "Strategic bombing, however, contributed to the destruction of the German air force which had a great and direct influence on the ground fighting."[92] Quite simply, less German CAS, brought about by RAF bombing, resulted in a less effective German Army.

Despite these tenuous and indirect results, the culture of strategic bombing stems from an irrepressible belief that strategic bombing works. The culture of bombing, along with the primacy of the pilot, runs deep. Distinguished pilot and historian Noble Frankland went so far as to claim that this culture is self-serving. On the topic of British Marshal of the Royal Air Force Hugh Trenchard, the father of the RAF, Frankland wrote that his "life's work became, in fact, the preservation of the Royal Air Force through thick and through thin. His case turned upon the theory of a strategic air offensive, for without it there was no convincing case for the preservation of a separate air service, just as without it there would have been no case for its creation."[93] Bombing culture pervaded.

U.S. General Billy Mitchell, the American contemporary of Douhet, believed less in area bombing and more so in precision, focusing on industrial and economic infrastructure.[94] He also had less interest in bombing itself. Mitchell campaigned for a balanced air element with mobility, observation, and bombing working together in harmony.[95] This approach was a step in the right direction toward a balanced airpower approach that manifested itself in the American doctrine of the Air-Land Battle.[96] Nevertheless, the culture of airpower for airpower's sake remained. As one historian remarked in relation to the USAF, "while the [USAF] controlled all military aviation, including close air support, it did not want to *do* close air support [emphasis added]. However, concerned with its roles and missions, and true to the principle of centralization of all air assets, it did not want the Army to perform it in its place either."[97]

Certainly, some airpower theorists were averse to strategic bombing. One among them, Robert Pape, argued strongly that indiscriminate bombing campaigns have little effect on nationalistic ideals of a population, harden opinions against the attacker, and strengthen support for a particular cause.[98] With the advent of precision targeting and stealth technology, however, advocates such as U.S. Air Force Colonel John Warden brought strategic bombing back to the forefront.[99]

The preponderance of airpower theorists throughout history maintained and reinforced the primacy of the air domain, occasionally to the detriment of air forces. Air power theories and the primacy of air forces provided fuel to inter-service rivalries, in particular since they were, as author and Australian military officer Aaron P. Jackson has opined, "often overstated, and the concepts they developed were still, in some cases, decades ahead of what contemporary technology could achieve."[100] The cultural and theoretical roots of airpower created a historical bias toward the single-service primacy of air forces.

THE GERMAN AIR-GROUND PERSPECTIVE

Despite the perspective of the majority of theorists, not all practitioners focused principally on air warfare. As discussed briefly earlier, the German Air Force was adept at providing CAS to ground troops. Leading up to the Second World War, the German military synergized the new technologies of tanks, aircraft, and radio to great effect. They developed a revolutionary approach in *Blitzkrieg*, and German pilots were open and adaptable to CAS missions due to a shared cultural understanding of the Army.[101] The synergy between the German Army and Air Force went even further. Historian David MacIssac has observed that the "role of its fighting aircraft, its airborne parachutists, and its air transport forces were all designed to support the operations of the *Wehrmacht*."[102] This unity of effort resulted in significant early success for Germany. After all, as historian Richard Overy assessed, "it was German armour and aircraft that tore the Allied front to shreds and sped almost unopposed across French soil; the combination of tank and aircraft proved irresistible."[103] Allied forces eventually overcame their early defeats. This eventuality could be construed as an argument *against* CAS, but MacIssac makes a strong point: "the German use of air power and ground mobility set their armed forces apart from every other major state."[104] Likewise, the Allies eventually triumphed in part, although triumph has many architects, because they began to imitate the *Wehrmacht*. The Allies integrated airpower and ground manoeuvre by imitating German tactics, albeit without an equal level of swift victory on the battlefield.[105] Victory came about through a reduction in inter-service rivalry and an increase in air support to ground troops.

HISTORICAL DEVELOPMENT OF THE RCAF

In the air domain, Canada began as a progeny of the United Kingdom and contributed approximately 25 percent of the RAF's flying personnel during the First World War.[106] The RCAF, as it became known in 1924, had a firm basis in U.K. doctrine and training. Indeed, according to the RCAF doctrine manual, it had "no written doctrine for offensive and defensive air operations to allow for British-Canadian interoperability; therefore, the RAF's doctrine was used."[107] The Cold War era necessitated a closer relationship between Canada and the United States as part of the North American Air Defense Command (NORAD).[108] Due to both influences, the United States and the United Kingdom, the culture of strategic bombing and strategic attack remained prominent in the RCAF. According to MacIssac, "establishing dominance (supremacy if possible) over the enemy air force was seen as in and of itself the single greatest contribution an air force could make to friendly surface forces."[109] RCAF culture remained relatively unchanged over time with the focus remaining principally on airpower for the sake of the air force while the security environment, at least contemporarily, requires greater interoperability between air forces and other elements.

However, the security environment necessitates additional SOF-specific airpower. There are small indications that RCAF culture is amenable to change, albeit slowly. The 2013 *Future Concept Directive* aspires to "explore alternate solutions and interconnections that break down our restraining traditional stovepipes of capability."[110] Likewise, the RCAF's Project Laminar Strike promotes the use of the CP-140 Aurora as a Swiss Army knife, "more towards what a platform is capable of doing rather than what it is designed to do."[111] These encouraging perspectives, among other statements in the same documents, demonstrate a desire for a cultural shift. Greater interoperability with CANSOFCOM would be a tangible step in the right direction.

LESSONS FROM FAILURE

Don't wait for a failure before standing something up.[112]

Colonel (retired) Kenneth Poole, U.S. Air Force
Veteran of Operation Eagle Claw

Another reason for sub-optimal and *ad hoc* relationships between CANSOFCOM and the RCAF is that Canada has thus far avoided significant operational failure due to airpower. Other nations have not. They have learned and adjusted through the anguish brought about by disaster.

THE UNITED STATES

U.S. Operation Eagle Claw was the seminal event in catalyzing the development of SOF Air capability. In response to the kidnapping of 52 Americans from the U.S. Embassy on November 4, 1979, in Tehran, Iran, the U.S. military launched a highly complex hostage-rescue attempt. On an austere landing strip in the Iranian desert, a series of disastrous events resulted in eight U.S. deaths, destruction of two helicopters and one C-130 Hercules transport plane, five helicopters abandoned, and classified mission documents left behind for Iranian exploitation.[113] In the aftermath of Operation Eagle Claw, most analysis indicates that the mission was feasible yet high risk.[114] In direct relation to SOF airpower, the helicopter force and the lack of experienced pilots is often singled out as one specific point of failure. One Special Mission Unit Officer and Vietnam War veteran remarked:

> God, it was a nightmare. It was a zoo. You've got people who are milk-run aviators, and all of a sudden you throw them into damn night flying …. I've been in some pretty hairy places, and I've never been more scared than I was riding around in the back of those helicopters.[115]

What is remarkable about this officer's fear is that it was not caused by enemy action, but by a lack of trust.[116]

The Holloway report, commissioned in 1980, after the failure of Operation Eagle Claw, concluded, "the ad hoc nature of the organization and planning was related to most of the major issues" and recommended the creation of permanent organization to plan, train, and conduct counterterrorism missions.[117] This would be the genesis for the creation of USSOCOM, and in particular, the 160th SOAR (A).[118] These specific capabilities for U.S. SOF ensured that, in the words of past U.S. Secretary of Defense Robert Gates, the U.S. "would never find our ambitions and our needs thwarted by our capabilities."[119]

AUSTRALIA

Australia was also not immune to disaster caused by sub-optimal SOF airpower. During Exercise Day Rotor 96, a 1996 domestic counterterrorism exercise, two UH-60 Blackhawk helicopters collided mid-air, resulting in 18 deaths and 12 injuries.[120] In the wake of the tragedy, the Australian government convened a Board of Inquiry that completed its work the following year. The inquiry found a number of principal factors contributing to the accident, as outlined in Table 4.

CATEGORY	FACTOR
Systemic factors	High rate of aircraft unserviceability in the two years leading up to the accident.
	High pilot separation rates.
Immediate factors	Inadequate planning for the air mission.
	Inadequate information about the target.
	Crew failure to resolve conflicting target locations.
	Conduct of the night mission differed from that of the day mission and there was no rehearsal of those changes.
	Helicopter Flight Lead lacked experience in leading SOF operations.

TABLE 4. Principal Contributing Factors, Australian Black Hawk Training Accident[121]

Based on the factors identified by the inquiry, the Australian government instituted a number of significant changes to the Australian Defence Force (ADF). Specific to SOF, the ADF reorganized aviation assets into specific units designated to support SOCOMD. The 6th Aviation Regiment and its subordinate squadrons now maintain the specific mandate to support SOCOMD.[122] Additionally, the ADF would "establish a training sequence to overcome the erosion of combined skills which had previously occurred."[123] This training sequence increased the frequency of training events from the historical two weeks of annual SOF-specific training. These measures, combined with pilot retention strategies and various other adaptations, have greatly improved Australian SOF. In a 1997 interview, General John Sanderson, Chief of the Australian Army, concluded, the "new resourcing regime and a new command regime" as a result of the inquiry had "improved, quite dramatically, the availability of aircraft and indeed the availability of training time" for SOF crews.[124] The training accident, although tragic, has resulted in tangible and significant improvements for the future of SOCOMD.

CANADA

Thus far, Canada has escaped such an aviation tragedy. This fact is not to imply, however, that it has avoided failure. In one well-documented historical example in 2005, CANSOFCOM narrowly escaped significant tragedy in Afghanistan. In June of that year, CANSOFCOM conducted a Direct Action mission targeting a Taliban leader and the improvised explosive device cell that he commanded in the village of Chernartu in the Sha Wali Kot valley.[125] The helicopter insertion began according to plan. Upon arrival at the objective area, significant enemy fire resulted in one of the CH-47 Chinook helicopters catching fire and crash landing with all personnel onboard. This helicopter was destroyed, another was badly damaged, and several others sustained damage from small-arms fire.[126] Three CANSOFCOM personnel sustained injuries, including one seriously injured, and six other coalition members sustained wounds.[127]

In the analysis of the operation, clearly the Taliban fighters strongly defended the objective with significant firepower. CANSOFCOM also clearly escaped relatively unscathed in comparison with what might have been the result. Nevertheless, some facets of this event are strikingly similar to the aforementioned United States and Australian tragedies. The U.S. air assets used for this mission were non-dedicated, relatively unfamiliar with CANSOFCOM, and not well-suited for the quick tempo of SOF operations. The short-notice nature of the mission prohibited rehearsals, and the *ad hoc* nature of the relationship with the helicopter crews meant that the aircrew and ground force radios were incompatible with each other.

