

# PROJECTING POWER: CANADA'S AIR FORCE 2035

EDITED BY  
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The year 2009 marks the 100th Anniversary of the first Powered Flight in Canada, which inaugurated a tradition of innovation in aviation. John A. D. McCurdy, who flew the Silver Dart from the frozen surface of Bras D'Or Lake on 23 February 1909, and succeeding generations of visionaries, have kept the dream of flight soaring to ever greater heights. No matter how spectacular the technology or awe inspiring the power of these flying machines, we must never forget that these all began as ideas fuelled by a fertile imagination. If this book encourages today's Air Force personnel, many of whom will be the leaders of tomorrow, to follow the example of their forebears and engage in thoughtful discussion and debate about the future of air power in the world of 2035, then it will have served its purpose.

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PROJECTING  
**POWER:**  
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**2035**

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## FOREWORD

As we near the end of the first decade of the 21<sup>st</sup> century, Canada's armed forces continue to operate in a complex international security environment characterized by uncertainty, volatility and risk. Yet even as the possibility of large force-on-force exchanges remains less likely in the immediate future, the likelihood of executing complex operations requiring a comprehensive civil-military approach will always be present. With innovative and adaptive adversaries taking full advantage of the physical, moral and informational domains in which we are expected to operate, Canada's future security challenges will require a strategically relevant, operationally responsive and tactically decisive armed force to defend Canada's interests.

As the second largest country in the world and touching three oceans, Canada has as much a requirement for rapid strategic reach at home as it does abroad. The interconnected and interdependent world in which we now live also suggests that the lines between internal and external security challenges will continue to blur if not disappear altogether. As a result, our armed forces must have the ability (unhindered as much as possible by time and space) to project power at home as well as internationally. Whether confronting instability across the globe or a natural disaster at home, it is within this context that we must prepare our Air Force.

As a critical component of the Department of National Defence (DND) and Canadian Forces (CF), the Canadian Air Force will continue to operate effectively as a full partner of the comprehensive approach (CA) team led by the Government of Canada. As such, it must work constantly to understand the nature and characteristics of the future security environment as well as its implications for future armed conflict in the air and beyond. The Air Force must continue to cultivate future concepts, designs and doctrine that are clear, relevant and forward thinking. Finally, it must employ these concepts and doctrine in the development of future air requirements and capabilities that will ensure the Air Force's effectiveness well into the future.

To this end, within the context of the DND/CF future security environment, the Canadian Forces Aerospace Warfare Centre has completed a study of the future security and operating environments as well as their implications for future aerospace power. Specifically, *Projecting Power: Canada's Air Force 2035* offers a detailed first look at how the Canadian Air Force may be conducting missions a generation from today as well as what capability requirements will be needed to operate within this environment.

It is clear from this study that the future security environment will offer significant challenges to both aerospace power and the air forces that project it. While some of the ideas presented here may seem fanciful to us today, we must keep in mind that air forces exist now because the visionaries of yesterday imagined a fanciful future where air power would have a prominent place. Today, that vision is not only realized, but it also presents new opportunities as well as new risks. As such, we must continue to ask hard questions of the future of aerospace power, even as we seek to create our own place within it.



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## TERMINOLOGY OF PROBABILITY

Throughout this study the reader will note instances where the words *will*, *probably*, *likely*, *possibly*, *possibility*, *may*, *might*, *could*, *unlikely*, *may not* and *will not* are italicized for additional emphasis. This is done to draw the reader's attention so that they will note the impact on the future aerospace power concept as a whole. The glossary below further explains the intent of this emphasis:

### *will*

Circumstances are already moving in this direction, and moving off this trajectory is not foreseeable.

### *probably/likely*

A change in circumstances could change the trend's trajectory, but this is not likely to happen.

### *possibly/possibility/may/might/could*

This occurrence is foreseeable, but a change in trends is not out of the question, thus bringing about a different outcome.

### *unlikely / may not / will not*

The outcome is deemed improbable as there is little or no evidence projecting its occurrence.

## EXECUTIVE SUMMARY

Professional volunteer air forces that actively anticipate the future are less likely to be surprised by it. As part of the Chief of the Air Staff's commitment to maintaining a relevant combat-effective Air Force for the future, this conceptual study was commissioned to look out to the year 2035 and to determine in broad terms how air forces would operate in the future security environment and what capabilities they *might* need to meet the challenges posed by that environment. The key findings of this study were as follows:

### FUTURE SECURITY ENVIRONMENT

It is anticipated that globalization *will* continue to connect the world both physically and through information, but it *will* also contribute to state weakness and failure. Issues related to the environment, identity, disparity, health and welfare *will* undermine stability where it is most needed.

Major peer-versus-peer conflict *will* remain less *likely* than smaller inter and intrastate conflicts. As well, it is more *likely* that these future conflicts *may* involve both state and non-state actors. Non-state actors, especially, *will* seek to exploit dependency, disenfranchisement and disparity to advance their own objectives.

Future aerospace security *will* become increasingly complex as access to aerospace travel and the number of aerospace platforms increases. There *will* be greater opportunities by more actors to exploit aerospace power, thereby increasing both the range and number of potential security threats in, through and from the air.

### FUTURE OPERATING ENVIRONMENT

The nature of future aerospace warfare *will* undergo dynamic changes over the next quarter century. Aerospace power *will* belong to those actors who embrace new technologies and processes. Aerospace supremacy, therefore, will belong to those who have imagination and the will to use it.

Manned areas of operation *will* expand to include suborbital altitudes and assets, while aerospace platforms *will* continue to grow both in number and in reach. The balance between manned and unmanned platforms in aerospace operations *will* become harmonized, and the systems *will* become increasingly lethal and precise. At the same time, the future operating environment *will* demand alternatives to simple destruction; therefore, the future Air Force must develop a full spectrum of precision effects.

The future operating environment *will* require ever more from the Air Force, meaning that it must encourage and sustain a robust, leadership-directed, pervasive force-development culture. As such, the future Air Force *will* need solid strategies, flexible policies and agile doctrine which are further shaped by enabling concepts, analysed by operational functions and made possible by well-researched capability requirements.



## FUTURE CAPABILITY REQUIREMENTS

The future Air Force requires robust capabilities that contribute directly to its relevance and combat effectiveness. To be successful, the future Air Force must be able to command, sense, shape, move and sustain itself in the battlespace. To do this, the Air Force requires a suite of capabilities that give it a physical, moral and informational edge in the battlespace.

Given the *likely* future security environment and future operating environment that the Air Force expects to face, it must be able to project power through precision effects. To do so, the Air Force must sustain its current capabilities as well as acquire many new ones. A definitive, comprehensive, but by no means exhaustive capability-requirements list highlights the need for advanced aerospace command, sense, shape, move and sustain capabilities.

Supported by an Air Force culture of innovation and creativity that encourages and tolerates new ideas and is willing to accept some risk, these capability requirements—shaped by dynamic, imaginative and forward thinking leadership—*will* serve as the benchmark from which to begin the development of the future Air Force.

# INTRODUCTION

*Ships and sails proper for the heavenly air should be fashioned. Then there will also be people, who do not shrink from the dreary vastness of space.<sup>1</sup>* ”

- Johannes Kepler, letter to Galileo Galilei, 1609

In December 1903 there were only two people—Orville and Wilbur Wright—engaged in powered air travel in the United States of America. A century later, the United States (US) commercial airlines transport nearly 2 million travellers daily to their destinations around the globe. In Canada, 13.3 million residents, or approximately one third of the country's total population, travelled by air in 2007.<sup>2</sup>

John McCurdy made the first historic flight in Canada in February 1909; less than five years later his “three axis control fixed wing flying machine” had evolved into an instrument of warfare. Today, sophisticated military aircraft comprise the sharp leading edge of an invaluable concept known as aerospace power. This same concept supported by technology and human resourcefulness has also enabled many nations to reach into space.

If one were to simply continue extrapolating the historical trends started 100 years ago for three more decades, it is not fantastic at all to suggest that by the year 2035 air forces *will* have evolved further just as the population of air travellers *will* surely continue to grow. In addition, air forces *will* continue to serve as a vital link for ground operations, as well as between land and sea operations. In the future, aerospace power *will* serve only to further strengthen these links. By the same token, the need to defend both the aerospace and air travellers against an increasing number of possible threats *will* only be matched by the increasing requirement for projecting aerospace power and its precision effects at home and abroad.

Still, to presume insight into what future aerospace power *may* look like is fraught with risk. Yet air forces that wish to consider themselves both professional and effective must do exactly this and do it continuously. The nature of aerospace power is constantly changing. However, when equipped with an understanding of one's past, an appreciation for one's present situation as well as a vision for future development, it becomes very possible to craft an effective path forward.

There is little to indicate any reduction in the importance of aerospace power to Canada over the next three decades. As a country whose population is often separated by **strategic** distances, the need for a robust Air Force at home is self-evident. Not only must the Air Force continue to have the capability to traverse the country from Newfoundland to British Columbia and the North, it must also be capable of operating in environments ranging from temperate to arctic.

The international security environment also suggests that dramatic implications lie ahead for Canada. With globalization expanding further, regional power bases as well as weak, fragile, failing and failed states *will* pose greater security challenges for stability. Demographic effects, religious conflict, resource scarcity and environmental change *will* exacerbate existing conflicts while fostering new threats in the future. The advent of cheap and easily accessible technologies *will* allow adversaries to more easily and more rapidly export threats in and through airspaces, while telerebotic and semi-autonomous aerospace platforms *will* allow these threats to be delivered remotely and over long distances.

<sup>1</sup> <http://www.skygod.com>

<sup>2</sup> North American Transportation Statistics Database, “Table 10-1: International Travel by Mode of Transportation,” North American Transportation Statistics, <http://nats.sct.gob.mx/nats/sys/tables.jsp?i=3&id=23> (accessed January 10, 2009).

It is therefore critical that as the political, societal and technological realities change, Canada's Air Force is prepared to mitigate future risks at home while effectively delivering precision effects abroad. The future Air Force must be robust, agile, flexible, relevant and decisive. It must be knowledge-based, combat-effective, interoperable and conducive to joint, interagency, multinational and public (JIMP) operations. The Air Force must be affordable, maintainable and, above all else, meaningful to the defence of Canada and its interests.

This study seeks to forecast and articulate the nature of aerospace power as well as the Canadian Air Force's role to the year 2035. The first part of this study builds on the recent Chief of Force Development draft study, *The Future Security Environment 2008–2030 Part 1: Current and Emerging Trends*,<sup>3</sup> by examining future security environment trends and drivers in the context of the air environment. It is within this forecasted future security environment (FSE) that the second part of this study explains the projected future operating environment (FOE) for Canada's Air Force. Finally, the third part of this study evaluates both the FSE as well as the FOE to construct a portfolio of proposed future capability requirements (FCR) for the Air Force.

This publication is intended to be a speculative think piece that presents a conceptual framework; it is designed to assist the Air Force in developing its future capability requirements. Though the document strives to articulate what Canada's future Air Force *might* look like, its purpose is not to definitively describe it. Rather, the aim of this document is to provide a starting point for further discussion, debate and discourse. The Air Force must not simply react to the future. Through this and other studies, the Air Force *will* seek to anticipate the future, shape it and, in essence, create it as much as is possible.

## NEVER UNDERESTIMATE AIR POWER

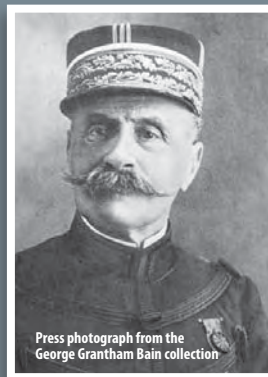
*Aeroplanes are interesting toys, but of no military value.*<sup>4</sup>

- Marshal Ferdinand Foch, Commandant,  
École Supérieure de Guerre, 1911

Before the start of World War I and as Commandant of the École Supérieure de Guerre (France's War College), Marshal Ferdinand Foch (1851–1929) had been the main architect of French military theory. National spirit, he believed, was as important as guns and men. "Victory is will," he once declared. But he also stressed the fundamentals of tactics and believed that plans should be flexible. A brilliant theorist and prolific writer, he was one of the most influential military officers in the French Army during the early 20<sup>th</sup> century.

In World War I, he was responsible, with General Joffre and General Gallieni, for halting the German advance at the Marne (1914). He participated in the first battle of Ypres (1915) and that of the Somme (1916); after a brief eclipse, he was appointed Chief of the French General Staff in 1917. A year later, Foch assumed the unified command of the British, French and American armies. In this capacity, he was perhaps more responsible than any other one man for the Allied victory in World War I.

A brilliant strategist, Foch, however, failed to truly appreciate the military potential of aeroplanes during the infancy stage of air power. Given the chance, would Marshal Foch like to take back the famous words he pronounced in 1911? In 1918, along with Field Marshal Haig, he planned the Grand Offensive<sup>5</sup> which eventually led to the defeat of Germany. That offensive featured a prominent role for airplanes.



3 Canada, Department of National Defence, *Future Security Environment 2008–2030 Part 1: Current and Emerging Trends* (Ottawa: Chief of Force Development, 27 January 2009). Available on the DIN at <http://cfd.mil.ca/sites/page-eng.asp?page=5996> (accessed March 10, 2009).

4 <http://www.skygod.com>

5 The Grand Offensive is also known in French as *Les cent jours du Canada* (Canada's Hundred Days), highlighting the prominent participation of the Canadian Corps under British First Army command.