All of these frictions of war, as they are colloquially known, are overcome easily when the enemy is overcome just as easily. When the enemy exacerbates the situation, such as in Chenartu, tragedy is possible, if not likely. The CANSOFCOM assault force commander on the mission in Chenartu stated, "we had luck that day."[128] In recognition of the need for improved air assets to meet the needs of expeditionary SOF operations, CANSOFCOM pursued the contracting of medium-lift MI-17 HIP helicopters and trained 427 SOAS crews to operate them in Afghanistan as discussed in Chapter One. Unfortunately, this paradigm shift was only temporary. The Canadian Government divested itself of these expeditionary helicopters at the end of the Afghanistan mission, and 427 SOAS reverted to sole employment of the CH-146 Griffon.[129]

The CH-146 Griffon has never been sufficient for the range of SOF operations conducted by Canada. In 2009, aviation pilot and professor Bernard Brister wrote, "it is readily acknowledged that the Griffon is not capable of performing all the required roles in support of SOF operations, and it is being employed as an interim platform for the execution of only the most essential domestic SOF tasks until a more suitable platform becomes available."[130] As a member of CANSOFCOM, the author can recount numerous examples of degraded mission results due to non-existent fixed-wing surveillance assets, lack of airborne precision fire support, poor integration with conventional aviation assets, or a combination of all the above. CANSOFCOM and the RCAF learned from experience, but not in the same broad-minded manner that our allies have. Canada is no less motivated to deploy SOF to expeditionary theatres; the 427 SOAS deployment in May of 2016 to support CANSOFCOM operations in Iraq is a prime example of national willingness.[131] For optimal employment, CANSOFCOM and the RCAF require greater interoperability. Canada has not yet learned from its failure, at least not in an enduring way. The examples provided previously relate directly to SOF mobility, yet apply equally across the other missions and tasks in the air domain.

SUMMARY

Before moving on to future trends that will shape future airpower, two points relative to prior successes and failures of SOF airpower deserve reinforcement. First, the Canadian Armed Forces can learn from the experiences of other nations. The tragedies of other countries should be lightning rods to direct RCAF and CANSOFCOM efforts. The experiences of the United States and Australia must illuminate the future for Canada, and other nations and military organizations seem to have done so already. In 2010, a NATO study concluded that without dedicated air assets its SOF elements could not execute missions for which they were otherwise capable and ready.[132] The NATO study provides several key reasons why any alternative is sub-optimal: Technical skills are different; common cultural understanding, values and norms are absent; finally, planning and rehearsal parameters vary significantly.[133] NATO SOF require dedicated air support to achieve success. Canada should derive the same conclusion.

Next, and to return to an earlier theme, the character of warfare has irrevocably changed. Its solutions require full joint cooperation between elements of the CAF, and CANSOFCOM and the RCAF are stronger together. In fact, actual, lasting, comprehensive solutions require one further step: interagency cooperation.[134] The CAF must achieve true jointness between CANSOFCOM and the other elements in order to extend CAF effects into the other departments of the government of Canada. CANSOFCOM should have evolved beyond jointness by now, into a joint, inter-agency and multinational organization. The benefit of introspection at this level is that it is not too late. Action now, including the initiatives contained within the 2017 Defence Policy Review and the conclusions that follow in this paper, can propel CANSOFCOM and the RCAF forward together.

To improve the chances of operational success in the future, CANSOFCOM must develop a mature airpower capability. The development of dedicated SOF airpower is necessary to resolve the security challenges of the future while keeping pace with, and being a good partner to, peer nations. Light utility helicopters have never been sufficient for the broad spectrum of CANSOFCOM missions. Additional capabilities are inevitably necessary, from across the Canadian Armed Forces or beyond.

CHAPTER FOUR
FUTURE TRENDS

There is a tendency in our planning to confuse
the unfamiliar with the improbable.[135]

Thomas C. Schelling
Economist

With a historical and theoretical basis for why CANSOFCOM and the RCAF should collaborate now complete, it is prudent to turn towards what may be possible in the realm of future airpower. There are eight specific, significant and relevant future trends:

1. Remote Piloting;
2. Artificial Intelligence and Autonomy;
3. Processing, Exploitation, and Dissemination of Data;
4. Intelligence, Surveillance, and Reconnaissance;
5. Mobility;
6. Precision Strike;
7. Alternative Service Delivery; and
8. Fuel Sources.

The timeline for the development and impact of each trend varies. In general, this study discusses trends out to 2040.[136] Beyond the 20-year horizon, it becomes problematic to predict accurate trajectories. As such, numerous ill-defined trends are also beyond the scope of this study. For example, cybernetic enhancement, quantum computing, and nanotechnology are all areas of significant interest for military science but lack the fidelity necessary for consideration at this time.[137] As well, the concepts of finder-seeker, striker-shielder, and changes to the offense-defense balance are related but outside the scope of this study.[138] The eight trends discussed are significant and relevant to CANSOFCOM and the RCAF and correspondingly are developed well enough to allow a viable estimate of their impact out to 2040 and beyond.

REMOTE PILOTING

The faster the aircraft travel, the more necessary automated control becomes.[139]

Frank Barnaby
The Automated Battlefield

The air domain now, and into the future, will mix aircraft with pilots onboard and those without. CANSOFCOM and the RCAF must embrace this trend. The inclusion of Remotely Piloted Aircraft (RPA), already common practice among well-developed militaries, is certain. Many missions flown in support of SOF, and increasingly in support of conventional force missions as well, include RPA. The suite of these platforms ranges from hand-held, micro-off-the-shelf varieties used by front-line tactical elements to medium- and high-altitude long-endurance strategic assets. Canada is currently in the process of procuring medium-altitude long endurance systems.[140]

The terminology for RPA has evolved along with the technology. The terms Unmanned Aerial System, Unmanned Aerial Vehicle, and Drone were all used at various times through the development of the technology. According to a recent U.S. study, the lexicon change from *unmanned* to *remotely piloted* attempts to remove any misinterpretation that humans are not in control: “people misinterpreted the terminology and concluded that the systems operated with total autonomy.”[141] The concept of autonomy is discussed in Trend 2. For the purposes of this study, the term RPA describes any asset in the air domain that does not carry a human pilot and flies either by remote control or by autonomous programming.[142]

The history of RPA use is surprisingly long. The United States has long been enamored with technology and its ability to reduce risk to human pilots. According to Lieutenant Colonel Bob Bateman, previously from the Pentagon's venerated Office of Net Assessment, the U.S. military has historically encouraged the use of remotely piloted systems for this very reason. He elaborated the preference exists, "extant since the Second World War, that the United States will always spend money instead of lives if at all possible. Exacerbating that is a trend towards preferences for increasingly complex systems."[143]

While the risk reduction factor of remotely piloted flight might appear as recently as the Second World War, the actual technical ability to fly without a pilot has existed as long as flight itself. Both rail-car and motor-vehicle launched versions of rudimentary pilotless "aerial torpedoes" existed in concept and early design during the First World War.[144]

Today, RPA represent more than 70 percent of the American inventory of platforms in the air domain.[145] A report from the U.S. Air Force Air University concluded that technology does not prevent the replacement of piloted fixed-wing assets with remotely piloted variants, and that, in some situations, the human pilot is the limiting factor.[146] It appears likely that most future military air assets will be remotely piloted. One AFSOC pilot stated it simply, "The only reason to put pilots in the front is if there are operators in the back."[147]

The CAF's forays into RPA came from humble beginnings in Afghanistan, relying on sub-par, short-term leased versions. A permanent solution for Canada requires procuring "interoperable, network-enabled Unmanned Aircraft Systems [UAS] to provide Intelligence, Surveillance, Reconnaissance, Target Acquisition and all-weather precision strike capabilities in support of CAF operations worldwide."[148] Long-delayed but highly anticipated, RPA will operationally enhance CANSOFCOM and the CAF as a whole. The current Chief of the Defence Staff, General John Vance, has voiced his support for RPA. "If [a target] needs to be struck to advance our tactical or strategic objectives," he asserted, "it will be struck." He concluded, "If we don't have a UAV, we're going to use artillery or a jet. UAVs are more precise."[149]

RPA use is diffusing. Beyond state-level employment by the CAF, commercial, off-the-shelf micro-RPA are affordable for the general population to purchase, something on which both allies and enemies have capitalized. It was widely reported that the Islamic State employed rudimentary homemade RPA armed with explosives in Iraq and Syria. Although the effects were relatively limited to only a few casualties, the resources required to combat this new threat, along with the indirect psychological effects, had a much deeper impact.[150] This example demonstrates the democratization of airpower, a lowering threshold for ownership of effective technology in the air domain. According to an advisor for Commander CANSOFCOM, this reduced barrier to entry is a new airpower reality in which:

> everyone has their own integral air force. UAS are likely the first step in this and that trend is only increasing.... [T]he idea that airpower can stay centralized under a single controlling entity is fundamentally flawed moving forward.... [T]he interface between SOF and Air is not only shifting location but also in fundamental nature (e.g., from shopkeeper-to-customer to shopkeeper-to-shopkeeper).[151]

One may defer the notion of phasing-out manned flight completely, but RPA are increasingly the preferred alternative for missions that are overly long, dull, or high risk.[152] Remotely piloted airpower is certain to become more prevalent in future war. As an example of the trend, the U.S. military had an inventory of almost 11,000 RPA as of July 2013, and more than 87 other nation-states employ them for military use.[153] The employment of RPA is certain. A better question is whether manned assets will continue to fly in their current numbers.

ARTIFICIAL INTELLIGENCE (AI) AND AUTONOMY

> *AIs might get out of control and treat us the way we treat ants, for their intelligence compared to ours is roughly what ours is to an ant.*[154]
>
> Donald Hoffman
> Cognitive Scientist

Some concepts of AI and autonomy are as murky as they are prevalent. The Government of Canada defines AI as "intelligent computer programs that can solve problems, learn from experience, understand language, interpret visual scenes, and, in general, behave in a way that would be considered intelligent if observed in a human."[155] No doctrinal military definition of machine autonomy currently exists although the *Oxford English Dictionary* defines it as a machine or apparatus that is "capable of carrying out, without supervision, tasks typically performed by humans."[156] Autonomy should not be considered binary, but rather a condition with a sliding scale. Defense Scientist Robert Sadowski, in a U.S. Army conference presentation, discussed the relationship between autonomy and humans as outlined in Table 5.

LEVEL OF AUTONOMY	DESCRIPTION	RELATIONSHIP TO HUMANS
Non-autonomous	Remote control. No autonomy in the system.	Human in the Loop via remote control
Semi-autonomous	Machines wait for human input before taking action.	Human in the Loop
Supervised autonomous	Humans can intervene in real time.	Human on the Loop
Fully autonomous	No ability for human to intervene in real time.	Human out of the Loop

TABLE 5. Levels of Machine Autonomy[157]

The concept of *Humans in the Loop* is a relationship between machines and humans in which the human has sole authority to decide when and how to employ the machine.[158] This concept correlates with *Humans on the Loop*, in which a human may choose to enter into an autonomous decision-making cycle to exercise control of the machine.[159]

The progression toward full autonomy is well underway. Consider, for instance, that much of commercial air travel is flown by autopilot despite the presence of a human pilot. For militaries, some analysts predict that full automation will become just as prevalent. Among them, defense analyst Frank Barnaby has written that "as computers become more able to make decisions, we must expect the military to use them to their full capacity."[160] There is certainly also an element of a security dilemma present, in which a nation-state like Canada may feel compelled to develop autonomous military capabilities because it knows other nation-states or non-state actors will do the same.

While the capability for full automation exists, several key characteristics of warfare keep humans involved. For nation-states, international treaties and laws of war, political considerations, and the natural reluctance for large bureaucracies to cede power will all reduce the likelihood for acceptance of full automation.

There are technological reasons for humans to remain in the loop as well. First, even though the technology of AI and autonomy is advancing rapidly, in most cases humans are more discerning than a machine. For example, an autonomous asset cannot currently differentiate a wounded soldier from a healthy one or a chaplain from a fighter, and may never be capable of human-level discernment.[161] Good AI is only as good as the humans who build it. Machines that learn how to act ethically and morally may never be possible. Authors Wendell Wallach and Colin Allen put this into perspective. "It is of course," they contend, "hard enough for humans to develop their own virtues, let alone developing appropriate virtues for computers."[162] As such, military and political leaders will likely never cede control of lethal force to a machine.[163]

Additionally, autonomous and intelligent machines are brittle. They can achieve performance levels far beyond humans, but only in narrow domains. Futurist Paul Scharre describes this well. He believes:

> when pushed outside the boundaries of their programming, however, they can fail – and fail badly. They can go from super smart to super dumb in an instant. Unlike humans, machines cannot flexibly adapt to novel situations.[164]

Without the ability to evolve, autonomous machines are brittle. This brittleness limits military utility.

Machines are also increasingly complex, which may result in unintended consequences. Scharre insists, "machine learning with giant datasets and huge, inscrutable black box deep neural networks can lead to some surprises."[165] Practical examples of this weakness exist outside of the military. For example, the algorithms controlling insurance adjustment and stock trading are so complex and opaque that they defy human understanding, while at the same time, in particular in the stock-trading example, they are becoming indispensable.[166] The trading algorithms conduct up to 70 percent of trading volume and gain their complexity when they interact with each other: "simple instructions that interact to create a market that is incomprehensible to the human mind and impossible to predict. For better or worse, the computers are now in control."[167]

The theme of complexity creating unintended consequences is reinforced by a recent glitch by Facebook's algorithm. At one point in 2017, according to *The New York Times*, the algorithm allowed advertisers to target groups of people identified by slurs and offensive language.[168] The Facebook algorithm knew that doing so was in the company's best interest on a superficial level without understanding the greater impact. Sheryl Sandberg, Facebook Chief Operating Officer, admitted both fault and incomprehension in a telling statement. "We never intended or anticipated this functionality being used this way," she conceded, "and that is on us."[169] In this case, inappropriate action by a business algorithm was a social and commercial problem. Conversely, when it comes to application of lethal force by a nation-state, mistakes by AI may have significantly higher consequences.[170] The complexity of machines has direct impact on military use.

Perhaps, however, the problem of autonomous algorithms is a lack of complexity, not the other way around. The examples of insurance, stock trading, and Facebook algorithms show complexity during their employment that defies human understanding, but the machines are not yet self-aware and therefore able to pursue self-improvement. Perhaps more complexity is required such that machines may correct themselves. Consider the perspective of Kevin Kelly, founding executive editor for *Wired* magazine, about the coming ubiquity of machine learning: "AI will enliven inert objects, much as electricity did more than a century ago. Everything that we formerly electrified, we will now cognitize."[171] Surely the opposition and fear surrounding AI will dissipate much as it did for electricity at the turn of the last century.[172] As opposition and fear dissipate, AI will come to be more and more depended on by military forces.

AI is likely to mature to the point that machines are trusted to make accurate first-order decisions. Nevertheless, they may never achieve human-level intuition. According to authors John R. Allen and Amir Hussein, "in this coming age of hyperwar, we will see humans providing broad, high-level inputs while machines do the planning, executing, and adapting to the reality of the mission and take on the burden of thousands of individual decisions with no additional input."[173] Autonomous and intelligent machines are here to stay. Humans will remain in, or on the loop, across the spectrum of missions in the air domain, but will recede further and further as technology advances.

PROCESSING, EXPLOITATION, AND DISSEMINATION

> *We have laid out our own electric networks on a global scale.... [T]hese circuits are loaded with data that move instantly and which have become indispensable to all decision-making in the western world*.[174]
>
> Marshall McLuhan (1965)

As the information domain becomes increasingly important in warfare, military organizations must achieve better decision-quality information faster than their opponents. Notwithstanding all the sophisticated collection assets discussed in detail in previous sections, the sheer depth and breadth of unstructured data requiring processing, exploitation and dissemination (PED) is a daunting challenge for any military element.

Commanders have access to an overall increase of data, and this data must enable decisions. While working for the RAND Corporation in the 1990s, John Arquilla and David Ronfeldt proposed that manoeuvre and firepower no longer dominate warfare: "What distinguishes the victors is their grasp of information."[175] In the book *Turning Point,* historian Kenneth Allard noted that decision-makers in the First Gulf War were "enabled" with 700,000 telephone calls, 152,000 data messages, and 35,000 tactical radio frequencies.[176] The unquestionable increase in connectivity since that time, predicated on Moore's Law, suggests that recent conflicts are no less awash in data. Nevertheless, information must enable decisions, not paralyze them. The author can personally recall clunky early versions of Blue Force Tracker technology in the Canadian Army's fleet of Light Armoured Vehicles that physically inhibited the movement of the crew while providing no discernable advantage for command and control. Connectivity and data can easily overwhelm as much as they can help.

Therefore, information systems are helpful only when they reduce the fog of war. In fact, Allard implored commanders to succeed without technological assistance. "The command structure is the one part of a military organization that, more than any other, must function as a weapon of war," he asserted, "It must either be a lethal, predatory weapon, capable of preying upon and killing other command structures – or else it runs the risk of becoming a bizarre, expensive techno-gaggle more likely to generate friction than to reduce it."[177] To achieve an advantage over adversaries, military organizations must translate data into decisions.

Paradoxically, the creation of data may actually result in good data lost among the rest. In this case, more of something is not necessarily better, and may actually mask small but critical data points. A good example of this stems from the First Gulf War and the Air Tasking Order (ATO). The ATO was created in Saudi Arabia by U.S. Central Command and subsequently disseminated throughout the deployed forces.[178] It was a complex document, over 300 pages of text-based data and, as all ATOs are, a key element of the targeting function and the mechanics of modern warfighting. Unfortunately, all the various data systems in the U.S. military could not talk to each other or deal with the magnitude of the ATO. As a result, the document required U.S. personnel to physically courier it to various end-users with degraded results.[179] More does not mean better, and may overly complicate important decision-making processes. Nevertheless, it is likely that even greater amounts of data will be required in the future, since good data cannot be reverse-engineered after the need for it is identified. Effective militaries must embrace big data and ably sift through it for wisdom.

Further complicating the ability to make decisions with increased data, the speed of war continues to accelerate, necessitating a corresponding increase in the speed of PED. Prior to the Second World War, war was fought at the speed of rail and telegraph. Tanks, trucks, aircraft, and radio technology quickened this pace to battles won or lost in days, hours, and sometimes minutes. Today, with the information revolution, war is fought in a matter of seconds. Lightning-quick attacks with automated kinetic or cyber weapons have far-ranging strategic effects.[180] Decision-making, then, must also accelerate at pace. With an ever-more complicated environment from which to make decisions despite imperfect knowledge, commanders struggle to maintain an information advantage. The speed of war reinforces the criticality of information systems in future warfare.

One solution for the challenge of the knowledge advantage is simply to get better at synthesizing big data into decisions. The current, novel glut of data does not need to overwhelm us as we have the technical capacity to process it. Indeed, others have previously solved this problem. At the turn of the 19th century, writer and statesman Johann Wolfgang von Goethe wrote, “The modern age has a false sense of superiority because of the great mass of data at its disposal, but the valid criterion of distinction is rather the extent to which man knows how to form and master the material at his command."[181] During the American Civil War, despite the preponderance of telegraph reporting across a significantly vast area of operations, U.S. General-in-Chief Ulysses Grant boiled the problem down to its essence. He concluded, "Find out where your enemy is ... strike at him as hard as you can and as often as you can, and keep moving on."[182]

During the Second World War, German panzer division HQs received great amounts of data, yet, they functioned well, partially due to their prior willingness to decentralize authority through the First World War concept of *Auftragstaktik* or Mission Command. Israeli Moshe Dayan replicated similar results through Optional Control.[183] Likewise, the British Chain Home radar stations and the Observer Corps achieved timely processing and structuring of enemy air movement data into decisions. Success in the Battle of Britain, however, was perhaps more a result of philosopher C. West Churchman's systems approach, which quite simply was winning, by viewing technology and people as "sets of components that work together for the overall objective of the whole."[184] Successful militaries are capable of synthesizing big data through innovative approaches.

The military complex has successfully and broadly surmounted data challenges in the past. The challenge posed by modern-day big data is not fundamentally different from these historical challenges. Intelligent, autonomous sensors must increasingly deliver decision-quality information vice raw data. The challenge for modern and future militaries is to turn it into wisdom.

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

The technological advances projected for ISR assets are significant and are nested in a number of the other trends discussed in this chapter. The government of Canada defines ISR as "an activity that synchronizes and integrates the planning and operation of all collection capabilities with processing and dissemination of the resulting information to the right person, at the right time, in the right format, in support of operations."[185] Functionally, the term ISR refers to the various sensors that collect data for military and intelligence purposes.

In its simplest interpretation, airborne ISR sensors are helicopters or aircraft manned by pilots and sensor operators. Airborne ISR tasks are assigned more frequently to fixed-wing assets since they historically provide more varied range, loiter time, payload, and altitude than their rotary-wing cousins. The future benefits and drawbacks between fixed- and rotary-wing platforms is discussed more fully in Trend 4, mobility.

Regardless of the means of propulsion, the preponderance of future airborne ISR platforms will be remotely piloted. This detail reduces both payload and human risk while increasing range and loiter time. It conversely increases response time and renders the communications downlink a critical component. The decision to either include a pilot or do so remotely will, in the future, involve a "crossover point when remote capability eclipses manned assets. At that time it does not make sense to fly manned anymore."[186] This crossover point is not likely in this decade or next, and for some "gold plated" bespoke ISR requirements such as high-end signals intelligence collection, it may never arise. Nevertheless, the future of airborne ISR in aggregate is trending toward RPA.

Once the pilot is remoted-in instead of onboard, the payload for an ISR platform significantly decreases. This increases loiter time and decreases the complexity of operating at higher altitudes, providing persistent coverage at altitudes beyond most countries' air defence systems. Current examples of what is technologically possible exist in this realm. China's CH-T4 solar powered high-altitude drone flies for months at a time and covers almost 650,000 square kilometers at a time with radio and visual coverage.[187] Similarly, in 2016 the British government purchased three ultra-lightweight high-altitude pseudo satellites, which fly at an altitude of 70,000 feet for up to 45 days at a time.[188] These impressive loiter times and altitudes are possible with current technology but only when the human pilot is removed. Pilots are less probable in future SOF mission-sets.

The line between high-altitude aircraft and low-earth orbit satellites for ISR purposes has begun to blur. One simple characteristic differentiates satellites and planes: satellites orbit while planes hover and fly. Beyond this designation, the technologies are merging to provide the persistence of a satellite and the responsiveness of a plane. Low-earth orbit satellites are abundant. The U.S. Army's Kestrel Eye micro-satellite, currently in orbit, is a "small, low-cost, visible-imagery satellite providing images rapidly to the tactical-level ground warfighter."[189] Civilian companies offer similar, and arguably more permeating, options.[190] The drawbacks of space-based ISR systems is what one USAF officer called the "tyranny of persistence."[191] The more persistent a sensor is, the farther from its target it must be. By bringing a sensor closer, such as a low-earth orbit satellite, its sensors have more fidelity, but it orbits the earth faster. Technology can overcome these limitations to some degree. The current solution is to place increasingly more satellite constellations into space.

The Government of Canada also plans to evolve its satellites into a constellation beginning in 2018, to provide "complete imaging of Canada and its maritime approaches on a daily basis, and partial coverage internationally."[192] According to the Canadian Department of National Defence, space initiatives contained in the 2017 Defence Policy will "improve the identification and tracking of threats and improve situational awareness of routine traffic in and through Canadian territory … and improve tactical narrow- and wide-band communications globally, including throughout Canada's Arctic region."[193] Just as anyone may now have their own micro RPA air force, the threshold for who possesses space-based assets has lowered.