# PART 1:

## THE FUTURE SECURITY ENVIRONMENT

*With this array of present and future threats, the aerospace defence problem becomes complicated, and that is the understatement of the day.<sup>6</sup>*

- Air Marshal C. R. Slemon CB, CBE  
Deputy Commander, NORAD, March 1963

**A**fter almost a decade into the 21<sup>st</sup> century, Canada remains engaged in an international environment marked by uncertainty, volatility and dynamic change. Trends considered the hallmarks of international security during the cold war and immediate post-cold war era continue to fade away and have been replaced by increasingly ambiguous and much more complex drivers and strategic shocks. This has had a tangible effect on both political leaders as well as their populations. Perhaps nowhere are the challenges that lie ahead more evident than in the sphere of national security.

Though there is no imminent threat of massive global warfare and major peer versus peer wars, the future security environment *will* be characterized by globalization; economic volatility; weak, fragile, failing and failed states; instability; regional conflict; disenfranchisement; terrorism; organized international crime; technological disparity; resource scarcity; and climate change. All of these factors could *possibly* lead to varying degrees of instability, posing threats to Canada and our national interests, both at home and abroad.

Given the shifting power balances, rapid scientific and technological innovations and diffusion, demographic shifts, growth of identity-based conflicts as well as agitation by non-state actors, the CF *will* face considerable challenges and, very *likely*, increasing demands for participation in international stability operations.

Canada's Air Force *will* form a critical part of this response. The Air Force *will* continue to be built around a core of combat effectiveness, while being shaped by future knowledge, science and technology. It *will* require not only the constant modernization of its current fleet of resources (both human and machine), but also the resources to innovate and develop new capabilities to mitigate the risks the future security environment *will* present. Additionally, the Air Force must be prepared to deal with a growing airborne population, increased global aerospace travel, intensified aerospace power projection, improved aerospace integration, a flurry of new aerospace technologies as well as diverse new threats to the aerospace. These threats will come from and through the same air and space that the Air Force must protect.

The following examination of key trends, drivers and strategic shocks *will* shed further light on the nature of the future security environment with respect to the aerospace environment. More importantly, perhaps, the extraction of specific characteristics from the future security environment that *may* affect future aerospace power *will* further broaden our understanding of the future operating environment, as well as the future capability requirements needed to function within it.

6 C. R. Slemon, "Meeting the Potential Soviet Threat from Space," *The Roundel* Vol/Iss #s (March 1963): 3.

## FUTURE TRENDS AND DRIVERS

The Canadian Air Force of 2035 will be influenced by the current, ongoing and yet to occur trends and drivers. These terms are defined as follows:

**Trend.** A tendency or a movement towards something or in a particular direction.

**Driver.** An event or human activity that provides impetus or motivation to fuel or sustain a trend.

In *The Future Security Environment 2008–2030 Part I: Current and Emerging Trends*, the Chief of Force Development has grouped the emerging trends into five categories. In this publication, trends and drivers are also categorized in the same manner, but as shown in Figure 1-1 with the following subcategories.

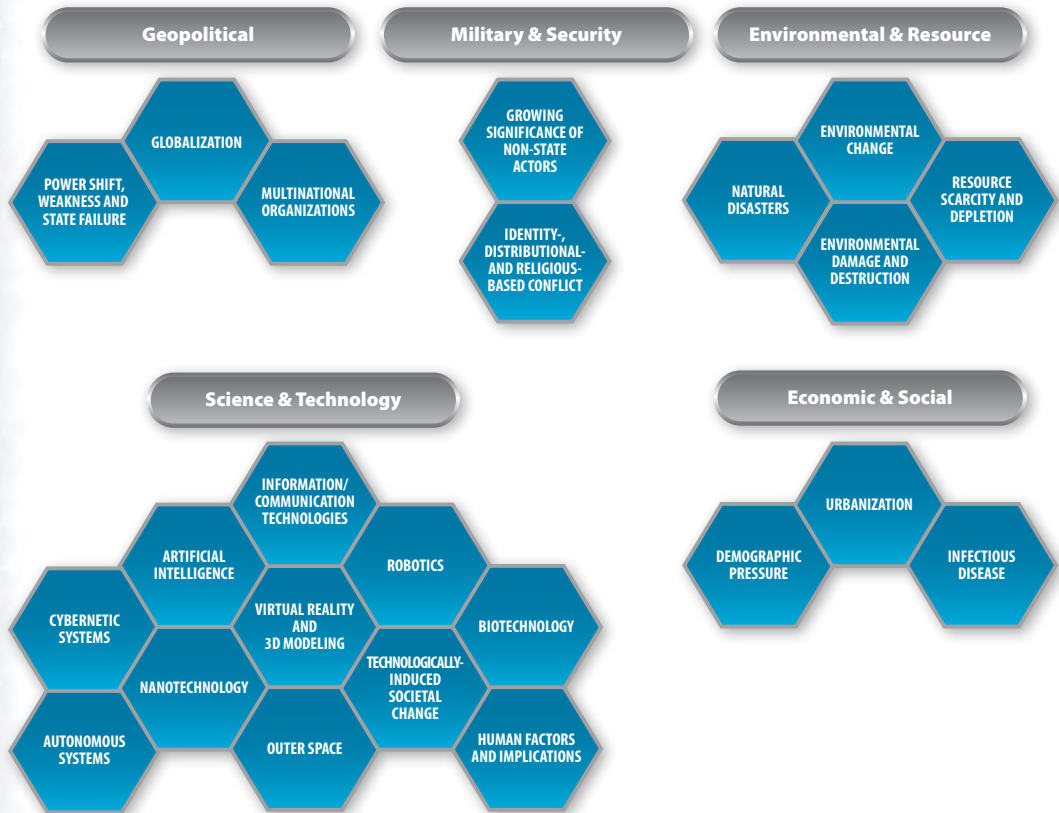


Figure 1-1: Emerging Trends and Drivers



## GEOPOLITICAL

### GLOBALIZATION

Perhaps the greatest recently observed geopolitical trend is globalization. This term refers to the increased flow and mobility of goods, services, ideas, information, people (including labour), technology and capital throughout the world. Though not an entirely new development, in its current form and married to the advent of several new technologies, it has manifested itself to the point of having a direct effect on the modern international system. Not only has modern globalization integrated international relations and economies, in some regions of the world it has integrated whole societies. The recent and tremendous advances in telecommunications have enabled whole societies to easily share everything from ideas to goods and services. Conversely, these societies now also share the risks as well as the threats that globalization *may* bring with it.

In many ways aerospace power, as well as international air travel in general, was one of the first products of modern globalization. Using new aerospace technologies developed during the Second World War, several nations were able to greatly expand their ability to project air power as well as extend their post-war global reach. While this allowed more frequent societal and service exchanges and contributed to the overall expansion of the international system, at the same time post-war air power<sup>7</sup> exacerbated international relations and security. For the two superpowers in particular, aerospace power<sup>7</sup> combined with nuclear armament presented serious risks and necessitated considerable investment in air defence. Today, these challenges continue to exist, and by the year 2035, they will *likely* have evolved further and *will* include more diverse actors.

Though it remains *likely* that the United States *will* continue to exist as the world's only hegemonic superpower in 2035, it is also very *likely* that globalization *will* have a greater effect on its power. From an aerospace power perspective, both manned and unmanned aerospace platforms from other nations *will* increasingly challenge airspaces currently dominated by the US and its allies. Part of this challenge *will* come simply from the demands and activities of an increasingly globalized world. Yet other challenges *will* be less benign in nature. Globalization *will* act as an instigator for increased air activities by emerging regional powers in areas traditionally dominated by allied air forces. This *may* lead to shifts in the geostrategic landscape associated with a slow shift towards a more multipolar international system, as well as the emergence of new powers that *could* limit US and allied dominance. For example, "China and India are restoring the positions they held two centuries ago when China produced 30 percent and India 15 percent of the world's wealth. China and India, for the first time since the 18<sup>th</sup> century are set to be the largest contributors to worldwide economic growth."<sup>8</sup>

Globalization has had and *will* continue to have a tremendous impact on aerospace power and air travel. In 2008 the demand for airplanes continued to grow. For example, Boeing received 662 orders for commercial aircraft this year alone. This brought its total backlog of orders for commercial aircraft to 3,700.<sup>9</sup> It is estimated that worldwide there are currently as many as 312,000 general aviation aircraft in service. By the year 2035, this number *could* double or easily triple, as aircraft continue to facilitate the movement of people, capital, goods and services around the world. From a security perspective, the globalization of future aerospace power is simply daunting.

<sup>7</sup> In this document air power and aerospace power have distinct meanings. Air power is used in connection with flying assets, strategy and doctrine associated with the early days of aviation, through World War I and World War II and up to the launch of Sputnik into orbit in 1957. Aerospace power is the modern view of that component of military power that is applied within or from the aerospace environment to achieve effects above, on and below the surface of the earth.

<sup>8</sup> United States, Director of National Intelligence, *Global Trends 2025: A Transformed World* (Washington: United States Office of the Director of National Intelligence, November 2008), 7. Available online at [http://www.dni.gov/nic/NIC\\_2025\\_project.html](http://www.dni.gov/nic/NIC_2025_project.html) (accessed April 23, 2009).

<sup>9</sup> Boeing, "Boeing Contracts in Quebec Exceed \$420 Million," Boeing, [http://www.boeing.com/news/releases/2008/q1/080121b\\_nr.html](http://www.boeing.com/news/releases/2008/q1/080121b_nr.html) (accessed February 2, 2009).



Photo composite by CFAWC

## GLOBALIZATION AND THE DISPROPORTIONATE COST OF WAR

In today's interconnected, fast-moving and interdependent global economy, many argue that these circumstances and the disproportionate cost of conflict are certain guarantees of peace among and between trading partners. These ideas are not new and have induced a widespread sense of security on at least two significant occasions within the last century.

In the years prior to the First World War, Norman Angell's influential book *The Great Illusion: A Study of the Relation of Military Power to National Advantage* (which was first published in 1909 and then translated into German, French, Russian and Italian) had achieved ten English printings by 1913. He forcefully argued that the integration of the economies of European countries had grown to such a degree that war between them would be entirely futile, making war obsolete. Most agreed, and if war did come, as it did in mid-summer 1914, that it would be, necessarily, of brief duration. The British believed that their soldiers would be "home by Christmas" or, as the German Kaiser projected, "before the leaves fall from the trees." Four years of bitter warfare and millions of dead would prove them wrong.

In the late 1930s, a group of distinguished American academics analysed and annotated the first unabridged English translation of *Mein Kampf*, Adolf Hitler's vision of his "Thousand Year Reich." Despite what are regarded today as explicit warnings in the text and growing tensions in Europe, the academics were not unduly alarmed. Perhaps with lurid memories of the "war to end all wars" only 20 years earlier, they assured their readers that war was unlikely. They concluded, "... it could hardly be to Germany's advantage to threaten Poland with war. The cost of such a struggle, in treasure and possibly also in prestige, would not compensate for the possible gains..."<sup>10</sup>

*Mein Kampf* did not make it off the US printing presses before German tanks and aircraft struck deep into Poland on 1 September 1939, initiating the chain of events that became the Second World War.

## POWER SHIFT, WEAKNESS AND STATE FAILURE

Air and aerospace power have contributed significantly to the measurement of state sovereignty and power since the end of the First World War. Yet, as much as the globalization of aerospace power contributes to societal integration, it can also influence power shifts, accentuate state weakness and, in some cases, contribute to state failure. The evolution of aerospace power, especially in developing regions of the world, has had considerable effects on shifting regional power balances. Aerospace power has played a major role, for example, in shaping the geopolitics of both Africa and the Middle East since the end of the Second World War.

In other cases, aerospace power has contributed to state instability and even failure, especially in countries where the government has little or no control over its airspace and little ability to defend itself from incursions by or through the air and space. States lacking adequate air traffic control (ATC) capabilities or air defence capabilities find themselves increasingly vulnerable to belligerent air forces and capabilities. This is especially the case in regions where the government infrastructure is damaged, corrupted or weak.

10 Adolf Hitler, *Mein Kampf* (New York: Reynal & Hitchcock, 1940), 372.



By 2035, external aerospace power *will* become a serious threat to weak, fragile, failing and failed states. (See Figure 1-2 for the continuum of state stability.) States that are unable to control their own airspaces *will* be exploited by a foreign aerospace power, whether by surveillance, overflight, air piracy or even unauthorized entry and exit. Consequently, they *will* have little opportunity to take advantage of the opportunities that aerospace power *could* offer without heavy investment. Weak, fragile, failing and failed states that choose to invest too heavily in air resources today often do so at the expense of other necessary, often societal, infrastructure. In the future this is *unlikely* to change.

It is often in these very same regions that Canada's Air Force will be expected to project its own aerospace power in support of Canadian interests and the stabilization of the international system. Counter-insurgency, crisis response, humanitarian and reconstruction missions to ameliorate the security situation will all require robust air capabilities that can command the airspace, shape the battlespace as well as move flexibly and freely.<sup>11</sup>



Figure 1-2: Continuum of State Stability

## MULTINATIONAL ORGANIZATIONS

Confronted with few overt threats and declining populations, most affluent societies *will*—for as long as it is in their interest to do so—attempt to minimize their defence burden in the future by investing in conflict prevention, participating in alliances, forming communities of interest and contracting out security.<sup>12</sup> In 2035 it is possible that traditional cooperative agreements and current defence sharing arrangements *will* have evolved to the point where traditional organizations are no longer required or even desired. For example, the establishment of United States Northern Command in 2002, a command that shares some

11 Canada, DND, *Future Security Environment 2008–2030 Part 1*, 88.

12 United Kingdom, Ministry of Defence, *The DCDC Global Strategic Trends Programme 2007–2036*, 3rd ed. (Shrivenham, SWINDON: Development, Concepts and Doctrine Centre, January 2007), 75. Available online at <http://www.mod.uk/DefenceInternet/MicroSite/DCDC/OurPublications/StrategicTrends+Programme/> (accessed April 29, 2009).



of the same air defence responsibilities as North American Aerospace Defense Command (NORAD), is perceived as a driver that *may* eventually lead to a further reduction of, or perhaps even elimination of, NORAD's traditional role in North American defence. In addition, with NORAD's core function of ballistic missile early warning and assessment gradually being conducted by the United States on its own, Canada's role as an influential "partner" in North American strategic defence faces further decline. When combined with recent political decisions taken in Ottawa against future participation in US missile defence programs, by 2035 the political value and utility of NORAD to Canada's security interests *may* cease to exist altogether.<sup>13</sup>

Likewise, other multilateral organizations such as the North Atlantic Treaty Organization (NATO) and United Nations (UN) *may* also witness some decline in favour of solving future defence problems by employing "like-minded" coalitions or regional defence structures. Since 1990, Western participation in international conflicts more often than not took the form of a "coalition of the willing." Even in today's theatres such as Afghanistan, NATO's burden is too often carried by only a handful of its most willing members. In the future, it is *likely* that consensus more than organization *will* determine who goes to war with whom.

## MILITARY AND SECURITY

### GROWING SIGNIFICANCE OF NON-STATE ACTORS

Many factors, including globalization, have increased the role played by non-state actors<sup>14</sup> in the international system. Although states and their governments *will* remain key players, by 2035 a number of third parties *will* play prominent roles in international affairs. This will *likely* include several different types of non-governmental organizations (NGOs), but it will also *likely* include organized and transnational armed groups (including rebel opposition forces, militias, warlords and insurgents) as well as terrorist and criminal organizations.<sup>15</sup> Figure 1-3 illustrates the level of possible involvement in state affairs by non-state actors.

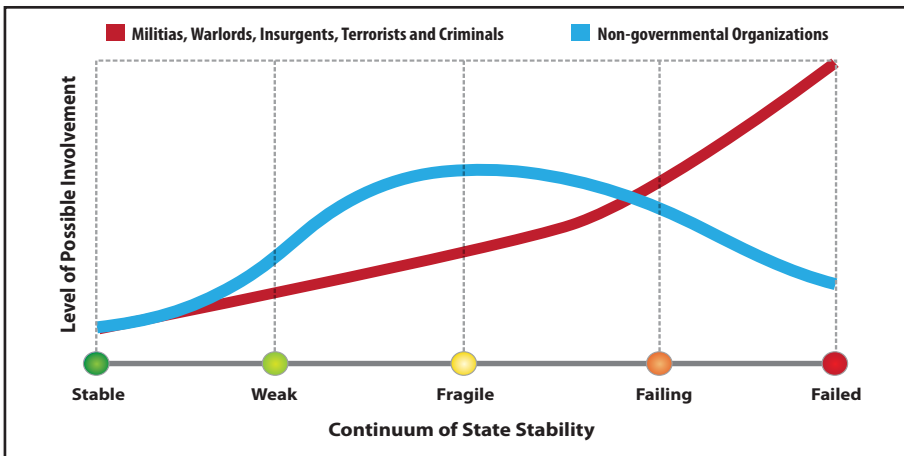


Figure 1-3: Level of Possible Involvement in State Affairs by Non-state Actors

13 Andrew Richter, "Conflict Scenarios, Airpower, and the Use of Force: How Recent Developments Are Affecting Canada's Strategic Choice," in *The International System, Canada, Armed Forces and Aerospace Power: 2018 and Beyond* Silver Dart Canadian Aerospace Studies, Vol. V, ed. James G. Fergusson (Winnipeg, MB: University of Manitoba, Centre for Defence and Security Studies, 2009), 171-2.

14 Non-state actors can include any of the following types of groups and organizations: non-governmental organizations, multinational corporations, the international media, armed groups (rebel opposition forces, militias, warlords, insurgents and private military firms), terrorist organizations, criminal organizations, religious groups, ecological organizations and transnational diaspora communities.

15 For an insightful discussion of the possibilities, see Thomas Homer-Dixon, "The Rise of Complex Terrorism," *Foreign Policy* (January-February 2002), 52-62.

These latter groups present a particular challenge to security and defence. The terrorist attacks against the United States on September 11, 2001 have already demonstrated the devastating effects achievable by hijacking commercial air assets and transforming civilian airliners into weapons. Future attacks against Canada *may* adopt similar tactics, although the current heightened state of alert and defence against such attacks suggest that this approach *will not* be mimicked in the near future. Instead, non-state actors *may* choose other means to deliver attacks in or through the air and *will* have increasing access to the products of globalization with which to do so.

In 2007 and as shown in Figure 1-4, there were many weak, fragile, failing and failed states. Without active internal and/or external intervention, this circumstance will not be reversed. Weak, fragile, failing and failed states provide safe haven for those wishing to carry out such attacks. They also threaten global stability including Canadian interests abroad. Today, as in the future, non-state actors can often move freely through the airspaces of weak, fragile, failing and failed states. They are also able to establish their own networks, including air routes, bases, logistics and re-supply points. In the future these “telltale” signs of air activity *will* become increasingly difficult to detect as access to aerospace science and technology widens. With increased access to aerospace resources, belligerent non-state actors *will* project greater levels of influence.

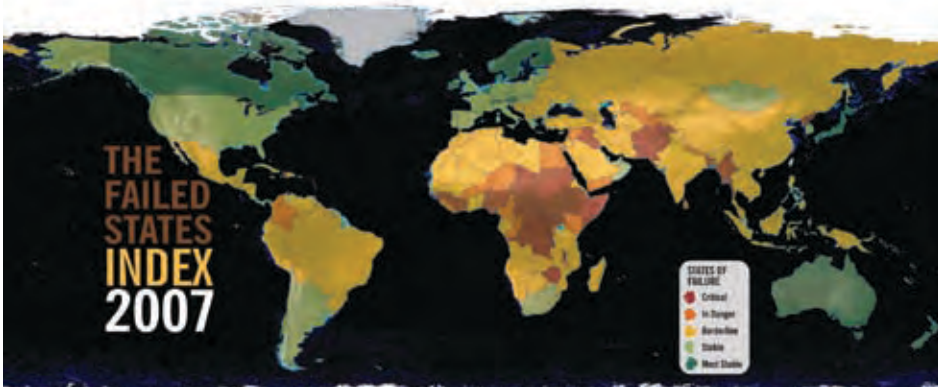


Figure 1-4: The 2007 Failed State Index<sup>16</sup>

From a more positive perspective, this broader access to aerospace resources *will* also serve the interests of NGOs, humanitarian organizations and other third parties seeking to address the problems of weak, fragile, failing and failed states. The International Civil Aviation Organization (ICAO), for example, is a lead advocate for enhancing global civil aviation security.<sup>17</sup> ICAO identifies and monitors existing types of security threats to civil aviation and seeks to develop and implement effective and relevant responses to emerging global threats. It conducts aviation security audits to identify deficiencies and encourages states to seek their resolution. The organization also develops, adopts and promotes new or amended measures to improve worldwide air travellers' security while promoting efficient border crossing procedures.

These and other measures assist weak and fragile states, especially, in addressing security related deficiencies within their own air capability through various aviation security mechanisms and technical cooperation programmes.

16 Reproduced with permission from FOREIGN POLICY #167 (July/August 2008) [www.foreignpolicy.com](http://www.foreignpolicy.com). © Copyright 2008 by the Fund for Peace and Washingtonpost.Newsweek Interactive, LLC.

17 International Civil Aviation Organization, “Strategic Objectives of ICAO 2005-2010,” International Civil Aviation Organization [http://www.icao.int/icao/en/strategic\\_objectives.htm](http://www.icao.int/icao/en/strategic_objectives.htm) (accessed January 10, 2009).

## IDENTITY-, DISTRIBUTIONAL- AND RELIGIOUS-BASED CONFLICT

Identity, distributional and religious differences *will* not only continue to instigate conflict in the future but *will* also continue being salient drivers of ongoing human and societal strife.

Identity-driven conflicts are particularly common, as currently witnessed, in places such as the Balkans, Central Africa as well as throughout much of southwest, central and southeast Asia. These conflicts are pervasive, persistent and often destructive on a wide scale; they are also prone to spilling across the borders of neighbouring states.

The gap between rich and poor nations and individuals will *likely* widen. Economic disparity, such as that witnessed today, *will* be a source of tension and potential conflict. An aggressive response to threats against trade or economic well-being is *likely*.<sup>18</sup> Transnational pressures, competition and globalization *will* challenge the robustness and resilience of governance and social mechanisms at every level.<sup>19</sup> Further negative trends in economics, demographics and social well-being *may* generate constant tension or may aggravate existing hostilities and problems in regions plagued by discontent, disparity and desperation.<sup>20</sup>

Religious ideology can be a catalyst for change and will very *likely* continue to initiate and sustain considerable conflict and strife in the world. Religious extremism motivated by narratives founded on disagreement with secular, pluralistic, social and governance models *will* drive wedges between societies and exacerbate relationships between cultures and communities.<sup>21</sup> Technology *will* assist in spreading this religious rhetoric. Information technology (allowing for instant connectivity, communication and learning) *will* enable religious-based threats to become increasingly decentralized and thus evolve into an eclectic array of groups, cells and individuals that do not need a stationary headquarters to plan and carry out operations.<sup>22</sup>

In the future, identity, distributional and religious conflicts *will* present tremendous challenges to Canada's Air Force. There is a general disregard for international law and norms in these wars, and as such, aerospace assets *will* find themselves at particular risk when trying to bring stability to these regions. Further fuelled by rapidly expanding globalization and technological development, identity-, distributional- and religious-based conflicts are *likely* to expand in scope, become increasingly difficult to contain and become increasingly influenced and/or supported by actors and assets external to the immediate region of conflict.

## ENVIRONMENTAL AND RESOURCE TRENDS

Though there is still much debate surrounding the level of impact the human race is having on the environment, few if any are suggesting that there is no impact at all. Throughout history and to the present day, resource scarcity, natural disasters and environmental change have contributed to and exacerbated human conflict. By 2035, the continuing impact on the world's weather systems and air quality *will* have a direct effect on future aerospace power, aerospace platforms and air travellers.<sup>23</sup>

18 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 17.

19 UK, MOD, *DCDC Global Strategic Trends Programme*, 14.

20 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 5.

21 Ibid., 30.

22 United States, Office of the Director of National Intelligence, *Mapping the Global Future, Report of the National Intelligence Council's 2020 Project* (Pittsburgh, PA: National Intelligence Council, December 2004). Available online at [http://www.dni.gov/nic/NIC\\_globaltrend2020.html](http://www.dni.gov/nic/NIC_globaltrend2020.html) (accessed April 23, 2009).

23 EarthTrends, "Global Climate Trends 2005," World Resource Institute <http://earthtrends.wri.org/datatables/index.php?theme=3> (accessed January 12, 2009).



## ENVIRONMENTAL CHANGE

There have been observable changes to the environment over the last thirty years. It is very *likely* that these changes *will not* be reversed, but rather, they *will* continue to challenge us over the next thirty years. If anything, some changes, such as those currently witnessed in the Arctic, are *likely* to accelerate. For example and as shown in Figure 1-5, the melting Arctic Sea ice *may* expand principle northern sea routes. As well, with a renewed Canadian interest in the security of the Arctic, the Air Force *will* need to be prepared for the challenges that climate change *will* bring to this strategically important region of Canada.

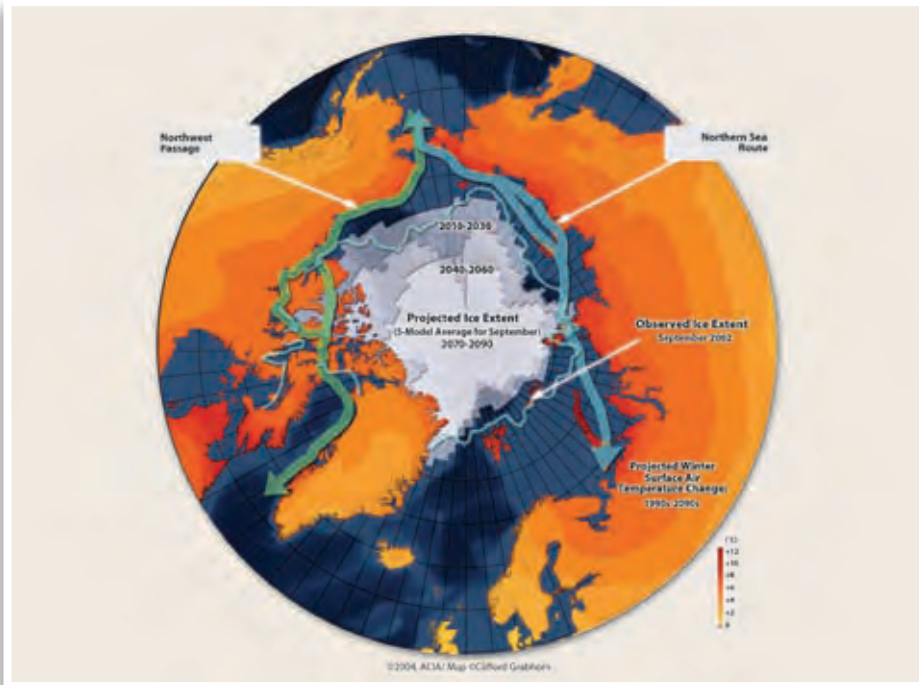


Figure 1-5: Possible Future Expansion of Northern Sea Routes<sup>24</sup>

With climate change already affecting the developed world, it is also very *likely* that, over the next 25 years, climate change *will* negatively impact the developing world. As the management of the environment becomes increasingly complex, it is likely that weak, fragile, failing and failed states *will* find themselves either unable or unwilling to protect their environments or invest in infrastructure that *may* serve environmental needs. In some cases, environmental degradation, destruction or disaster *may* serve as the catalyst for Canadian intervention. It is very *likely* that the Air Force *will* be required to project its own capabilities in such scenarios and deliver precision effects in response to international environmental tragedies.