Other more novel options for future airborne ISR also exist. Toronto-based company Solar Ship has prototyped hybrid dirigible-solar airplanes designed to carry payloads into remote areas such as Canada's north or undeveloped areas in Africa. Their hybrid aircraft operate without fixed infrastructure for take-off and landing and aspire to carry a payload of 30,000 kilograms for more than 2,000 kilometers.[194] The Canadian government has considered hybrid air vehicles to replace rail and road infrastructure in the north.[195] There is an ISR application for dirigibles, one that the U.S. Army has experimented with previously as the Long Endurance Multi-Intelligence Vehicle.[196] With technological improvements to come in high altitude planes, low-earth orbit satellites, dirigibles, and other less-well-known-platforms, the omnipresence of future remotely piloted ISR platforms is certain.[197]

The employment of future ISR platforms is governed by two general concepts: a mothership or a swarm. In the mothership concept, a large platform such as a CC-130 Hercules controls, launches, and recovers smaller RPA in a hub-and-spoke concept. In this particular example, described by political scientist and futurist P.W. Singer, the RPA "fly in and out of the cargo bay in the back, turning the plane into an aircraft carrier that is actually airborne."[198] The mothership concept allows for centralized control while achieving dispersed coverage of sensor platforms. It also presents a single point of failure if the mothership becomes incapacitated. In the swarm concept, highly mobile, individually autonomous RPA self-organize, like a flock of birds, into highly effective groups.

According to the original forecasters of swarm tactics, an effective swarm must have large numbers of small units that create a sensory organization and are "tightly internetted – i.e., that can communicate and coordinate with each other at will, and are expected to do so."[199]

While the mothership has centralized control and decentralized execution, a swarm has the exact opposite. As such, a swarm has no single point of failure. These two concepts appear exclusionary, but are likely complementary in nature. The benefit of a mothership able to provide life-cycle management to a swarm of RPA from outside of contested airspace seems intuitively beneficial.

The notion of contested airspace brings up a significant challenge for future airborne ISR platforms. The penetration of sovereign airspace, in particular that of peer and near-peer adversaries who possess well-developed electronic warfare anti-access technology, is increasingly difficult. One way that the U.S. military has solved this problem is by combining remote piloting and stealth technology. Stealth RPA, such as the RQ-180, should possess the capability to penetrate contested and denied airspace.[200]

Future ISR platforms will be remotely piloted, increasingly autonomous, and sourced from both military forces and civilian companies. They will operate in air and space, use alternative fuel sources, and remain persistently aloft. These platforms will be increasingly capable, omnipresent, and unbounded by altitude, range, or payload.

SOF MOBILITY

Mobility, in general military terms, is the capability of a force to "move from place to place while retaining the ability to fulfill their primary mission."[201] SOF mobility, the insertion and extraction of

SOF personnel, is a core capability. In an article on SOF mobility, *Jane's Defence* wrote:

> almost no aspect of SOF operations is riskier than insertion—the delivery of small numbers of personnel and equipment into a target area, often in the vicinity of numerically superior enemy forces. Only extraction under duress may be more dangerous, and that usually requires employment of the same assets.[202]

It appears certain that in the air domain these critical insertion and extraction tasks will be increasingly allocated to rotary-wing assets as technological advancements position them as the platform of choice for SOF missions. Future aviation platforms, however, are trending in two different directions, both with longer combat ranges, faster speeds, and capable of operating in higher and hotter conditions than today. First is the compound helicopter, exemplified by the S-97 Raider. With two coaxial counter-rotating main blades coupled with a rear thrust propeller, the Raider and other variants achieve significantly increased speed without any drastic reduction in range, capacity, or auxiliary capabilities.[203] These compound helicopters will likely demonstrate slower speeds than their tilt-rotor competitors, but may demonstrate increased manoeuverability and agility on the objective.[204]

The second direction for future vertical lift is the tilt-rotor platform, exemplified by the V-280 Valor. This category blends the vertical takeoff and landing of a helicopter with the speed and range – and eventually payload – of a fixed-wing aircraft. The future of tilt-rotor technology looks bright, with the Valor providing a fast, precise vertical takeoff mobility platform.[205] The speed of the Valor may also has trade-offs, since today's tilt-rotor aircraft generate increased down wash effects, and the Valor's manoeuvreability and agility has yet to be proven in flight tests.[206]

The tilt-rotor concept may have a technological advantage over other options in that it scales up remarkably well. Although a larger tilt-rotor platform would be less manoeuvreable than the Valor, by the 2040s, it may achieve similar payloads to that of a CC-130 Hercules.[207] Regardless of the direction, either compound helicopters or tilt-rotor, it appears that the payload and range differences between helicopters and fixed-wing assets will continue to merge in the tactical realm. For all but heavy lift, a future SOF planner is likely to choose a precision asset instead of one requiring fixed infrastructure for take-off and landing.

PRECISION STRIKE

SOF operations will continue to require precision fire support in the future. This support may come from ground-based or maritime platforms but will primarily be provided by air forces. Precision strike is the capability of a military force to target and strike an objective with meticulous timing and accuracy. This strike can be achieved with conventional unguided munitions, guided bombs and missiles, and, increasingly, electronic and cyber means.

Of the multiple offensive roles and missions of air forces, precision strike is the one most applicable to ground forces and to SOF in particular. As an indication of this significance, the U.S. Congress cancelled the impending retirement of the USAF’s venerable A-10 Warthog. According to open source reporting, “much of the leadership within the Air Force [was] keen to retire the A-10 so that the resources used to maintain the fleet can be pumped into the fifth-generation F-35 program.”[208] However, the high demand for the A-10, as the premier close air support (CAS) platform, other than the AC-130 gunship, makes it a constant go-to asset in support of ground forces.[209] The trend of supporting a joint air-ground battle is one that will continue into the future as attempts in recent history to achieve decisive victory without committing ground forces have failed. In the rare and unlikely event that a future conflict does not involve SOF in some capacity, it will certainly involve proxy forces, civilians in need of defending, and other contingencies. Precision strike is a future necessity, in both kinetic and electronic forms.

An informative examination of future precision strike is the juxtaposition between the F-35 Lightning II and the relatively simple light attack platforms in the U.S. OA-X program. This juxtaposition illustrates the debate between expensive, complex strategic platforms and ones that are simple, abundant, and tactically focused. The future of strategic airpower was intended to rest on fifth-generation stealth fighters which blend a high-technology airframe with a human pilot. With production delays, cost overruns, and sponsors (such as Canada) withdrawing from the program, however, the F-35 seems fraught with problems.[210] Nevertheless, the program continues, with a current cost per plane of approximately $100 million.[211]

This cost is likely unworkable for the RCAF, which has a short-term need for a replacement airframe, while defence spending on large-scale capital projects has been deferred by just over $3.7 billion from the 2016 budget.[212] The 2017 Canadian Defence Policy backed away from previous government commitments to purchase the F-35, indicating plans for procurement of 88 "advanced fighter aircraft" without specifying more details.[213] F-35 costs have raised the ire of others as well. U.S. President Donald Trump at one point tweeted, "based on the tremendous cost and cost overruns of the Lockheed Martin F-35, I have asked Boeing to price-out a comparable F-18 Super Hornet!"[214] Plagued by problems, the F-35 program continues to purport that its fighter jets will fill a multi-role function, including CAS.

Juxtaposed with the titanic F-35 is the A-29 Super Tucano light attack aircraft, one of the OA-X contenders. The A-29 costs a mere $10 million and performs multiple roles including precision strike and surveillance and reconnaissance.[215] Its utility should not be overstated. The A-29 certainly cannot replace the platform requirement necessary to compete for air superiority or defend Canada's north as part of our NORAD commitments. It is not a stealth fighter or fifth-generation aircraft and as such is likely unable to penetrate near-peer air defenses. Nevertheless, it is the platform most suitable for the most likely types of conflict Canada will face.

Exceptional technology simplifies the end-user experience. Consider the modern automobile, a highly complex machine running upwards of 100 million lines of computer code.[216] This complicated conglomeration of metal and plastic remains, in most cases, easy for a relatively inexperienced individual to drive safely. The auto industry has done well to simplify the end-user experience, which directly translates a test drive into a sale at the cash register. A modern smart phone is similar. Military technology often is not.

For cases in which high-tech items are not simple for the end-user, a number of negative consequences are clear. First, the user may only use a fraction of the computing power that the item possesses. Next, it might take a significant amount of training time to allow the user to leverage the technology's advantages. This is the F-35 experience. One test pilot wrote, "the F-35 is in its seventh year of flight test and still has a few more years to go.... [W]e're still learning what the F-35 can do, and we need people who know the airplane and can continue to drive it to its ultimate performance."[217]

This idea is key, the struggle to build enough experience in the F-35 to fly it at its peak performance, achieving technological overmatch against a capable adversary, is a real struggle. Lastly, great technology not simplified for users will remain just that – great technology. In order to have great utility, it must be simplified and packaged well.

OA-X avoids the negative consequences of the F-35 through the simplicity of its technology. The program, in a paradoxical way, also complements the F-35. After running field trials for the A-29 and three other similar platforms, the USAF deemed that it could:

> remove some of the burden from faster-moving attack aircraft built for more contested airspace. Current U.S. enemies have no air defense networks to speak of, so jaw-dropping aircraft performance and sophisticated countermeasures are largely wasted. Add OA-X to the mix, and the advanced aircraft can go back to doing what they are built for: Flying through, and laying waste to, top-notch air defenses.[218]

Not only does OA-X complement the F-35, it also helps the soldiers on the ground in ways that the F-35 cannot. In a RAND study from 2017, many ground commanders from the Afghanistan campaign expressed a preference for CAS guns, such as those on the A-10 and the OA-X, over precision bombs. This preference is because the guns are "highly accurate, better able to hit moving targets than even precision bombs, and produce less collateral damage than bombs. Also, many missions involved a show of force, in which aircraft flew low and slow over the U.S. ground forces to deter adversary activity."[219] This preference also extends to more recent conflicts.[220] The OA-X light attack aircraft cannot do everything, but they provide an optimal link between airpower and ground forces. Benefits and tradeoffs exist between high-end and low-end assets, and an optimized air force has a mix of both.

ALTERNATIVE SERVICE DELIVERY

Future air forces will blend military assets with civilian-owned resources arranged through the mechanism of Alternative Service Delivery (ASD). The Government of Canada defines this arrangement as a method of improving performance in "delivering programs and services to citizens and businesses. It includes the following mechanisms: privatization, franchising/licensing, public-private partnerships, purchase of service, devolution, delegated administrative authority, and agency and direct delivery."[221] The involvement of contracted support to military operations has increased significantly over the past decades as depicted in Figure 5.

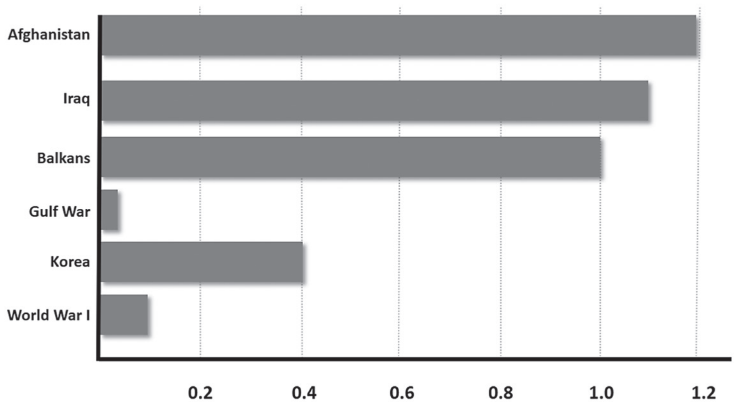

FIGURE 5. Contractors per U.S. Uniformed Military Personnel, 2014[222]

Contractor support to U.S. operations extend beyond the conflicts depicted in Figure 5. In Africa, for example, USSOCOM units employ contractors for various tasks and missions. During Operation Observant Compass in Uganda, civilian companies provided air resupply, manned ISR, casualty evacuation, and psychological operations support.[223] U.S. AFRICOM has also successfully used contracted fixed- and rotary-wing assets in operational theatres with success, and recently awarded new medium-term contracts to three separate air mobility providers.[224]

Several successful Canadian military examples confirm the benefits to these partnerships as well. The RCAF Contracted Airborne Training Services program uses civilian pilots and airframes to provide live-flying instruction as part of fighter pilot training.[225] ASD can also easily extend beyond the training realm. PAL Aerospace, headquartered in Canada, purports to have already provided over 250,000 hours of airborne ISR in support of military and law enforcement missions.[226]

In times of relative fiscal constraint, the lease versus buy flexibility provided by ASD reduces cost for the RCAF and CANSOFCOM. It also opens up flexibility for CANSOFCOM that the RCAF cannot provide. In 2014, the *Global and Mail* reported that reduction of the CC-144 Challenger fleet would mean the “air force may have to use larger, more costly aircraft for important military missions, including medical evacuation.”[227] Outsourcing access to platforms, perhaps even with outsourced crews, solves future resource scarcity. Contracted civilian aircraft via ASD would ease pressure on scarce RCAF resources while providing much-needed operational flexibility to CANSOFCOM well into the future.

There are, however, options other than employing civilians during military operations. As a hybrid model, AFSOC created a non-standard aviation program to employ low-signature commercial aircraft, flown by AFSOC crews, for SOF missions.[228] This program was designed to operate during low profile, small footprint missions, and bridges the gap between civilian contractors and full-visibility standard military aircraft.[229]

The concept of adapting assets for alternate use may also be applied to current RCAF platforms in order to provide SOF-specific mission capabilities. This is a novel solution with significant potential for CANSOFCOM. The U.S. Marine Corps achieved something similar with their UH-1 Huey platforms, in which they upgraded a portion of their fleet into more powerful light-attack helicopters while maintaining 85 percent commonality of parts.[230] This same style of upgrade, applied to the Griffon Limited-Life Extension, would benefit CANSOFCOM airframes.[231] Further, more short-term variations of this concept include lightweight, rapidly reconfigurable weapon and sensor mounts for the Griffon helicopter.[232] With a system such as this one, CANSOFCOM helicopters could quickly re-role from mobility platforms to precision fire support. As well, this concept is applicable beyond helicopters. The concept of roll-on/roll-off, applied across the spectrum of RCAF platforms, allows greater flexibility and operational relevance for CANSOFCOM through alternate means of delivery. Air support from non-traditional sources is a viable option in the Canadian context.

FUEL SOURCES

The cost and environmental impact of carbon fuel sources will continue to push militaries to develop alternative fuel sources. The U.S. Navy began this process with The Great Green Fleet, a program designed to help their ships and aircraft "go farther, stay longer and deliver more firepower" through, among other things, advanced biofuel.[233] As well, a USAF study in 2007 concluded that ocean-grown algae biofuel offers a "secure energy source" and, with more testing, could replace high quality jet fuel from a secure domestic source with zero-sum environmental costs.[234] Similarly, USSOCOM is currently fielding solar wings on its fleet of RQ-20A Puma RPA.[235]

Power for RCAF airframes will one day originate from perpetual fuel sources such as solar power. In the foreseeable future, however, planes and helicopters will continue to refuel regularly. There are two viable tactical refueling options, from either in the air or on the ground. Air-to-air refueling has long been a standard practice for fixed-wing platforms. It is beginning to transition into the conventional aviation realm, although the RCAF's newest helicopter is not equipped with this capability.[236] Ground refueling via a forward arming and refueling point remains the most likely tactical option for most aviation and may be the preferred option for both fixed- and rotary-wing mission profiles unsuitable for vulnerable tanker aircraft.

In recognition of the continuing need to refuel, CANSOFCOM has developed the Airfield Surface Assessment and Reconnaissance (ASAR) capability to facilitate tactical airfield operations on unprepared, unconventional, and semi-prepared airfields.[237] This capability allows CANSOFCOM to facilitate wet-wing refueling from CC-130 Hercules to helicopters, along with various other concepts to extend the range of tactical mobility platforms.[238] Notwithstanding future fuel sources not yet operationalized, the need to refuel will exist well into the future. The goal of perpetual fuel is likely unreachable in the near-to-medium term. Capabilities such as ASAR increase the operational reach that the RCAF and CANSOFCOM can achieve together.

CHAPTER FIVE
IMPLICATIONS

> *You can have the best Special Mission Unit in the world, but if you can't get 'em there, it's like a Mercedes you can't get out of the garage.*[239]
>
> Colonel (retired) Kenneth Poole, USAF

The eight trends analyzed above demonstrate what the future may hold in the realms of both the probable and the possible. This study now turns to practicalities. What do these trends specifically mean for Canada? Based on the trends described in the previous chapter, it is now opportune to evaluate ten implications for CANSOFCOM and the RCAF.

THE ENDURING NEED FOR HUMAN INVOLVEMENT

> *After all the GBUs have been dropped and the UAVs have landed, war remains a very human business. It cannot be done long-distance … it is done in the dirt, over chai, conversation and mutual understanding.*[240]
>
> U.S. Army Officer, Iraq War

Notwithstanding all the technological advances applicable to the conduct of war, the need for boots on the ground endures, meaning that lasting effects require direct human influence. Libya provides an excellent contemporaneous example. A 2018 study by the Jamestown Foundation concluded that airstrikes carried out against terrorists in Libya proved mostly ineffective. "Rather than being scattered or deterred," it assessed, "many [terrorists] merely shifted their base of operations."[241] Airstrikes seem to have actually emboldened insurgent elements.[242] The situation has worsened due to a lack of effective influence on the ground. In these examples and others, air operations and ground operations are mutually reinforcing. There is enduring synergy to be found between RCAF air assets and CANSOFCOM ground-based human sensors.

Synergy between humans and technology is mutually advantageous for CANSOFCOM and the RCAF. Put simply, why would Canadian aircrew not want Canadian personnel on the ground to provide detailed targeting data? Likewise, a Canadian aircraft, particularly one optimized for observation and ground attack, is the preferred air support provider for Canadian ground operations. Those familiar with the targeting process know that a great deal of work goes into the precise, command-driven, and legally scrutinized process of target approval and engagement. The more that certainty is assured by, with, and through Canadians, the better.

The unique perspective of one Canadian pilot makes this point abundantly clear. Captain Alan Lockerby fought as a ground-based Forward Air Controller in Afghanistan. As such, he was responsible to coordinate air strikes against enemy positions from forward positions and in close proximity to the enemy.[243] He subsequently deployed to Libya in 2011 as a CP-140 Aurora pilot, doing a similar job but from the air. Lockerby explained:

> as a FAC in Kandahar, I knew exactly what my target was, who wanted it attacked, why it was to be engaged, and where friendly troops were positioned. Furthermore, with troops nearby, I could leverage friendly reporting.... [S]uch was not always the case in Libya, for myself or any other individual involved in this line of work. A person staring at an object or event on a screen from thousands of feet for hours on end will never have the same awareness as someone who spent just minutes looking at the same thing from ground level.[244]

Lockerby advocated for an increase of joint air-ground capability for his particular platform. His recommendation for interoperability applies across the range of RCAF aircraft for SOF operations.

The enduring need for human involvement does not presuppose a large, highly visible military force on the ground. There are many tasks to be done on the ground, such as: nomination of targets, battle damage assessment, collection of evidence and intelligence, persistent influence, mentorship of proxy forces, and support to other government departments, to name a few. These tasks are not necessarily limited to SOF, and the need for effective air-ground synergy applies to all ground forces. Perhaps shoes on the ground, not boots, is a more applicable idiom going forward. Future conflict does not necessitate solely uniformed military professionals to achieve these tasks, and a lower-profile option provided by CANSOFCOM may be more appropriate. Likewise, the opportunity for inter-agency collaboration between diplomats, intelligence agents, and the military may also be highly appropriate.

With these comments in mind, the SOF Truth that “humans are more important than hardware” remains highly relevant. All the technological advances aside, the decision-action cycle requires human authority. Certainly, SOF operations need human decision-making in the near term while there is yet very low (or zero) trust from humans for autonomous machines. More broadly speaking, however, military and political decision-makers must remain involved in order to provide accountability to the public they serve. Likewise, improvements in Canadian SOF airpower must be focused with the human dimension in mind since superior technology alone does not necessarily achieve intent. British Royal Marine Colonel David Heaver has observed:

> many missions can be safely accomplished by highly trained crews using conventional, unmodified aircraft.…

> [I]t was SOF aviators, flying conventional aircraft better than their non-SOF counterparts – more precisely, in harsher environments, mitigating the risks, and using conventional equipment in innovative ways – that proved it is the person, not the technology, that defines special operations.[245]

In any form, future conflict involving CANSOFCOM and the RCAF requires human influence to achieve long-term success.

HUMAN-MACHINE TEAMING

> *People and systems will become increasingly connected by technology that moves and analyses information faster, more accurately and with more automation.*[246]

CANSOFCOM *Future Operating Environment Handbook*

Intelligent machines will increasingly augment SOF missions as team members rather than tools. CANSOFCOM and RCAF personnel will remain in the loop across the spectrum of SOF mission-sets but are likely to recede from it. As machines become increasingly autonomous, humans will correspondingly become more reliant upon them during tactical tasks, as depicted in Figure 6.

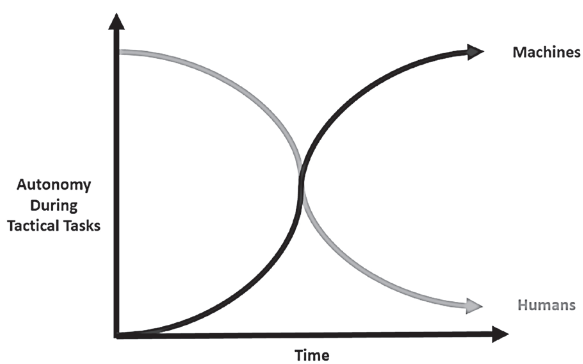

FIGURE 6. Human and Machine Autonomy during Tactical Tasks

Although the graph is highly simplified, the idea is complex. Human reliance on technology is occurring with faster acceleration and wider diffusion than previously expected. The military application of this was dubbed the Centaur Army:

> the idea is not machines replacing humans. It's not even about machines working autonomously alongside humans. It's about machines and humans being joined at the hip in a symbiotic relationship where each brings what it does best.[247]

The combination of (intuitive, lateral-thinking, discerning, acute, and creative) military personnel teamed with smart machines is potent.

An everyday example of the benefits of human-machine teaming is found in the game of chess. The chess world was upended in 1997, when the human grandmaster, Garry Kasparov, lost to a computer, which was a monumental event. Even more astonishing, however, was that in 2005, two amateur players, teamed with their personal computers, produced victories in a major chess tournament against grandmasters.[248] Kasparov describes this moment as "Their skill at manipulating and 'coaching' their computers to look very deeply into positions effectively counteracted the superior chess understanding of their grandmaster opponents."[249] Simple machines teamed with amateur humans yielded exceptional results.