## NATURAL DISASTERS

The number of reported natural disasters increased significantly during the last decades of the 20<sup>th</sup> century.<sup>25</sup> Though the linkages between the rise in the number of these events and

<sup>24</sup> United Kingdom, Department of Defence, The DCDC Strategic Trends Programme: Regional Survey The Arctic out to 2040 (Shrivenham, SWINDON: Development, Concepts and Doctrine Centre, September 2008), 18.

<sup>25</sup> For a very comprehensive overview of natural disasters and access to databases of information on their effects see Centre for Research on the Epidemiology of Disasters, "Emergency Events Database," School of Public Health of the Catholic University of Louvain <http://www.emdat.be/> (accessed May 1, 2009).

environmental change are not absolute, the fact (see Figure 1-6) remains that over the 20<sup>th</sup> century there has been an exponential increase in the number of reported natural disasters. Canada, with a tradition of helping afflicted nations, *will* increasingly be called on to respond with humanitarian assistance.

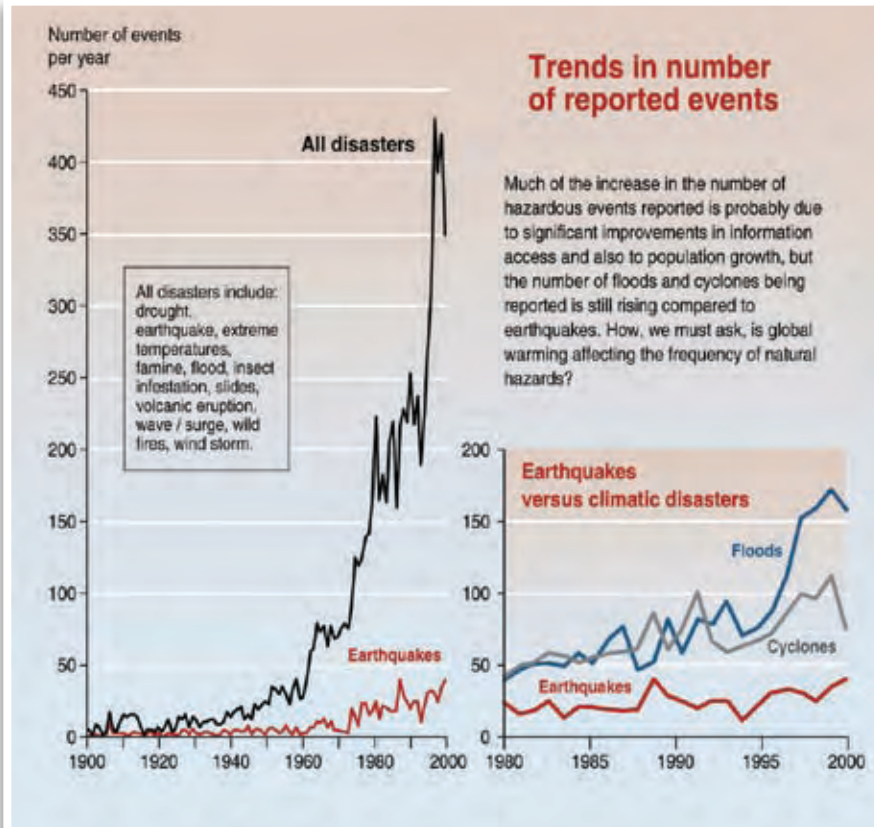


Figure 1-6: Natural Disasters Reported Globally, 1900–2000<sup>26</sup>

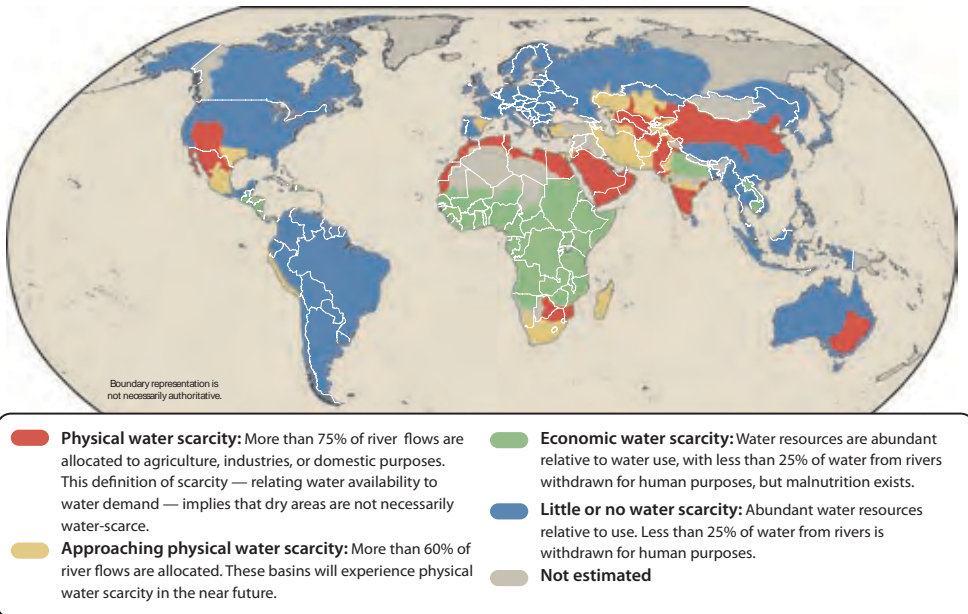
Much of the world's population is situated in the littoral regions of the planet, and in the future, increasingly violent weather patterns *will* have a greater destructive effect on these rapidly growing populations. The resulting damage from earthquakes, tsunamis, hurricanes and fires will *likely* require greater military support (ranging from humanitarian relief to full-scale stability operations) to assist and safeguard victims around the world.<sup>27</sup> As well, the urgency required to provide relief quickly *will* demand rapidly deployable military assistance by air. Recent Canadian humanitarian relief missions in Turkey, Haiti and Pakistan all required significant employment of air assets to achieve their objectives. In the future, the rapid projection of aerospace power to prevent further instability and mitigate the damage already caused *will* become critical, and only well-developed, balanced aerospace forces *will* have the capability to respond.

<sup>26</sup> Emmanuelle Bournay and UNEP/GRID-Arendal, Trends in natural disasters, *UNEP/GRID-Arendal Maps and Graphics Library*, <http://maps.grida.no/go/graphic/trends-in-natural-disasters> (accessed May 21, 2009). Data provided by Centre for Research on the Epidemiology of Disasters (CRED).

<sup>27</sup> Canada, DND, *Future Security Environment 2008–2030 Part 1*, 37.

## RESOURCE SCARCITY AND DEPLETION

There already exists in the world a serious competition for many resources such as food, water (see Figure 1-7), timber, oil and strategic minerals; these competitions often lead to conflict. In 2035, both resource scarcity and depletion *will* continue to be major drivers in interstate as well as intrastate conflict. In addition, these conflicts *will* contribute to state and societal instability as well as economic disparity.



**Figure 1-7: Projected Global Water Scarcity, 2025<sup>28</sup>**

Famine and water scarcity are of particular concern. Today, more than 840 million people suffer from malnourishment. Approximately 799 million of these people live in the developing world. By 2035, this number is expected to triple as populations continue to expand in poorly developed regions of the world. At the same time, increasing water deficits *will* also affect these regions, and some estimates suggest that as much as 40 per cent of the world's population *will* have limited access to adequate water resources by 2035.<sup>29</sup>

Beyond food and water scarcities, other non-renewable natural resources such as oil and strategic minerals *will* also lead to conflicts. As a result of better management of their own reserves and better access through international trade agreements, developed countries *will* be less vulnerable to the uncontrolled depletion of these resources. Unstable states, however, *will* suffer as their ability to exploit or trade for such resources diminishes. As a result, future conflict is more *likely* to break out in weak, fragile, failing and failed states where these resources cannot be effectively secured.

At the same time, resource-rich countries such as Canada *could* become a desirable target for resource-starved states and non-state actors, and threats *could* appear in several ways. For example, foreign actors *may* attempt to exploit Canadian resources through semi-legitimate or illegal means. This is not limited to, but *could* include, activities such as poaching fish and wildlife stocks, onshore mining and deforestation, offshore drilling and other similar exploitations of valuable resources.

<sup>28</sup> US, DNI, *Global Trends 2025*, 55.

<sup>29</sup> For an overview see Marq de Villiers, "Water Wars of the Near Future," in *ITT Industries Guidebook to Global Water Issues*. Available online at <http://www.itt.com/waterbook/toc.asp> (accessed May 8, 2009).



Ecological migrants fleeing their own resource-starved nations *might* see Canada as an attractive destination and, thus, put pressure on existing resources as well as future resource development.

Oil and gas resources present particular challenges and are currently major drivers in both interstate and intrastate conflict. As indicated in Figure 1-8, it is *unlikely* that by 2035 this trend *will* have eased, although it is *possible* that developed world dependency on oil and gas resources *will* have decreased as a result of the general acceptance and integration of more efficient fuels, as well as alternative fuels. As the demand continues to outstrip refinement capabilities, viable energy alternatives *will* have to be found to run economies and militaries.<sup>30</sup> This matter has significant implications for the future Air Force, as the cost of aviation gas *will* become increasingly expensive and therefore put increasing strain on operating budgets.

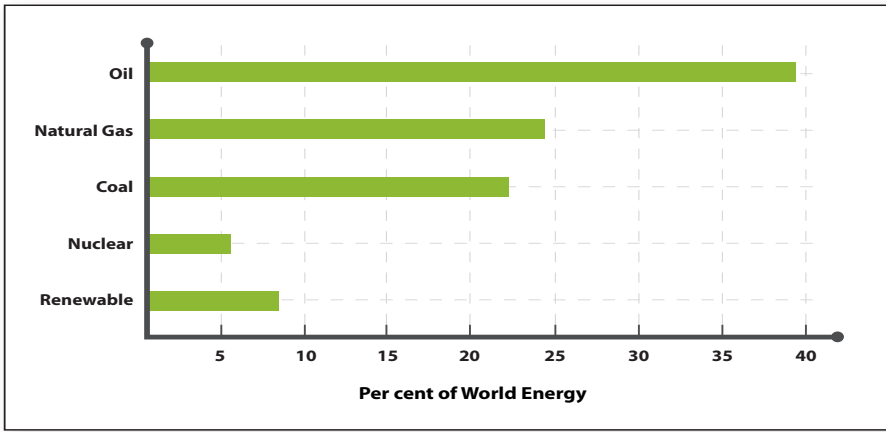


Figure 1-8: Projected Energy Consumption to 2020 (by Fuel Type)<sup>31</sup>

For the future Air Force, dependency on traditional energy sources *will* need to be re-examined. It *will* become increasingly difficult to secure local sources of fuel in conflict regions, and the need for greater resource independency *will* demand greater efficiency from future aerospace platforms. For resource-poor states, maintaining modern air fleets *will* become increasingly difficult if not altogether impossible in some cases. At best, such aerospace power *may* be maintained only at great expense or perhaps even at the sacrifice of other much needed resources.

## ENVIRONMENTAL DAMAGE AND DESTRUCTION

Less scrupulous external actors *will* pose direct threats to Canada's natural resources by damaging natural ecosystems that affect the country's environment. This damage *will* affect the air, land and seas and will require responses from Canada's Air Force ranging from deterring those who would threaten our environment to detecting the damage and even, in extreme cases, engaging in a fight to limit or contain the damage.

Environmental damage *will* occur in the air and space. The accidental or deliberate introduction of objects, toxins or other aerosols into airspaces *may* affect both air travellers as well as populations on the ground. Canada's Air Force must work to reduce this damage, lead by example and, whenever possible and appropriate, guide others.

30 Despite the trend toward more efficient energy use, total energy consumed will *probably* rise by about 50 per cent in the next two decades compared to a 34 percent expansion from 1980–2000, with an increasing share provided by petroleum. See US, DNI, *Mapping the Global Future*, 59.

31 US, DNI, *Mapping the Global Future*, 59.

Environmental damage *will* happen on land. Canada's Air Force will *likely* be among the first responders to conduct surveillance, assess impact and, in some cases, provide direct support to mitigate the damage. For example, the Air Force *may* play roles in fighting large-scale forest fires, containing industrial accidents, and in certain circumstances, assisting civil powers.

Similarly, environmental damage *will* also occur off the coast. For example, accidental or careless oil spills in Canadian waters *will* have a significant impact on this environment.<sup>32</sup> To date, some oil spills have been in excess of 700 tons, and in the future as the size of oil tankers increases, the *possibility* for oil spills of even larger proportions will also increase. The future Air Force *will* need to be able to respond rapidly to such environmental damage and to provide capabilities such as defence and deterrence, surveillance and reconnaissance as well as search and rescue (SAR).