Chess and other games are, or course, bounded by rules while warfare on any scale is ambiguous and far more complex. War, then, requires even more human intuition. This human intellect is optimized when teamed with the processing power of a machine. According to the U.S. Army's Training and Doctrine Command, "only human judgment can wield military art, but such judgment is now best generated in hybrid solution approaches that join carefully selected, educated, and trained individuals with cognitive human performance enhancements."[250]

In a practical military application of human-machine teaming, consider the relationship between sensors and intelligence analysts. Chapter Four discussed the overall challenge of big data and the requirement for automation. Currently, the ratio of sensors to analyst is heavily weighted in one direction, at times requiring up to a crew of six personnel to operate and analyze one sensor platform.[251] With developments in smart sensors and automation, this ratio will likely invert, and single individuals will monitor multiple sensors and harvest decision-quality information.[252] Just like mission command has defined military leadership since the wars of the 20th century, the idea that human leaders will command intelligent machines is likely to begin to define leadership over the next few decades.[253] SOF and Air Force leaders must integrate smart, autonomous machines into the fabric of organizational culture and leadership.

JOINT BY DESIGN

The SOF Truth that most special operations require non-SOF assistance will remain relevant far into the future, necessitating joint operations between SOF and the other elements of the CAF. CANSOFCOM is unlikely to grow air assets across the entire spectrum of tasks and capabilities. With a medium-size military and a budget below NATO guidelines, Canada cannot expect to replicate U.S. SOF assets.[254] As such, CANSOFCOM and the RCAF must be fully interoperable and must increase the number of designated RCAF elements that support SOF missions. These relationships cannot fall prey to other nations' *ad hoc* approaches that led to past mistakes, but rather need to be lasting and meaningful in order to foster common culture and shared understanding. The Royal Australian Air Force describes their perspective as joint-by-design, which presumes a joint relationship is the start-state to any operational task.[255] This presumption is optimal for Canada.

The U.S. Marine Corps has a similar cultural perspective. Every Marine operation begins, other than in exceptional cases, with a joint air and ground task force. According to its doctrine, the Marine Air-Ground Task Force (MAGTF, pronounced "mag-taff") is the "principal organization for the conduct of all missions across the range of military operations. MAGTFs are balanced, combined-arms forces with organic ground, aviation, and sustainment elements."[256] (See Figure 7).

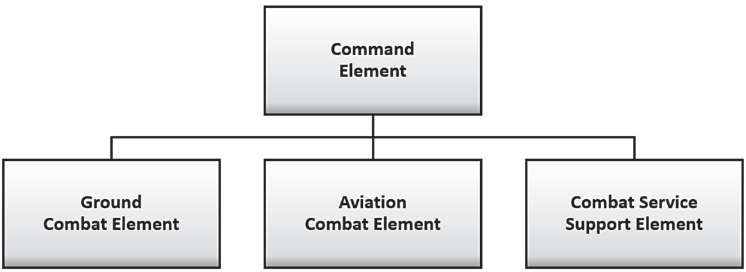

FIGURE 7. MAGTF Doctrinal Organization[257]

MAGTFs are flexible, task-organized forces capable of global and rapid contingency response.[258] While balanced, they are wholly focused and organized to support the Ground Combat Element. A Marine aircraft maintenance officer reflected, in an interview on 22 February 2018, that "every time a Marine maintainer works on a plane, or a Marine pilot steps into a cockpit, the primary focus is support to the Marine on the ground. That's it. That's our ethos, that's our culture."[259] CANSOFCOM operations would benefit from a similar start-state in both organization and ethos. An expanded apportionment of full-spectrum air assets to CANSOFCOM by default, removed only by exception, would respond to future trends in the air domain.

MODULAR BY DESIGN

The concept of modularity, operationally flexible by design, is highly relevant for future Canadian SOF airframes. Why not sense without the ability to strike? Why spend the time, fuel, and associated costs to transit a relatively expensive and scarce asset into an operational area without retaining the ability to achieve multiple effects on the ground? Chapter Four introduced the concept of roll-on/roll-off modularity. The ability to rapidly reconfigure an air platform, fixed- or rotary-wing, piloted or otherwise, is gaining relevance and momentum in both industry and Western militaries. Numerous defense industry partners offer modular ISR and precision strike packages for many platforms.

A roll-on/roll-off ISR and precision strike configuration for the CC-130 Hercules or the recently procured CC-295 is technically and technologically well-developed and may be viable for CANSOFCOM and the RCAF. The CC-295 fleet, in particular, is optimal in the Canadian context. It comprises 16 turbo-prop utility aircraft capable of short take-off and landing and is compatible with palletized sensor and weapon platforms.[260] This plane was procured originally for the important task of domestic search and rescue. As a positive step to widen its operational role, the RCAF later changed the color of the CC-295 from canary yellow to tactical grey.[261] Furthermore, two recent studies by RCAF officers advocated for combined ISR and precision strike packages for both the CP-130 Aurora and the CC-130 Hercules.[262] All three of these RCAF platforms are suitably modular for ISR and precision strike roles.

There are international examples of successful airframe modularity. Both the Jordanian and Italian militaries employ a light-variant gunship on an airframe similar to the CC-295.[263] The U.S. Marine Corps integrated modularity into its KC-130 Hercules fleet, employing a “bolt-on/bolt-off ISR/weapon mission kit” known as Harvest Hawk, on ten airframes.[264] Based on the success of this program, the Marine Corps plans to expand it to the entire fleet of Hercules aircraft and may apply the concept to their fleet of MV-22 Osprey tilt-rotor aircraft.[265] The ability for an airframe to quickly re-role from mobility into an ISR or strike platform, or perhaps even do these all at once, would be significantly advantageous for CANSOFCOM and the RCAF.

To support modularity in a more general sense, hardware configurations should be standardized across the range of CANSOFCOM and RCAF platforms. USSOCOM has implemented this concept in the Airborne Mission Network program, in which standardized mounts and wiring in aircraft and vehicles allow installation of communication devices in a plug-and-play fashion.[266] Concepts such as universal payload adaptors, common and nonproprietary interfaces, cross-domain data sharing, and open architecture all lead to more flexibility for the end user. Modular-by-design ideas such as these also minimize life-cycle costs, reduce the size of fleets, decrease integration timelines, simplify logistics, and promote rapid adaptation to changing or new technology.[267] The benefits of modularity are many, particularly for a medium-size military such as Canada.

Retrofitting hardware onto a pre-existing airframe can pose difficult engineering problems.[268] Broadening the skill-sets of specialized aircrew can pose skills training and currency challenges. When considering a new asset, care must be taken not to hijack procurements, for adding more requirements late-to-need can draw out an already cumbersome defence procurement process. Finally, creating a jack-of-all-trades air platform may result in one that is good at many things but excellent at nothing.

Notwithstanding the necessity for these prudent considerations, modularity makes eminent sense for CANSOFCOM and the RCAF.

With the inclusion of future technology, one platform could provide, in alternate configurations at the same or different times, mobility, surveillance, and fire support. To entrench this concept, CANSOFCOM equities must be considered during major RCAF procurements and life extensions and vice-versa.

ALTERNATIVE SERVICE DELIVERY

Viable air support for CANSOFCOM operations can and should be sourced from non-traditional assets such as civilian contractors. In some cases, doing so will alleviate resource constraints for the RCAF. The *Future Concepts Directive* admits that "manned air surveillance of the domestic AOR [area of responsibility] vastly exceeds the capacity of the RCAF, both now and in the foreseeable future. The RCAF should investigate concepts and the implications and cost of outsourcing some of the low risk collection to commercial providers."[269] CANSOFCOM currently employs contracted air support in a domestic context. This use of ASD should be expanded in the future to include tasks other than fixed-wing surveillance – for example, commercial satellite coverage – both domestically and abroad.

Non-standard platforms for fixed-wing precision strike should be explored. Alternative service delivery may provide a solution, although risk management may continue to be a thorny issue with the blending of military personnel and civilian contractors in an operational context. Perhaps, however, a non-standard platform does not always need to be operated by a contractor. The Afghan campaign has proved that leasing a civilian platform and employing it with CANSOFCOM aircrew is viable and should be considered.[270]

Non-traditional sources of air support are viable for CANSOFCOM. RCAF support should always be considered the preferred supplier, but the scope of support sourced from commercial sources should be expanded in both a domestic and expeditionary context.

FUEL SOURCES

Perpetual fuel sources and unlimited flight duration will one day become commonplace, although not likely within Horizon 3. Therefore, CANSOFCOM and the RCAF must coordinate mutually reinforcing capabilities to extend the range of RCAF assets. Examples discussed previously, such as high-altitude pseudo satellites, clearly mark the trend of alternative energy sources. These burgeoning technologies provide numerous advantages, not least among them a significant reduction in the use of expensive and limited fossil fuels. Future fuel sources such as solar will not only reduce costs but will also positively affect the government of Canada's goals to reduce its carbon footprint.[271] The other significant benefit of future fuel sources is a reduction in the key factors of size, weight, and cooling so critical to determining aircraft payloads and range.

The development of these energy sources is expected and likely; however, their trajectories are difficult to predict. In the short to near term, CANSOFCOM must continue to support tactical refueling of RCAF assets to extend operational reach beyond current capabilities. While air-to-air refueling is desirable, this capability is considered both prohibitively scarce and prohibitively expensive.[272] As such, the conduct of tactical refueling is expected to remain on the ground for all but high-end CANSOFCOM and RCAF assets.

The CANSOFCOM ASAR capability extends tactical reach of CANSOFCOM and RCAF air assets in austere conditions. ASAR should be operationalized and broadened to include additional airframes beyond the CC-130 Hercules and should synchronize with the RCAF to achieve the expectation laid out in the 2017 Defence Policy Review that the RCAF can "operate from prepared or austere airfields anywhere in the world."[273]

With the expected development of perpetual fuel in the future, CANSOFCOM and the RCAF must remain engaged with technology industry partners and allied nations to observe and leverage advancements as they appear.

PROCESSING, EXPLOITATION, AND DISSEMINATION

> *The underlying problem is that there are simply not enough people available to analyse all the data being collected, even if personnel budgets were unconstrained. The problem is compounded as humans are inherently slow.*[274]
>
> Group Captain Peter Layton
> Royal Australian Air Force

Information is increasingly dominant and omnipresent, growing in volume, velocity and variety.[275] Still, data quality trumps data quantity. CANSOFCOM and the RCAF must harness the power of smart, autonomous machines to avoid decision paralysis. As an indication of the increasing importance of information, the U.S. military recently added Information as a core warfighting function. According to a capstone joint publication, this addition will foster "deliberate integration with other joint functions to influence relevant actor perceptions, behavior, action or inaction, and support human and automated decision making."[276] Information dominance is key to successful CANSOFCOM and RCAF operations and is achieved through optimized PED.

One method to achieve better PED is to front-load as much processing and exploitation of data as possible at the sensor. Smart sensors can improve PED by limiting the amount of raw data requiring dissemination and further exploitation. The U.S. program known as the Autonomous Real-Time Ground Ubiquitous Surveillance Imaging System does just that. This system provides continuous full-motion video coverage of more than 100 square kilometers but only transmits high-definition elements to analysts on the ground on-demand.[277] PED at the sensor is an area in which machine learning is making great strides as image and pattern recognition is becoming much more sophisticated. In addition to reducing the transmission of raw data, data compression at the sensor prior to transmission also significantly decreases the size of the downlink required between sensor and receiver. CANSOFCOM and the RCAF must harness these two significant growth areas.

A second method to improve PED is to rear-load processing and exploitation that cannot be accomplished by smart sensors. Big data should be exploited and disseminated by personnel in Canada where fixed-point infrastructure and a larger and more diverse pool of personnel provides greater bandwidth, analytic tools, and redundancy.[278] Rear-loaded PED is not necessarily optimal in all cases, however. Forward deployed forces might be optimized for PED due to time-sensitivity, a degraded communications environment, or compartmented mission parameters. The correlation between location and amount of PED is simplified and depicted in Figure 8.

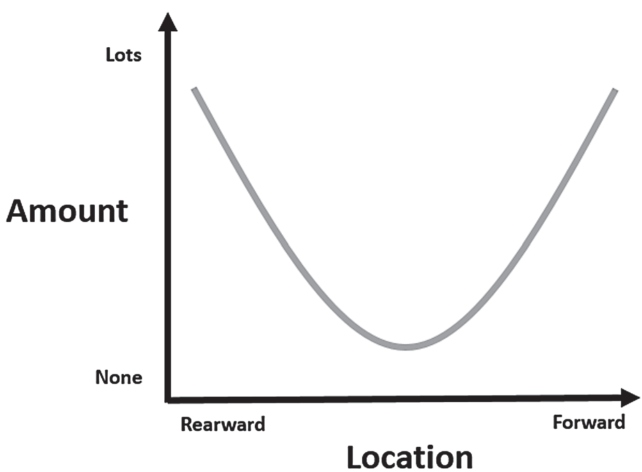

FIGURE 8. Optimized PED Location and Amount

In most cases, optimal PED is achieved either as far forward or as far rearward as possible.

To further optimize PED, Canadian intelligence analysts must also employ new and novel methods of automated data analysis. There are a host of options in this domain, which a RAND study describes as being comprised of "automated tools that can analyze incoming motion imagery and cue human analysts to inspect segments that might depict prescribed objects or activities of interest."[279] There are also valuable lessons from pop culture. The same RAND study found relevant best practices in the production of both reality television programs and high-level sports events. More drastically, RAND recommended that the USAF should work to "give [Intelligence Analysts] the same capabilities at their workstations that many already enjoy with their personal DVRs at home."[280] Novel analytics solutions are widely available and should be explored and adapted for CANSOFCOM and RCAF use. Both organizations would benefit from inclusion in the U.S. Department of Defense's Project Maven, designed to augment or automate the "enormous volume of data available to DoD [the Department of Defense] into actionable intelligence and insights at speed."[281]

These three methods of optimizing PED – use of smart sensors, front-end or back-end loading of exploitation, and novel and automated analytics – will deliver information dominance to CANSOFCOM and the RCAF.

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

The demand for ISR in support of CANSOFCOM missions will continue to grow. The methods of providing that ISR, however, will diversify significantly. The majority of ISR will operate in the air domain although ground-based sensors and aggregation from cyber sources will continue to grow in relevance.[282] As discussed in Chapter Four, ISR will be increasingly autonomous and remotely piloted. The border between air and space will continue to fade, and the platforms operating therein will be increasingly capable, omnipresent, and unbounded by altitude, range, or payload.

CANSOFCOM and the RCAF, along with the Canadian Armed Forces a whole, must employ a prudent number of ISR platforms of diverse types and capabilities. The 2017 Canadian Defence Policy Review confirmed these requirements, vowing that the CAF will procure "next generation surveillance aircraft, remotely piloted systems … and space-based surveillance assets to significantly expand its Joint Intelligence, Surveillance, and Reconnaissance capacity."[283] Table 6 lists the range of available options for remotely piloted ISR platforms.

CLASS	CATEGORY	MAXIMUM ALTITUDE/RANGE	EXAMPLE
Class I (Less than 150 kg)	Micro (Less than 2 kg)	200 feet/5 km	SkyRanger, Maverick
	Mini (2–20 kg)	3000 feet/25 km	Raven, Scan Eagle
	Small (20–150 kg)	5000 feet/50 km	Shadow, Blackjack
Class II (150–600 kg)	n/a	10,000 feet/200 km	Sperwer
Class III (more than 600 kg)	Medium Altitude	45,000 feet/unlimited	Heron, MQ-9 Reaper, Fire Scout
	High Altitude	65,000 feet/unlimited	Global Hawk, Zephyr

TABLE 6. RPA Classification Table[284]

To achieve its stated aims, the Government of Canada must consider employment of RPA ISR from all classes and classifications. Tactical elements must employ micro and mini variants for intimate support while higher-level SOF target development and operations will require robust and highly sophisticated sources.

Remotely piloted aircraft will likely predominate future ISR. In most cases, piloting an ISR platform remotely, with a human on or in the loop, will be the preferred relationship between human and machine. This preference is certainly accurate for surveilling Canada's borders and coastline, and other dull, dirty, or dangerous surveillance missions.[285] Increasingly, the mission parameters possible without a human onboard will make RPA more capable. In other cases, remote piloting may be the only option, particularly with tactical level micro, mini, and small RPA. Swarms of mesh-networked and disposable RPA will provide persistent coverage and support over wide swaths of land or sea. With ongoing work in the area of downlink resilience, the difficulties of degraded communications environments are slowly receding.[286] USSOCOM intends for the majority of SOF ISR platforms to be remotely piloted by 2023.[287] RPA should also make up the preponderance of CANSOFCOM and RCAF ISR assets.

CANSOFCOM still possesses, however, a requirement for Manned ISR (MAISR). Sensors and aircraft operated by discerning humans provide some advantages over RPA, in particular for mission-sets that depend on real-time intelligence, a shortened response time between sensor and analyst, or analysis without a data-enabled communication downlink. MAISR may also be more useful since "environmental conditions, flexible equipment or configuration requirements, and political permissiveness, as restrictions, tend not to impact [MAISR] as severely as they do RPA."[288] MAISR may also be more reactive to split-second adjustments, emerging threats, or crisis response situations. A 2017 Australian study observed, "if we want to out-pace and out-manoeuvre a peer adversary in a very complex and highly dynamic environment, we need to resort to a high degree of dynamic (re)tasking."[289] This dynamic re-tasking capability may favor dynamic human involvement onboard. In the end, however, the optimal solution is not one or the other, but a complementary mixture of and cooperative action between both MAISR and RPA.

Other, more novel ISR solutions will likely become prevalent with the progress of time. Space-based ISR is one solution. As of 2014, nine countries had space-launch capabilities and 1,167 satellites operated by thirty-five countries were in orbit.[290] Space assets are less vulnerable to enemy action as they operate above our traditional concept of contested airspace, yet, they do not provide a complete solution due to the tyranny of persistence described in Chapter Four. Other solutions, such as high-altitude balloons, pseudo satellites, and loitering munitions, all broaden the array of ISR options that should be considered for future CANSOFCOM and RCAF procurement.[291] As discussed earlier, the optimal solution for Canada is a robust, synergistic combination of many of these assets operating in a complementary fashion.

As a final ISR consideration, CANSOFCOM must own a portion of the ISR continuum. Affiliation may work for other RCAF assets but will not work for high-payoff, low-density intelligence collectors. NATO SOF HQ determined from a study that "reliance on non-dedicated air support … is equally disadvantageous due to scarcity of resources, lack of a habitual training relationship, and unfamiliarity with the SOF mission."[292] One 427 SOAS pilot wrote, in reference to SOF air support in general, that "the last, and least desirable, support relationship which may provide limited air effects to SOF is that of an *ad hoc* or non-dedicated nature. Only in executing the most basic tasks is this relationship helpful."[293] Without dedicated ISR, deployed SOF operations are only possible with the acceptance of greater risk. The Government of Canada acknowledged this reality in the 2017 Defence Policy Review by pledging that an "airborne Intelligence, Surveillance and Reconnaissance platform will be acquired for the Special Operations Forces."[294] The CANSOFCOM requirement for broad ISR capabilities will continue to grow.

A complementary mix of high-end SOF-specific platforms, dedicated and affiliated RCAF assets, and smaller, tactical, commercially available assets are necessary to meet ISR requirements out to the 2040s and beyond. Optimally, this mix involves the space and cyber domains, includes smart sensors, and incorporates assets that are modular and joint by design.

SOF MOBILITY

The insertion and extraction of SOF personnel will continue to be a core tactical task. Consequently, consideration of pragmatic and incremental growth in SOF rotary-wing assets should occur. The 2017 Defence Policy Review should retroactively add a replacement for the CH-146 Griffon with SOF-specific considerations onboard.[295] If optimized, this replacement would consider involvement in the U.S. Army's Future Vertical Lift program due to the long-term benefits of tilt-rotor technology discussed in Chapter Four. In the interim, CANSOFCOM and the RCAF must collaborate to meet current needs as part of the Griffon Limited-Life Extension. The U.S. Marine Corps UH-1 Huey upgrade provides a viable and pragmatic example. Likewise, commercial off-the-shelf options for modular weapon and sensor suites abound.[296]

CANSOFCOM interoperability with the RCAF medium-lift helicopter capability should be continued and expanded. This relationship must support CANSOFCOM adequately to allow for episodic and sustained joint training while determining the best practices for integration of light and medium platforms under a domestic or expeditionary Special Operations Aviation Detachment. The Afghanistan campaign developed much of this force employment concept previously although without a SOF-specific nexus.

For CANSOFCOM mobility needs beyond what helicopters can provide, CANSOFCOM interoperability with the CC-130 Hercules community must continue and expand for maintenance of the status quo is sub-optimal. In 2010, former pilot Bernard Brister wrote, relative to RCAF fixed-wing mobility, "the heavy demands placed upon these aircraft, even for the day-to-day support of CF operations, makes them largely unavailable for special operations, barring an executive order that essentially would cripple the CF air movement plan for weeks or months thereafter."[297] While the numbers and types of aircraft have changed since 2010, the need for interoperability remains constant. However, momentum behind CANSOFCOM in the tactical fixed-wing community is growing. The recent designation of SOF-specific aircrew for the CC-130J is an excellent step in the right direction.[298] Interoperability, through greater exposure during both training and operations, will generate a stronger relationship and shared cultural understanding between CANSOFCOM and RCAF tactical fixed-wing transport.

Future SOF mobility can be assured through SOF-specific precision rotary-wing, sustained training and operations with the RCAF heavy rotary-wing component, and expanded interoperability with the tactical fixed-wing community.

PRECISION STRIKE

The need for SOF-specific precision strike will likely extend far into the future. Then again, procuring a SOF-specific fixed-wing precision strike platform may remain fiscally and politically untenable for Canada. Nevertheless, a few implications regarding precision strike for CANSOFCOM still apply. First, CANSOFCOM must maintain the relationship between its Joint Terminal Attack Controllers and the RCAF fighter community. This relationship is based on over 12 years of operations and training and provides an excellent backbone for RCAF air support and precision strike during CANSOFCOM operations.

Regardless of the direction that the CF-188 Hornet replacement project pursues, CANSOFCOM equities must be considered during the procurement process. It appears that this advanced fighter aircraft will be the sole attack aircraft in the RCAF.[299] As such, it behooves both CANSOFCOM and the RCAF for it to be joint and modular to the benefit of both.

Notwithstanding the RCAF advanced fighter aircraft replacement, momentum appears to be gaining for a less technically advanced alternative to fifth-generation fighters. The USAF and AFSOC continue to invest resources into the OA-X program.[300] According to *Jane's Defence*, these light, primarily turbo-prop aircraft are "powered by technology advances that make it possible to combine the ISR and strike capabilities once provided by multiple aircraft into a single, relatively simple and affordable platform."[301] Although this may be an overly glowing description, OA-X does appear to provide a multi-role solution for tasks short of control of the air. With greater production levels of these light-strike platforms, Canada may be able to leverage lower per-unit costs if it elects to pursue this capability.[302] Possessing a combination of both high-end fifth generation fighters and down-"teched" observation and attack aircraft such as OA-X would be the optimal mix.