## SCIENCE AND TECHNOLOGY

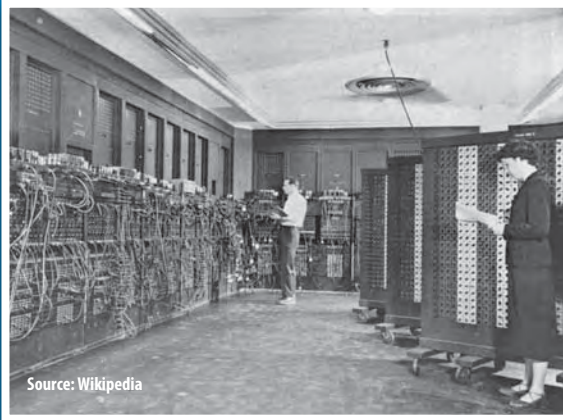
The current rapid pace of science and technology innovation and adaptation is very *likely* to sustain itself, if not further accelerate by 2035. This environment *will* present tremendous opportunities for Canada's future Air Force, and it *will* also present tremendous challenges. Automation, customization and miniaturization *will* underpin many technological breakthroughs that contribute to future Air Force capabilities.<sup>33</sup> At the same time, the Air Force *will* struggle with rapid obsolescence of both networks and platforms at a non-linear rate, which *will* cause a massive strain on future budgets as the time between the introduction and obsolescence of a new technology shortens.

New technologies, such as ultrastrong and lightweight materials, advanced weapons, microtechnologies, small networked sensors, advanced medical treatments as well as protection and communications/information systems that are cheaper, lighter, smaller and highly energy efficient, combined with ubiquitous computing and artificial intelligence, *will* herald, in the defence context, capabilities such as: all pervasive sensing, robotics, autonomous platforms, autonomous networks, smart weapons and advanced decision tools.<sup>34</sup> The future Air Force *will* have to accept these developments, pursue their own interests within these fields and rapidly incorporate those technologies that serve to ameliorate the Air Force's capabilities. At the same time, the Air Force must keep abreast of future scientific and technological developments and the potential threats they pose, with the view of appreciating how future aerospace power and air capabilities *may* affect air forces in the year 2035.

32 For one analysis of worldwide oil spills see "Oil Tanker Spill Statistics: 2007," The International Tanker Owners Pollution Federation [http://www.itopf.com/information-services/data-and-statistics/statistics/documents/stats07\\_000.pdf](http://www.itopf.com/information-services/data-and-statistics/statistics/documents/stats07_000.pdf) (accessed May 1, 2009).

33 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 7.

34 Canada, Department of National Defence, *Objective Force 2028* (Final Draft), (Ottawa: Chief of Force Development, n.d.), 5/19. Available on the DIN at <http://cfd.mil.ca/sites/page-eng.asp?page=4463> (accessed April 28, 2009).

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Source: Wikipedia

## THE FUTURE OF COMPUTERS

Primitive digital computers appeared in the early 1940s. The first generation computers used vacuum tubes and were heavy (the SAGE aircraft-warning system built in 1954 weighed 275 tons), bulky (the US Census Bureau computer in 1951 filled several rooms) and expensive (the IBM 650 medium-size computer rental cost was \$5,000 a month). By the mid-1950s, they were replaced by smaller and cheaper second generation computers that featured transistors. The introduction of integrated circuits in the 1960s ushered in the

era of the third generation computers. By 1970, with the advent of the microprocessor, fourth generation computers were becoming small enough to make personal computers a reality. The advent of the World Wide Web in 1991 also marked the arrival of the fifth generation computer which featured powerful microchips.

The exponential rise in computing power (known as Moore's Law<sup>35</sup>) has been truly exceptional and has shown no sign of slowing down; although, some experts have recently warned that we might now be approaching the physical limits of miniaturization. Consequently, future computers may involve completely novel ways of computing data.

Research is currently underway—with working prototypes in several prominent universities—on optical computers, organic computers and the much anticipated quantum computers. These new innovations all have one thing in common: they are all raising the hope of virtually infinite processing power.<sup>36</sup>

In any case, using Moore's Law, it is predicted that machines with human-level intelligence will appear by 2030, making possible astonishing feats involving seamless human-machine interaction. Therefore, it is highly plausible to imagine that beyond 2035, sophisticated autonomous artificial intelligence devices would be routinely deployed to enhance our warfighting capabilities.

## INFORMATION/COMMUNICATION TECHNOLOGIES

Since the invention of the integrated circuit in 1958, which was followed by Gordon Moore's prediction in 1965 that its capacity would double every two years, communication technologies have delivered near unimaginable capabilities to the world. Even today, Moore's Law remains valid as new chip layering technologies such as "through-silicon vias" promise to add a third dimension to the typically already packed 45-nanometre chip. Overall, the advancements in this particular field have surpassed all predictions and expectations, and this trend is very *likely* to continue over the next 25 years.

The immediate future promises further miniaturization, increased power, increased data storage, more bandwidth, better wireless capabilities, increased interfacing and other developments

<sup>35</sup> Wikipedia: *The Free Encyclopedia*, s.v. "Moore's Law," [http://en.wikipedia.org/wiki/Moore%27s\\_Law](http://en.wikipedia.org/wiki/Moore%27s_Law) (accessed May 1, 2009).

<sup>36</sup> Moore's Law would no longer apply; these future computers would have a processing power millions of times faster than today's best computers. A quantum computer, for instance, *could* easily complete in seconds a task that would take a silicon computer billions of years!

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that could very *likely* lead to a ubiquitous open source information/communication technology environment. The Air Force *will not* be able to ignore this environment, as the importance of information technology and its associated networks continues to grow.

The success of future air forces hinges on their ability to fully embrace these technologies and to ensure their widest distribution down to the lowest tactical levels. It is only by giving everyone an opportunity to join networks that they will better utilize collective information and knowledge and, thus, make more informed decisions. At the same time, it must be recognized that “too much” information can lead to decision paralysis; therefore, future air forces must apply filters to balance the inputs and useable outputs of these capabilities.

## ARTIFICIAL INTELLIGENCE

After failing to arrive amid the many promises made twenty years ago, the tremendous progress in the development of information/communication technology since then has helped artificial intelligence (AI) research to gain momentum once more. Intelligent agents and personalized assistants that learn are already in common use. In the future, as with robotics, AI or near-AI capabilities *will* increasingly replace functions that today remain the sole purview of humans. From an Air Force perspective, future AI capabilities *could* be applied to air defence, flight safety and even search and rescue.

As AI becomes increasingly possible, the Air Force *will* have to consider the moral, ethical and legal implications associated with taking the human agent out of the loop. In some cases, it *may* remain unacceptable to completely replace a human activity or decision-making process with a machine, yet in other cases, the speed and precision required to make the decision *may* only be possible with the capabilities that an AI *may* possess.

## ROBOTICS

Telerobotic capabilities were first tested and introduced early in the evolution of air warfare. During the Second World War, the US Eighth Air Force launched Operation Aphrodite, a plan using explosives-packed, radio-controlled B-17 bombers against hardened German targets. Since then, robotics have been increasingly present in modern flight, to the point today where most air forces now operate a number of remote-controlled and semi-autonomous aerospace platforms. The most widely recognized of this class is the unmanned aerial vehicle (UAV) such as the Heron shown in Figure 1-9. By the year 2035, the variety and number of these platforms *will* have increased dramatically.



CF Photo by Corporal Andrew Saunders

Figure 1-9: Canadian Air Force Heron Unmanned Aerial Vehicle

Unmanned vehicles (including balloons) *will* become more reliable, smaller, more sophisticated and less expensive. Equally available and attractive to friend and foe, these powerful and long endurance (measured in days) UAVs as well as unmanned combat aerial vehicles (UCAVs) *will* have the ability to apply persistent effects on the battlefield. UAVs—capable of operating within networks and equipped with common weapons, sensors and defensive air suites (DAS)—*may* have utility in circumstances where attrition levels or resource costs are *likely* to be high.<sup>37</sup>

Also envisioned are micro air vehicles—from UAVs the size of paper aircraft to “smart dust” nanotechnology—that *will* be used as efficient short-range weapons and intelligence, surveillance and reconnaissance (ISR) collectors. Their small signatures mean that they *will* be very hard to detect and engage. They *will* be able to discriminate between friend and foe, and they *will* also be able to use swarming and linking tactics to deliver effects and collect intelligence.

Future robotics *will* adopt many shapes and sizes (much as they do today) and become increasingly modular, reconfigurable and, to some degree, self-repairing and self-sustaining. They *will* increasingly be inspired by, and prone to mimic, biological structures such as insects. It is expected that such items *will* become increasingly inexpensive and commonplace due to their size and weight; as a result, these tools will be available to an increasing range of both allies and adversaries.

Future air forces *will* come to depend heavily on robotic systems. On the ground, they *will* assist in everything from air asset construction through their sustainment. In the air itself and through outer space, robotic devices *will*, at the very least, be present in various combinations and proportions and, in some cases, may replace the human. For example, in some situations (such as casualty aversion, environmental hazards or even combat intensity), the employment of robots *will* be the preferred option.

## CYBERNETIC SYSTEMS

Some of the earliest attempts at employing cybernetic systems within the Air Force included gunner turrets in bombers, as designers attempted to pair man and machine as much as possible within the confines of a military airframe. Today, the integration of mechanics, electronics, bionics and robotics is increasingly commonplace. The typical example is the exoskeleton suit shown in Figure 1-10. In the near future, certain models will enable a single crewmember to load a 500-kilogram bomb onto an aircraft.

Farther over the horizon, cybernetics *could* play a role in ground as well as aircrew enhancement, allowing pilots to perform greater manoeuvres in aircraft or, perhaps, even fly using simply their eyes or thoughts instead of their hands.



Figure 1-10: An Exoskeleton Suit<sup>38</sup>

37 United Kingdom, Ministry of Defence, *The High Level Operational Conceptual Commentary* (Shrivenham, SWINDON: Development, Concepts and Doctrine Centre, n.d.), 6-5.

38 Image provided courtesy of Lockheed Martin.

## VIRTUAL REALITY AND THREE-DIMENSIONAL MODELING

Powerful personal computing capabilities as well as increased access to a wide variety of software applications have had a direct impact on both three-dimensional (3D) modelling as well as virtual reality products.

More and more easily, humans are able to immerse themselves into virtual environments where they can simulate all sorts of actions, including everything from conducting air campaigns to simulated flying of the platforms themselves. With flight simulators already capable of providing extremely realistic flight simulation environments, one can only wonder what capabilities *may* exist for the air forces of 2035. At the very least, both onscreen and three-dimension “holodeck”-like simulators *will* evolve considerably to replicate, as much as possible, the actual experience of flying.

3D modeling has advanced considerably over the last decade, with technologies such as reasonably small-scale 3D printers already commercially available to the private user. In the future, ground crews *will* be able to employ deployable versions of the 3D printer to fabricate aircraft parts locally without cannibalizing an aircraft or being obliged to return one home for service.

## BIOTECHNOLOGY

Just as engineers are developing computers and other communications technologies, biologists are examining new ways to develop and employ synthetic materials to enhance and/or create new biotechnological capabilities. As our understanding in the field grows, the potential of being able to fundamentally enhance and/or alter the human being *will* increase. New dramatic capabilities *will* emerge; concurrently, however, biotechnology *will* expose new weaknesses while at the same time it *will* become a potentially devastating and deadly weapon if it is biohacked.

Biotechnologies *may* offer tremendously promising new enablers for the Air Force of the future. Humans chosen to become pilots *may* undergo specific enhancement procedures to reduce their vulnerability to g-forces, for example, or to increase their ability to resist hypoxia. Other options *may* include neural enhancements to take fuller advantage of cybernetic systems or to simply facilitate aviation medicine requirements by tracking personnel with biosensors.

## NANOTECHNOLOGY

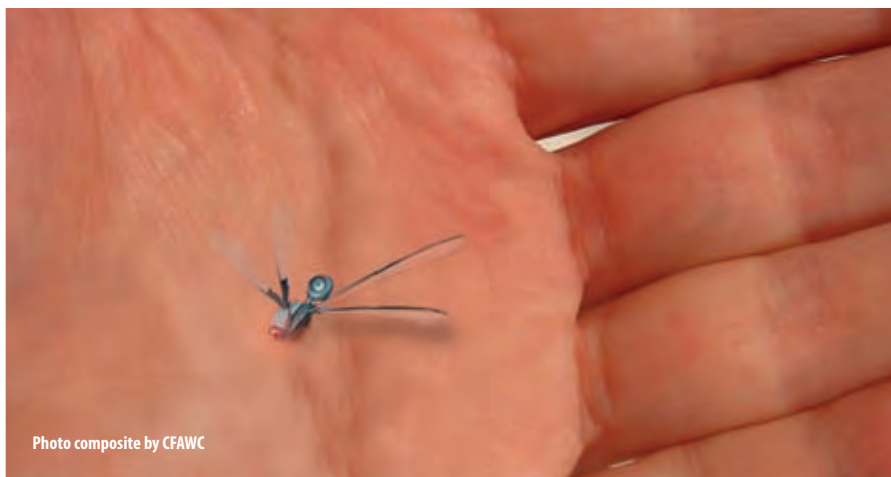


Photo composite by CFAWC



Advanced demonstration nanotechnology exists today. After 2035, a wide range of nano-devices will *likely* become commonplace, including everything from swarms of autonomous machines capable of conducting sensing missions to innovative, targeted, medical-drug delivery systems, augmented wound-healing compounds and brain-machine interfaces that sustain aircrew.

Nanotechnology *may* also provide future aerospace platforms with enhanced capabilities, such as self-repair abilities or even highly adaptive camouflage and stealth technologies. Where humans are unessential or incapable of operating, nanotechnologies *may* fulfil vital mission roles.

## TECHNOLOGY-INDUCED SOCIETAL CHANGE

It is inevitable that future technologies *will* continue to induce societal changes that *will* have far-reaching implications for both national security and defence. At the highest levels, the Air Force must consider how strategy, policy and doctrine *will* be affected by technological evolution. As the same time, the Air Force must embrace innovation and understand how technologies *will* permanently affect its future community and culture.

## AUTONOMOUS SYSTEMS

By the year 2035, it is very *likely* that advances in aerospace technologies *will* have noticeable impacts on current aerospace power. Autonomous systems *will* have evolved air forces into fully integrated fleets, including both manned and unmanned platforms. Over time, UAVs *could* replace manned platforms altogether. It is also recognized that without further augmentation, humans are gradually becoming the limiting factor in both air and space flight. It is, therefore, possible that future high-intensity peer versus peer conflicts *may* include few or perhaps no manned aircraft. Future cruise missile technology performance *may* also allow completely remote employment, thus avoiding pilot casualties. Finally, removing the cockpit, ejection seat, instrument panel, flight controls and life-support system would substantially improve aerodynamics and reduce weight, which could then be allocated to fuel capacity or mission payload in an unmanned platform. This is simply an inevitable evolution; however, it does not necessarily mean the entire removal of human agency from the aerospace power projection process.<sup>39</sup>

## OUTER SPACE

Despite the considerable advances in science and technology, human activity in the upper atmosphere and outer space remains a difficult, high-risk endeavour. By the year 2035, therefore, it is *likely* that the number of unmanned objects in orbit *will* have increased, but it is *unlikely* that the number of manned objects *will* have increased. It is very *unlikely* that we will witness major orbital or other extraterrestrial settlements or activities by the year 2035.

Still, considering the massive investment in space programs by major global powers, it is *unlikely* that outer space will become less important than it is now, and it is very *likely* that new investments in outer space will influence the future security environment in some way. For example, the United States currently invests upwards of \$10 billion annually in its missile defence program alone; therefore, it is very *likely* that in 2035 the US *will* continue to possess impressive space-based capabilities. It is also *likely* that the next weapons race *will* occur in space as treaties on the non-weaponization of space lapse, are circumvented or are simply ignored.

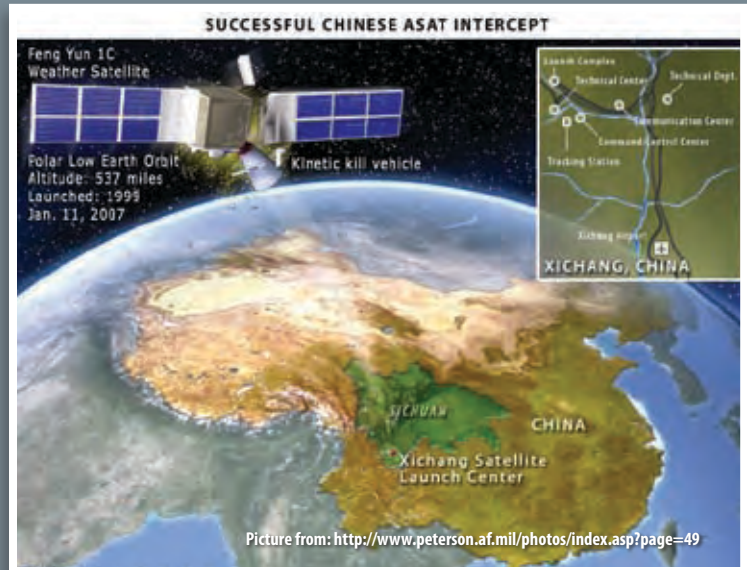
<sup>39</sup> STRATFOR Global Intelligence, "U.S.: An Existential Move for the Air Force," STRATFOR Global Intelligence [http://www.stratfor.com/u\\_s\\_existential\\_move\\_air\\_force](http://www.stratfor.com/u_s_existential_move_air_force) (accessed December 2, 2008).

## GROWING IMPORTANCE OF SPACE

In January 2007, China launched an antisatellite (ASAT) missile against one of its older and antiquated weather satellites. That particular act signalled to the rest of the world that China had taken another step in its quest to become a military power in space. Not since the October 1957 launch of Russia's Sputnik (which America answered by developing the greatest space program on Earth) had the US felt as threatened by another country's space activities.

Until 2007, only the US and Russia had the technology to shoot down satellites. The Chinese acquisition of this technology has signalled a major power shift. The last time such technology was tested was in 1985, with the US shooting down one of its own orbiting satellites. Concerns about satellite debris caused the testing programs to be shut down. When a satellite is destroyed, it leaves a large cloud of debris. With as many as 300,000 pieces in that cloud, there will be hundreds which are large enough to cause problems to other space orbiting systems. That debris can seriously damage other communication satellites or spaceships that pass through the region.

Similar to the profusion of inexpensive precision weapons, technological advances and increasing wealth will give new players the ability to conduct military operations in space. Other countries will continue to leverage lower costing technology for the benefits of commercial applications in space and may soon do the same for military reasons. In coming decades, the requirement to protect critical satellite communication systems will become increasingly important and will prompt the need for international space governing agencies and associated laws.



Picture from: <http://www.peterson.af.mil/photos/index.asp?page=49>

Space access technologies continue to pose considerable challenges. Though advances have been made in command, guidance, control and fuel efficiency, the basic concept of getting into orbit using prohibitively expensive post-Second World War era expendable launch vehicles remains largely unchanged. Though smaller and simpler alternative space-access vehicles have shown their future promise, current government policies—with the exception of demonstrating prototypes—are often detrimental to alternative space-access technology innovation. Still, developments in short-duration, suborbital spacecraft show tremendous potential, and it is *possible* that limited commercial and private spaceflight will exist by the year 2035. For air forces, small military space vehicles *could* enter the inventories of larger powers, with very limited access to or use by smaller powers.

Space applications *will* continue to expand as new and improved satellites and satellite constellations enter service. It is *likely* that advances in computer technologies, digitization, miniaturization as well as mechanical engineering *will* encourage a trend towards the



increased use of microsatellites and short-duration satellites. These *will* be launched and controlled locally, with the expectation that they *will not* remain in orbit, thus minimizing the hazard to other space-based objects. Space-based systems *will* continue to provide many forms of data, with new sensor packages being added to, or replacing, existing orbital platforms over the next two decades. It is *unlikely* that the basic design paradigms of orbital platforms will change significantly; however, the link between space-based assets and their ground-based, main control centres *will* continue to evolve.

Specifically, navigation systems, weapon guidance, communication and a variety of sensors *will* continue to reside in space or depend upon this infrastructure.<sup>40</sup> Military and civilian applications that require range and visibility, particularly sensing applications, are currently moving from ground to airborne use. As they become practically and economically viable, many of these applications *will* be increasingly exploited either in the high atmosphere or in space.<sup>41</sup> Finally, ISR capabilities *will* remain particularly essential. Intelligence, surveillance and reconnaissance capabilities—whether at home or abroad—will remain essential in maintaining situational awareness in a world where sensing technology is becoming increasingly pervasive and universally available.<sup>42</sup>

40 Canada, Department of National Defence, *Integrated Capstone Concept Discussion Paper (Peer Review Version)* (Ottawa, Chief of Force Development, Director Future Security Analysis, 6 August 2008), 18.

41 UK, MOD, *DCDC Global Strategic Trends Programme*, 66.

42 Canada, DND, *Future Security Environment 2008–2030 Part 1*, 91.



Space weapons are not necessarily new technologies, but their return to orbit is a *possibility* in the future. Although the United States is just as interested in creating a space sanctuary as they are in potentially weaponizing space, other regional powers, such as China, are even now actively pursuing both space weapon and anti-satellite technologies. As space-based assets become more persistent and pervasive in their coverage of terrestrial affairs, the *possibility* increases that space weapons *will* be deployed to defend privacy or perhaps even enforce security. These weapons *could* have detrimental effects on both space-based and terrestrial space systems. In addition, any physical destruction of space-based assets *will* add to the already sizeable amount of dangerous debris that orbits the earth.

## HUMAN FACTORS AND IMPLICATIONS

As in the past, rapid science and technological innovation *will* have massive implications for everyone. Constant and near ubiquitous knowledge access in the future *will* present both tremendous opportunities as well as considerable challenges and risks to decision makers. On the positive side, humans *will* be able to take full advantage of previously unavailable resources in a collaborative environment to reach greater objectives. New technologies *will* offer new opportunities to those who seek to benefit from innovation. On the negative side, pervasive and persistent technological integration *may* become overwhelming, causing societal instability and, in some cases, outright resistance.

Trends in technology *will* reach a point where computing, knowledge access, sensing and the increased use of autonomous intelligent systems (network-centric concepts) are omnipresent.<sup>43</sup> The rapid pace of technological change and the abundance of information resulting from the growing presence of computers *may* overwhelm decision makers with a flood of data and information.

With increased access to inexpensive computing equipment, traditional “have-not” nations and non-state actors could *possibly* gain significant influence and equal footing in certain capabilities with long-established military powers through the acquisition of commercially available technological developments.<sup>44</sup>

Since asymmetric adversaries are not necessarily constrained by the same moral, ethical or legal considerations, these unethical actors have taken and *will* continue to take advantage of science and technology in the future. Foes *will* be armed with advanced equipment and will *likely* operate in unpredictable, intuitive and primitive ways.<sup>45</sup> Hence it is *possible* to envision a form of dynamic warfare that blends asymmetric tactics with high technology.

## ECONOMIC AND SOCIAL TRENDS

Globalization *will* continue to intensify in the foreseeable future.<sup>46</sup> Socially, looser forms of political, cultural and economic association *will* multiply. Politically, globalization *will* raise levels of interdependence between states that are increasingly integrated within the globalized economy.<sup>47</sup> Globalization *will* bring both opportunities and challenges to our world.

Opportunities *will* include increased connectivity, interdependence, association and cooperation. These circumstances will make possible an integrated globalized trading community.

<sup>43</sup> Ibid., 74.

<sup>44</sup> Ibid., 77.

<sup>45</sup> UK, MOD, *High Level Operational Conceptual Commentary*, 1-2.

<sup>46</sup> Canada, DND, *Future Security Environment 2008-2030 Part 1*, 10.

<sup>47</sup> UK, MOD, *DCDC Global Strategic Trends Programme*, 3.

Economies *will* improve and there *will* be greater wealth for increasing numbers of individuals, non-state actors and states. Vastly increased networks also suggest there *will* be improved lines of supply. Market competition, liberalization of trade and the efficiency of commercial transport networks *will* encourage vastly increased and more efficient lines of supply.<sup>48</sup>

Yet there *will* be challenges as well. Interdependency can also cause a global economic downturn, such as the one currently being witnessed in the markets today. The negative impacts of such economic and social trends are potential causes of instability for states and *will* cause aggravation within stable regions, while at the same time increasing tension and competition between states.<sup>49</sup> Global economic and financial interdependency *will* ensure that the effects of any major regional or national economic downturn *will* be felt not only in the affected states but also throughout the increasingly interdependent world.<sup>50</sup> The negative effects of globalization *may* force some states into greater isolation or increased vulnerability.

## FUTURE RECRUITING CHALLENGES



Reduced indigenous birth rates coupled with mass migration will continue to change the demographics of this country. In the future, the Air Force will be recruiting from a dwindling skilled labour pool that will be aggressively targeted by other employment sectors.

Offering citizenship in return for service in the Canadian Forces for a fixed period of service could be one way to increase the size of the Air Force and at the same time instill cherished Canadian values in a new citizen.

Within NATO nations, Canada "has among the highest participation of women in terms of proportion of the force and deployment responsibilities."<sup>51</sup> But at only 12.6 per cent of the total CF members, this number could still be increased. During World War II, the Royal Canadian Air Force also experienced a shortage of personnel. To allow as many men as possible to contribute to wartime operational duties overseas, women took over many responsibilities once held exclusively by men. Women joined the Royal Canadian Air Force (RCAF) Women's Division not just as clerks, fabric workers and nurses but also as drivers, mechanics, parachute riggers, photographers, air photo interpreters, intelligence officers, instructors, weather observers, pharmacists, wireless operators and Service Police. Many of the women served overseas with No. 6 (Bomber) Group. In all, over 17,400 women served with the RCAF Women's Division before it was discontinued in December 1946.

## URBANIZATION

As illustrated in Figure 1-11, there has been and will continue to be a more urbanized global population. This circumstance has already demonstrated that urban areas are both attractive to insurgents, terrorists as well as criminals and are vulnerable as a base for their operations. These groups, cells and individuals are able to hide easily among the

48 UK, MOD, *High Level Operational Conceptual Commentary*, 7-1.

49 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 5.

50 UK, MOD, *DCDC Global Strategic Trends Programme*, 54.

51 Jungwee Park, "A Profile of the Canadian Forces," *Perspectives on Labour and Income* 9, no. 7 (July 2008): 17-30. Available online at <http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=75-001-X&chprog=1&lang=eng&yr=1#y2008> (accessed April 6, 2009).

non-combatant population. It is difficult to detect them, and responding to their threats and activities is fraught with the danger of inordinate, unacceptable collateral damage.