More pragmatic, perhaps, is the option for a roll-on/roll-off precision strike capability. CANSOFCOM and the RCAF should pursue the relatively inexpensive procurement of a modular weapon and sensor suite for both fixed- and rotary-wing platforms. Examples of both of these configurations abound.[303] The greater challenge, when operationalizing modularity-by-design, will be the development of aircrew expertise and force employment concepts. Apart from the training delta, an expansion of the operational employment for current aircraft fleets achieves multiple complementary goals for both CANSOFCOM and the RCAF and should be pursued.

The future of precision strike in a Canadian context should involve a continuation of current relationships, consideration of CANSOFCOM equities in the CF-188 Hornet replacement, and either a modular roll-on/roll-off capability or a dedicated precision strike platform optimized for SOF.

CONCLUSION

L'union fait la force has sought to determine which future air assets will be necessary to fulfill the government of Canada's mandate for CANSOFCOM. This analysis focused on the optimization of SOF airpower in Canada. Even so, any benefit to CANSOFCOM airpower would mutually reinforce and benefit the RCAF, the Canadian Armed Forces as a whole, Canada, and perhaps even its allies. All of these entities can be stronger when CANSOFCOM and the RCAF operate jointly.

SUMMARY OF TRENDS AND IMPLICATIONS

The eight trends shaping the composition of future CANSOFCOM airpower are summarized in Table 7.

FUTURE TREND		SUMMARY
1	**Remote Piloting**	A mixture of traditionally piloted and Remotely Piloted Aircraft (RPA) will achieve all future effects in the air domain. The use of these systems is certain, to the point where a better question is whether manned assets will continue to fly in their current numbers.
2	**Artificial Intelligence and Autonomy**	The world of artificial intelligence (AI) and autonomy is burgeoning as it relates to airpower. Humans may not remain intimately connected to future platforms and will recede further and further as technology advances.
3	**Processing, Exploitation, and Dissemination of Data**	The sheer depth and breadth of data requiring processing, exploitation, and dissemination (PED) is a daunting challenge for any military element now and into the future. CANSOFCOM must turn data into decisions.
4	**Intelligence, Surveillance, and Reconnaissance**	These first three trends directly influence future ISR platforms. These platforms are increasingly capable, omnipresent, and unbounded by altitude, range or payload.
5	**Mobility**	Future mobility may trend in two separate directions, toward compound helicopters, personified in the SB-1 Defiant, or the tilt-rotor class of aircraft platforms, most notably the V280 Valor. Regardless of the path, evidently the payload and range differences between helicopters and fixed-wing assets will continue to coalesce in the tactical realm.
6	**Precision Strike**	The future of fixed-wing strike platforms also has a rift between highly complex, expensive, and scarce fifth- and sixth- generation stealth fighters, and simple, "low-technology" observation-attack platforms such as the A-29 Super Tucano. Benefits and trade-offs exist between high-end and low-end assets, and an optimized air force possesses a mix of both.
7	**Alternative Service Delivery**	Resources employed in or supporting the air domain may increasingly use contractor owned and operated platforms involving civilian companies instead of traditional military units. Current examples, in Canada as well as abroad, show that air support from non-traditional sources is a viable option in the Canadian context.
8	**Fuel Sources**	Fuel sources will continue to develop and enable greater range and payload capacity across the spectrum of platforms in the air domain. However, the goal of perpetual fuel is likely unreachable in the near-to-medium term.

TABLE 7. Summary of Trends

With these trends established, this study turned toward ten specific implications for CANSOFCOM and the RCAF (see Table 8).

IMPLICATION		SUMMARY
1	**The Enduring Need for Human Involvement**	Notwithstanding all the technological advances applicable to the conduct of war, the need for boots (or shoes) on the ground endures, since that lasting effects require direct human influence. Synergy between humans and technology is mutually advantageous for CANSOFCOM and the RCAF, and humans are enduringly more important than hardware.
2	**Human-Machine Teaming**	CANSOFCOM and RCAF personnel will remain in the loop across the spectrum of SOF mission sets but are likely to recede from it both literally and figuratively. Human intellect is optimized when teamed with the processing powering of a machine. SOF and Air Force leaders must integrate smart, autonomous machines into the fabric of operational culture.
3	**Joint by Design**	CANSOFCOM operations would benefit from a joint-by-design start-state in both organization and ethos. An expanded apportionment of full-spectrum air assets by default, removed only by exception, would increase the synergy between CANSOFCOM and the RCAF.
4	**Modular by Design**	Roll-on/roll-off ISR and precision strike packages would allow multi-role employment of RCAF assets without larger fleets. Modular design of hardware, in a broader context, makes eminent sense for CANSOFCOM and the RCAF.
5	**Alternative Service Delivery**	Viable air support for CANSOFCOM operations can and should be sourced from non-traditional assets. RCAF support should always be considered the preferred supplier, yet the scope of support sourced from commercial sources should be expanded in both a domestic and expeditionary context.
6	**Fuel Sources**	Perpetual fuel and unlimited flight duration will one day become commonplace. Until then, CANSOFCOM and the RCAF must coordinate mutually reinforcing capabilities, such as ASAR, to extend the range of RCAF assets.
7	**Processing, Exploitation, and Dissemination**	CANSOFCOM and the RCAF must harness the power of smart, autonomous, analytical machines to avoid decision paralysis. Processing and exploitation should be done either at the sensor or back in Canada and should incorporate novel and automated analytics. Quality trumps quantity.

cont...

8	**Intelligence, Surveil-lance, and Reconnais-sance**	The demand for ISR in support of CANSOFCOM missions will continue to grow, yet the methods of providing that ISR will diversify significantly. Remotely piloted aircraft will predominate future ISR while CANSOFCOM still has a requirement for its own organic manned ISR.
9	**SOF Mobility**	Consideration of pragmatic and incremental growth in CANSOFCOM rotary-wing assets should occur. Interoperability with the RCAF medium-lift helicopter and CC-130 Hercules capability should be continued and expanded.
10	**Precision Strike**	Procuring a SOF-specific fixed-wing precision strike platform may remain untenable for Canada, yet the need for SOF-specific precision strike will extend far into the future. Future precision strike should involve a continuation of current relationships, consideration of CANSOFCOM equities in the CF-188 Hornet replacement, and either a modular roll-on/roll-off capability or a dedicated precision strike platform optimized for SOF.

TABLE 8. Summary of Implications

Crucially, CANSOFCOM would struggle to address these implications alone and requires synchronization with the RCAF from the outset. The benefit in doing so is holistic for the CAF. Fulfilling these implications will create a stronger CANSOFCOM, a more interoperable RCAF, and a CAF focused on what the future holds for operations in the air domain.

INTEROPERABILITY, NOT INTERDEPENDENCE

Addressing the implications proposed in this study would make CANSOFCOM and the RCAF stronger together. Nevertheless, the absence of opposition to these ideas would be an anomaly. Unconventional military forces have traditionally faced resistance despite being implicitly complementary to their conventional counterparts. The U.S. military has battled over ownership of ISR assets for decades and saw similar contention during the reorganization of rotary-wing assets as a result of Operation Eagle Claw.[304] In one description, some in the U.S. military viewed this reorganization as "an atrociously dumb idea."[305]

Opposition to augmented SOF airpower in Canada is expected but surmountable. It becomes particularly so because CANSOFCOM has no inherent interest in, and would never advocate for, a reduction in the capabilities of the RCAF or, for that matter, any other instrument of Canadian military power. CANSOFCOM must retain its ability to operate independently during SOF-specific missions and tasks. Pilot and professor Bernard Brister wrote, "a national SOF contribution must have the resources and capabilities to operate as a discrete force in the execution of its missions" while concurrently integrating attachment from the other military elements.[306] A mature SOF element, which CANSOFCOM has become, must be equipped with enough capability to operate discretely. Retired U.S. Special Forces officer and professor Hy Rothstein wrote a similar opinion article in which he asked, "why would any organization link its success to dependence on another organization, especially when lives are at stake? … The greater the interdependence, the greater the likelihood of conventionalizing a [special operation] and losing sight of the mission's original purpose."[307] Both CANSOFCOM and the RCAF must remain highly skilled at their own specialized and niche areas, yet, must equally join together in matters of national interest when appropriate.

AREAS FOR FURTHER STUDY

This study strove to encompass background and analysis sufficient to spur change. Even so, further study is necessary. The exact composition of an expanded CANSOFCOM air component remains outside the scope of this study. This absence is mostly due to scale since the analysis for a composite special operations aviation squadron would likely necessitate a study proportionate to this one. Equally importantly, the exact composition and command and control arrangement will morph as elements are added and subtracted iteratively, over time. Further study, incorporating concepts from the field of Organizational Design, could address the exact composition of a CANSOFCOM air component.[308]

As a start point, however, this study offers several broad option areas to begin this design. First, growing a SOF-specific air wing for Canada is likely far too elaborate and unnecessary. Light, agile, and interoperable are characteristics that are far more appropriate, and a composite Special Operations Aviation Squadron based around 427 SOAS is an appropriate framework. To determine precise requirements, a joint RCAF-CANSOFCOM-Canadian Army symposium should be planned to discuss common issues facing air support to ground forces.[309] Last, the addition of a RCAF Air Component Commander in CANSOFCOM HQ, with a reciprocal SOF air advisor in 1 Canadian Air Division, would give additional coherence and organization to the employment of SOF air power.[310]

FINAL THOUGHTS

CANSOFCOM is a key component of the Canadian Armed Forces with deepening operational relevance, yet it lacks optimal airpower. This study sought to determine which future airpower trends Canada must consider in order to optimize SOF airpower out to 2040 and beyond. Although this analysis may not provide an unobstructed roadmap into the future, it fills a gap in previous literature and should serve as a starting point or reinvigorate further discussion. Notwithstanding the complexity of the future, the links between CANSOFCOM and the RCAF must grow in order for those organizations to remain relevant. They are each stronger together.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADF	Australian Defence Force
AFRICOM	Africa Command
AFSOC	U.S. Air Force Special Operations Command
AI	Artificial Intelligence
AOR	Area of Responsibility
ASAR	Airfield Surface Assessment and Reconnaissance
ASD	Alternative Service Delivery
ATO	Air Tasking Order
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
C5I	Command, Control, Communications, Computers, Cyber, and Intelligence
CAF	Canadian Armed Forces
CAS	Close Air Support
CANSOFCOM	Canadian Special Operations Forces Command
CBRN	Chemical, Biological, Radiological, and Nuclear
FAC	Forward Air Controller
FSE	Future Security Environment
FSSF	First Special Service Force
HQ	Headquarters
ISR	Intelligence, Surveillance, and Reconnaissance
JTF 2	Joint Task Force Two

MAGTF	U.S. Marine Corps Air-Ground Task Force
MAISR	Manned Airborne ISR
MND	Minister of National Defence
NATO	North Atlantic Treaty Organization
NORAD	North American Air Defense Command
NORSOF	Norwegian Special Operations Forces
NSHQ	NATO SOF Headquarters
PED	Processing, Exploitation, and Dissemination
RAF	British Royal Air Force
RCAF	Royal Canadian Air Force
RPA	Remotely Piloted Aircraft
SOAR (A)	Special Operations Aviation Regiment (Airborne)
SOAS	Special Operations Aviation Squadron
SOCOMD	Special Operations Command Australia
SOE	Special Operations Executive
SOF	Special Operations Forces
SOTF	Special Operations Task Force
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UKSF	United Kingdom Special Forces
USAF	United States Air Force
USASOAC	U.S. Army Special Operations Aviation Command
USSOCOM	United States Special Operations Command

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