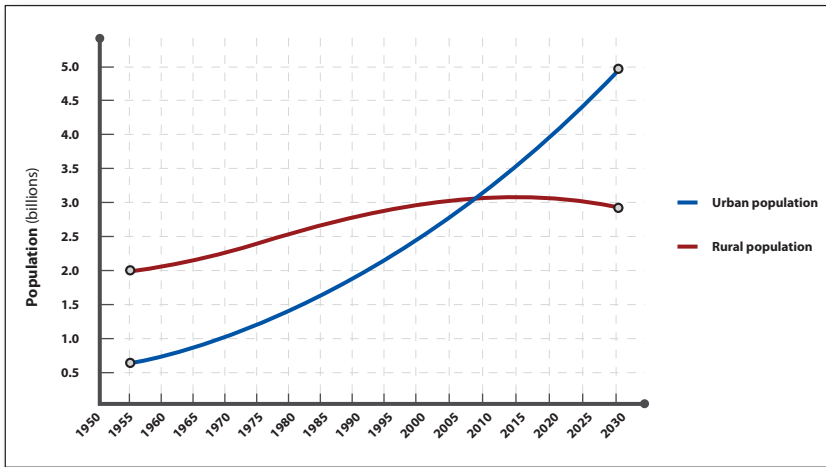


Figure 1-11: An Urbanizing World, 1950–2030<sup>52</sup>

## DEMOGRAPHIC PRESSURE

By the year 2016, the number of Canadians over the age of 65 *will* exceed those under the age of 15.<sup>53</sup> This trend is very *likely* to continue through to the year 2035. As shown in Figure 1-12, the Air Force *will* be recruiting from a dwindling labour pool which *will* be targeted with tenacity by other employment sectors. The Air Force *will* require intelligent and highly technically literate personnel but *will* face the challenges of a shrinking demographic pool, attractive alternative employment as well as changing social contexts and attitudes in the society from which it draws its people. The Air Force *will* require personnel with highly attuned cognitive skills and personal attributes;<sup>54</sup> however, these are also skills desired by many other competing employers. Thus, future demographic pressures *will not* be confined only to weak, fragile, failing and failed states. Stable states *will* also face challenges from their ever-changing demography.

52 *World Urbanization Prospects: The 2005 Revision*, (New York: United Nations, Department of Economic and Social Affairs, Population Division, 2006), 9. Referred to as Working Paper No. ESA/P/WP/200 and available online at [http://www.un.org/esa/population/publications/WUP2005/2005WUPHighlights\\_color.pdf](http://www.un.org/esa/population/publications/WUP2005/2005WUPHighlights_color.pdf) (accessed April 23, 2009).

53 Canada, DND, *Future Security Environment 2008–2030 Part 1*, 5.

54 See “Broadsword or Rapier? The Canadian Forces’ Involvement in 21<sup>st</sup> Century Coalition Operations,” (Kingston, ON: Canadian Forces Leadership Institute, April 2008). Referred to as CFLI Technical Report 2008-01 and available online at <http://www.acd.forces.gc.ca/cfli-ilfc/doc/cds-eng.pdf> (accessed April 23, 2009). For example, page 3 of this report states: “The analysis of both the literature review and interview results identified a number of key attributes/factors for individuals working in coalition “Whole of Government” [or CA] settings. These are:

- open mindedness;
- risk accepting;
- lifetime learner;
- patience;
- honesty;
- openness/transparency;
- cultural awareness;
- personality—capable of dealing positively with other people—gregarious;
- cumulative operational/overseas experience at all career stages to provide exposure to multi-national political dynamics and diplomacy; and
- experience with post conflict resolution (i.e., operations involving multiple agencies—civilian and military), involving integrated security, governance and development lines of operation and project management of public funds.”



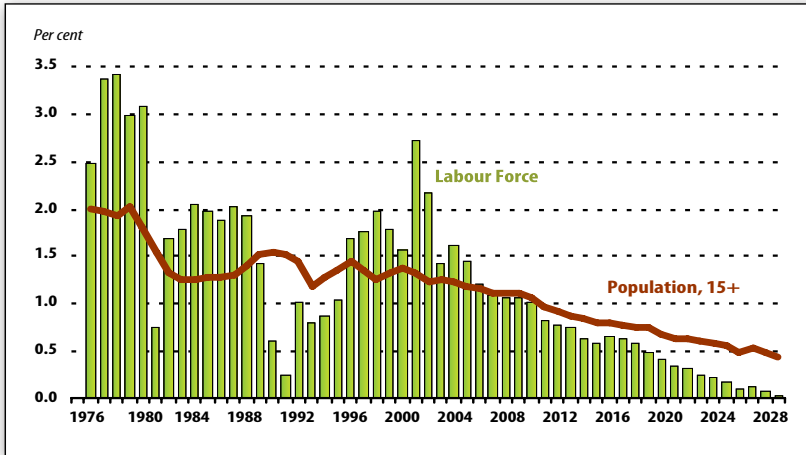


Figure 1-12: Canadian Labour Force, 1976–2028<sup>55</sup>

In contrast to places such as North America and as shown in Figure 1-13, many countries in Africa and Asia faced a large demographic youth bulge in 2000. Furthermore, most of these countries *will* face another youth bulge in 2015. Youth bulges (especially when coupled with high unemployment rates) are often spawning grounds for radical movements;<sup>56</sup> for in these circumstances, young men—in particular—are subject to many obstacles which frustrate their abilities to succeed or even to survive in an environment of limited opportunity. These young men are highly vulnerable to being manipulated and exploited by criminals, terrorists and extremists who capitalize on their hopelessness to advance their particular agenda.

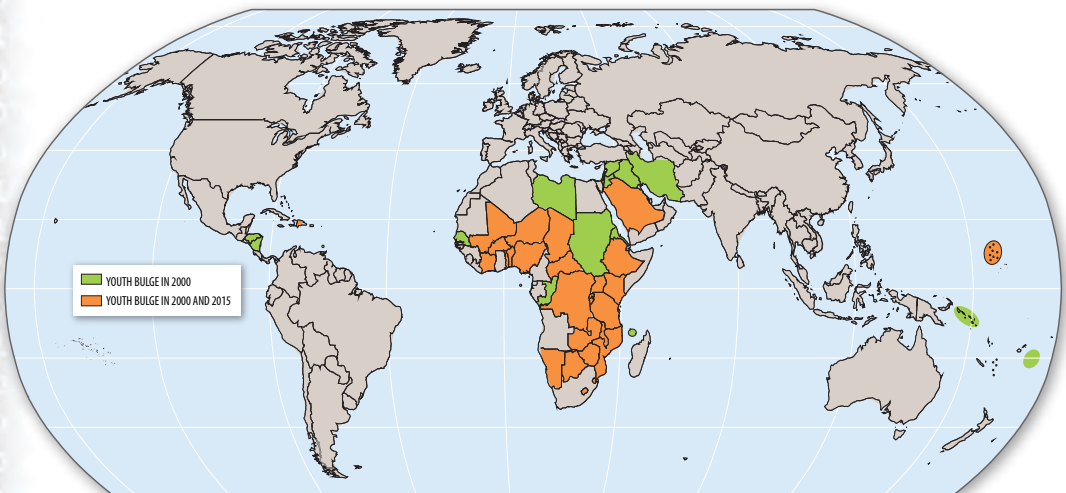


Figure 1-13: Global Youth Bulges in 2000 and 2015<sup>57</sup>

<sup>55</sup> Graph from Maxime Fougère, Marcelle Merette and Guohan Zhu, "Population Ageing in Canada and Labour Market Challenges," ([Ottawa?]: Human Resources and Social Development Canada, November 2006), 3.

<sup>56</sup> US, DNI, Mapping the Global Future, 14.

<sup>57</sup> United States, National Intelligence Council, *Global Trends 2015: A Dialogue About the Future with Non-Governmental Experts* (Washington DC: Central Intelligence Agency and National Foreign Intelligence Council, December 2000), 33. Available online at [http://www.dni.gov/nic/NIC\\_globaltrend2015.html](http://www.dni.gov/nic/NIC_globaltrend2015.html) (accessed May 5, 2009).

## INFECTIOUS DISEASE

Owing to the nature of globalization, it *will* be extremely difficult to control the spread of infectious diseases. Nations *will* have to be prepared to respond to the consequences of a global outbreak of infectious diseases.<sup>58</sup> This is difficult enough to achieve in the developed world where systems are in place to deal with crises and people are generally aware when it comes to health hazards.

In the developing world, weak, fragile, failing and failed states that already suffer from dysfunctional health care systems are especially at risk from epidemic outbreaks. Without the means to treat victims, quarantine contagious persons or control the spread of disease, unstable regions pose considerable risks to global health and welfare.

In the future, air forces *may* be increasingly called upon to deliver antidotes, humanitarian supplies and other treatments from the air. This assistance *may* be provided by manned aircraft or, depending on the risk, unmanned aerial vehicles.

## FUTURE POSSIBILITIES

Given the range and diversity of emerging trends as well as the constant *possibility* of unforeseen drivers and strategic shocks, it is obviously impossible to determine absolutely what direction the future *will* take. Still, a solid understanding of the history of the security environment as well as the trends that influence this environment allow one to determine with some certainty a range of possible futures in which the Air Force is *likely* to operate. The most *likely* future security environments are thus briefly described as follows.

### STATUS QUO

One possible future is simply maintaining the status quo. The United States—alongside strong regional powers such as China, India, Germany and the United Kingdom—will continue as the sole world power in the international system. Canada *will* continue to enjoy stability and security at home while contributing to security abroad. Its armed forces *will* continue to operate across the full spectrum of conflict, from peacetime military engagement to major combat operations. The Air Force *will* continue to be a major component in these activities.

### COMPETING POWER BLOCS

In this possible future, the United States is unable to fully stabilize either its economy or security. As a result, competing power blocs *will* emerge to form a rough counterbalance of world power. Canada's economy and security are challenged in this environment, and the Government must take greater steps to ensure both our resources and citizens are protected. Canada *may* also find itself partially excluded from the markets of traditional trading partners or challenged by these partners for access to the same resources and markets. The Air Force *will* find itself increasing its expeditionary capabilities while renewing commitments to air defence roles at home.

### EMERGING GLOBAL COMMUNITY

In this possible future, international conflict is increasingly solved through diplomacy and trade, reducing the total number of interstate and intrastate wars. Instead of competition,

<sup>58</sup> Canada, DND, *Future Security Environment 2008-2030 Part 1*, 27.

an emerging global community is formed thanks to the effects of globalization as well as advanced communications such as the World Wide Web. In this future, perhaps a global challenge, catalyst or objective unites previous competitors in a common goal. The end result is a more cooperative international environment where the Air Force *may* find itself more engaged in stability, training and humanitarian assistance roles both at home and abroad. Its expeditionary capabilities, meanwhile, *will* require tremendous robustness to function.

### BALKANIZATION

This possible future reflects the exact opposite of the emerging global community. Instead of increased cooperation, constant international conflict degrades the international system to the point where the globe and its interests are highly Balkanized. Major powers become increasingly protective and isolated from international affairs, and an air of mutual distrust permeates all aspects of international relations. Canada finds itself increasingly reliant on self-defence and whatever bilateral agreements it can foster with its closest allies. The Air Force *would* find itself heavily tasked with sovereignty operations as well as air defence capability development.

### CONCLUSION

As a consequence of globalization and the overall reduced risk of an imminent occurrence of major war among nation states, confrontation with non-state actors *will likely* continue to be the prevalent form of conflict.<sup>59</sup> Intrastate conflicts are less *likely* but cannot be ruled out entirely. As witnessed both in the Middle East as well as the Caucasus region, countries *will* continue to go to war for both economic- and identity-based reasons. A more formal Russia-China and US-India alignment *will* lead to increased tensions in the region but armed conflicts are *unlikely*.

Instead and short of a major catalyst, the future *will* be replete with increasingly creative, sophisticated and injurious asymmetric attacks against both military and civilian (including infrastructure, economic and symbolic) targets.<sup>60</sup> To address their unequal military capabilities, certain adversaries *will* focus on asymmetric ways and means of undermining countries such as the United States and Canada.<sup>61</sup>

Irregular war is certainly a *likely* form of war in the future, but it is by no means **the** future of warfare itself. The Air Force *will* need to maintain capabilities to wage conventional warfare, counter-insurgency warfare, stability operations and reconstruction missions.<sup>62</sup> Difficulties *will not* only exist in the ability to maintain readiness to respond to conventional threats, but also in coping effectively with capable non-state actors that operate in austere, urban and littoral battlespaces. These demands *will* continue to strain conventional forces and *will* call for new capabilities and new approaches to combat new adversarial means and weapons.<sup>63</sup>

Increased complexity in future conflict *will* require increasingly complex responses from Canada. The CF of the future must be a multi-role, combat effective force that can perform a broad range of tasks and operate in all engagement spaces (land, maritime, air, space, cyber

<sup>59</sup> Ibid., 6.

<sup>60</sup> Ibid., 88.

<sup>61</sup> Ibid., 95.

<sup>62</sup> Elinor Sloan, "The Role of Aerospace Power 2018 and Beyond," in *The International System, Canada, Armed Forces and Aerospace power: 2018 and Beyond* Silver Dart Canadian Aerospace Studies, vol. V, ed. James G. Fergusson (Winnipeg, MB: University of Manitoba, Centre for Defence and Security Studies, 2009), 145.

<sup>63</sup> Canada, DND, *Future Security Environment 2008-2030 Part 1*, 9.



and cognitive).<sup>64</sup> Because there is a need to maintain a full spectrum of warfare capabilities, the CF *will* need to be strategically relevant, operationally responsive and tactically decisive. Its Air Force must be balanced and agile, networked and integrated, deployable and sustainable as well as able to use lethal and non-lethal means that are both precise and discriminating.

The Canadian Forces, and in particular its Air Force, *will* face considerable challenges in acquiring new platforms or modernizing equipment to remain effective and relevant. Rapid innovation and constant science and technological discovery *will* revolutionize society in ways that today are very hard to predict. Yet the Air Force must quickly embrace these emerging technologies to ensure that its own legacy systems remain relevant as the technological society changes.

In sum, future operations *will* occur in the physical, moral and information domains; at home and abroad; and in complex or extreme environments. However, these operations will be conducted primarily in the urban and littoral regions, with both conventional and asymmetric means and weapons.<sup>65</sup> As part of the CF, the Air Force *will* be expected to function in this future security environment, anticipate its needs and mitigate its risks. Failure to do so *will* put both future sovereignty and future security at risk and diminish Canada's ability to remain a viable and relevant actor on the world stage.

<sup>64</sup> Ibid., 89.

<sup>65</sup> Canada, DND, *Objective Force 2028*, 4/19.



## PART 2: THE FUTURE OPERATING ENVIRONMENT

*Much can be done by the routine testing of equipment and its use in tactical exercises. But the most important questions are matters of concept, of formulating broad designs giving proportion and place to the numerous parts and pieces, and this can come only through the use of imagination and enquiry...*<sup>66</sup>

- Wing Commander J. I. Jackson, DFC,  
Royal Canadian Air Force

**A**rmed with an appreciation of the future security environment, the future operating environment will describe in greater detail the concepts and broad designs that will shape the future Air Force. This understanding will enable the Air Force to operate effectively as it carries out its core role of protecting and projecting Canadian national interests at home and abroad.

This part examines the FOE through the CF aerospace functions—Command, Sense, Shape, Move and Sustain. These lenses assist the Air Force in answering the questions of both “why” and to some degree “how” the Air Force should and/or could operate in the FSE. From this analysis, a broader understanding of what future capability requirements the Air Force will need can then be established. The FCR will be examined in greater detail in Part 3.

### THE NATURE OF FUTURE WARFARE

The exact nature of future warfare *will* be forever difficult to define. Any number of catalysts can abruptly transform a world of relative stability and peace into one of near or total war. Still, modern defence and security analysis has proven beneficial to anticipating and mitigating future risks. In addition, it has allowed armed forces to execute informed strategic forecasting with an eye to discerning what is probable without neglecting the plausible or possible.<sup>67</sup>

Until the end of the cold war, NATO air forces prepared for a possible confrontation against Soviet, Warsaw Pact or similarly aligned air forces. As institutions, these air forces were situated within a well-defined strategic context and prepared for a high-intensity war to defend a static theatre of operations against a well defined, structured and technologically predictable adversary. It was perceived that politics would be largely separated from military operations once the shooting began and that third parties to the conflict would receive only the most limited consideration in defining the mission or its outcome. In essence, any change within cold war air forces was pre-situated by the type of air war NATO *wanted* to fight, as opposed to the types of wars they actually did end up fighting.

<sup>66</sup> J.I. Jackson, “Air Power and Future Wars,” *RCAF Staff College Journal 1957*, (Toronto: Armour Heights Publishers, 1957), 29-35.

<sup>67</sup> In the end, however, strategic forecasting can only inform decision makers on available options for force development, generation and employment. It cannot impose specific choices upon them.



The end of the cold war dramatically altered this paradigm. Instead of static prepositioning to control a single theatre, Canada's Air Force found itself deployed into a variety of situations across the globe, ranging across the entire spectrum of conflict from peacetime military engagement to major combat operations. Far from fighting the type of war it originally expected to, Canada's Air Force instead found itself situated in a poorly defined strategic environment, deployed to multiple theatres of operations and conducting a full spectrum of operations against increasingly technologically innovative, elusive and adaptive adversaries. It was a security environment much removed from the one that the Air Force had traditionally prepared to fight in, but certainly one it *could* adapt to with sufficient foresight.

The nature of the future security environment suggests that the Air Force's future operating environment *will not* become static again for some time. Given that a major peer versus peer war involving Canada is *unlikely* in the foreseeable future, it is more *likely* that the Air Force *will* continue to operate in complex yet poorly defined theatres. However, given the possible futures suggested by the FSE, there is nothing to indicate that the Air Force's operating environments *will* be less demanding than they are today or that the Air Force *will* be restricted to certain roles. Instead, the increasing complexity of the FSE concludes that the FOE *will* be more demanding than it is today as aerospace technology and operations continue to evolve.

#### The future Air Force can expect to face four broad types of challenges;

- peer versus peer or near peer conflicts often associated with major wars and interstate conflicts;
- irregular challenges such as civil wars, insurgencies and asymmetrical warfare;<sup>68</sup>
- catastrophic challenges such as weapons of mass destruction attacks, terrorist attacks and humanitarian disasters; and
- disruptive challenges such as natural disasters, piracy or even computer network attacks.<sup>69</sup>

### PEER VERSUS PEER CHALLENGES

In the foreseeable future, traditional challenges (state versus state) are always possible, but *unlikely*. Highly capable, conventional opponents employing regular forces and conventional military techniques *could* re-emerge to openly challenge Canada and its allies, but the international system is well established and works constantly and aggressively to defuse tensions leading to such conflicts. Still, this does not mean that Canada's sovereignty *will not* be challenged in the future or that other states would not use their own military power to coerce, influence or openly challenge Canadian national interests at home and abroad.

In the last twenty years Canada's armed forces have, on at least three occasions, confronted a conventional adversary.<sup>70</sup> Therefore, we can expect within the next twenty years to be confronted at least once by the conventional military power of a sovereign state either singly or through a regional conflict. More *likely* indeed, a multiplicity of state and non-state threats and situations (i.e., natural and humanitarian disasters, evacuations under hostile arms and protection of interests and vital resources) *could* occur simultaneously as part of a major war.<sup>71</sup>

68 Common asymmetrical warfare tactics involve actors that tend to be militarily weak with forces generally lacking regular organization and/or modern weaponry. They do not tend to carry arms openly, and this, coupled with their unwillingness/inability to wear uniforms, means that they do not present easy targets to opponents. Further, they do not abide by—and indeed frequently flaunt—the established rules of warfare. See Richter, "Conflict Scenarios, Airpower, and the Use of Force," 158.

69 Sloan, "The Role of Aerospace Power 2018 and Beyond," 141.

70 The Canadian Air Force confronted the Iraqi military in the Gulf (1990-91), the Serbian military in the Balkans (1999) as well as Taliban insurgents in Afghanistan (2001-present). In addition, the Air Force has routinely intercepted Soviet and Russian aircraft over the Canadian Arctic since 1945.

71 UK, MOD, *High Level Operational Conceptual Commentary*, 1-2.

Therefore, for all these reasons, interstate conflicts *will* continue to be a *possibility* that cannot be completely wished away.

In peer versus peer challenges, threats *will* come from the enemy's aerospace power projection and air defence; surveillance; fixed-wing (both manned and unmanned), rotary wing, aerostatic attack and denial assets; ranged missile attacks as well as their exploitation and denial of the electromagnetic spectrum. In addition, air forces should expect that their routine combat capabilities *will* be degraded somewhat by a mix of regular and irregular threats that *might* involve the use of unconventional munitions, methods and substances; any combination of which *may* give an enemy the advantage.

## GANDER AIRPORT – FUTURE VISION AND RETENTION OF CAPABILITY

As early as 1935, apprehensions of another world war were growing. Closely observing commercial aviation developments, the British Air Ministry predicted that land-based aircraft would, eventually, be able to cross the North Atlantic with passengers and cargo. Anticipating commercial and, potentially, military requirements, the Ministry directed that a major airport be built in Newfoundland. The Dominion of Newfoundland, under temporary administration of the British-appointed Commission of Government, made available for this purpose an ideal site at Gander in the wilderness of central Newfoundland.



Photo courtesy of Gander International Airport

It was an immense economic gamble to take in the midst of the Great Depression, as no aircraft capable of making such a crossing then existed. Consequently, the world's largest airport sat for several years in "splendid isolation," waiting as the planners' best hopes and worst fears came to pass. Suddenly, at the outbreak of war in 1939, Gander Airport was thrust into strategic importance. Ultimately, 18,000 military bombers, transports and later, even fighters, crossed to Britain from Newfoundland as the U-boat peril made it too dangerous to risk shipping them by sea. It also became a major base of operations for Canadian and American antisubmarine squadrons that protected the convoys by hunting the U-boats, thus contributing greatly to the Allied victory in Europe.

On September 11, 2001, the United States came under terrorist attack by air. American air space was immediately closed and the US Transportation Secretary, Norman Mineta, directed, "Get those goddamn planes down!"<sup>72</sup> All aircraft aloft were ordered to make emergency landfall. Gander once more took on a strategic role as transatlantic aircraft urgently sought the nearest safe haven capable of handling large airliners. The 6,595 souls on board the 38 aircraft diverted to Gander would have cause to appreciate, albeit unknowingly, the foresight of the early aviation planners who placed a series of world-class runways on a remote plateau in the heart of the Newfoundland wilderness almost eight decades earlier.

72 Jim Defede, *The Day the World Came to Town: 9/11 in Gander, Newfoundland* (New York: Regan Books, 2002), 5.



## IRREGULAR CHALLENGES

The most prevalent form of conflict out to the year 2035 will *likely* remain irregular challenges. Lower intensity conflicts have dominated much of the history of warfare and will *likely* continue to do so in the future. Such conflicts have the following characteristics:<sup>73</sup>

- They tend to take place across the developing world in failing and failed states.
- Adversaries are rarely composed of traditional standing forces.
- These opponents do not always rely on sophisticated military technologies and networks that Western armed forces tend to favour.
- In certain cases, irregular challenges pose deadlier threats than other types of conflict.

Most important, perhaps, irregular challenges are difficult to define and will very *likely* remain so in the future. Many non-state actors who engage in irregular warfare *will* disregard the laws of armed conflict (LOAC) and *will* demonstrate morals and ethics that are not aligned with traditional Western values. This *will* present an array of irregular threats derived from terrorists, criminals, insurgents and opportunists and *will* result in unconventional risks to formations, units and individuals. Regular and irregular opponents *will* seek to present dilemmas—frequently of a legal, moral, or ethical nature. Based on physical threat and psychological pressure, these irregular methods are intended to induce an increased sense of personal vulnerability, with the aim of reducing the effectiveness and morale of military forces.<sup>74</sup>

Irregular adversaries will *likely* be composed of poorly defined groups hidden among a larger population base rather than being a well-equipped, traditional military. These opponents are *likely* to deliberately incur civilian casualties either in support of their objectives or to simply demonstrate their own power.<sup>75</sup> These adversaries *will* be harder to identify; their actions *will* be less conducive to anticipation or deterrence. Furthermore, they will *likely* use asymmetric tactics in lieu of risking a conventional, head-on confrontation.<sup>76</sup> Such adversaries

73 Martin Van Creveld, *The Transformation of War* (New York: Simon & Schuster, 1991) and Martin Van Creveld, *The Changing Face of War: Lessons From Combat, From the Marne to Iraq* (New York: Ballantine Books, 2006).

74 UK, MOD, *High Level Operational Conceptual Commentary*, 5-3.

75 Ibid., 6-4.

76 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 79.



have already demonstrated, and *will* continue to demonstrate, imaginative use of commercially available existing technologies in ways not envisaged by their original developers for purposes inimical to Canadian objectives.<sup>77</sup> In such an environment, a more pervasive sense of insecurity—to include continued terrorism acts—is *likely* to prevail. It is possible that the US-led global war on terrorism, already being referred to by some as the long war, *will* still be raging in the year 2035.

Third parties, both armed and unarmed, have played a much more dominant role in this environment as well and *will* continue to do so in the future. Irregular war in 2035 *will* witness a continued increase in the employment of surrogate, proxy and private military air forces. Today, private military companies (PMC) are already widely employed by several NATO countries to supplement and support deployed standing armed forces. Mixing forces and chains of command *will* contribute to the overall complexity of the future security environment.<sup>78</sup> This *may* become a particular challenge in the future as more private air forces become involved in global operations.

There is a constant risk of having a dominant but irrelevant Air Force in such a future security environment. Relatively small irregular forces *will* always be capable of nullifying many of the advantages that sophisticated air forces possess, and this pattern can be expected to continue in the future.<sup>79</sup> Western states, most likely led by the United States, *will* feature ever more powerful air forces, but their ability to employ them effectively *may* decline as future warfare falls further outside the traditional laws of armed conflict and the actors involved show less and less respect for the international system, third parties and non-combatants.<sup>80</sup> These future hybrid wars, an inseparable mix of conventional and asymmetric conflicts, *will* pose considerable challenges to the relevance of doctrinally and technologically dominant air forces.

Consequently, the Canadian Air Force must be prepared to play a relevant part in such future conflicts. This means developing capabilities applicable across the entire continuum of operations, not just for major combat operations. Combat effectiveness must never be compromised, but nor should it exclude the ability to bring the appropriate capabilities to bear as the situation demands.

## CATASTROPHIC CHALLENGES

By the year 2035, it is *unlikely* that the threat of catastrophic attack will have receded. Catastrophic challenges *may* come in many forms from geopolitically driven declarations of total war against Canada to sudden and large-scale irregular and asymmetric attacks against Canadian interests at home and abroad. Additionally, catastrophic attacks *may* come in the form of a humanitarian disaster. By 2035, Canada will *likely* face at least one catastrophic challenge at home and *possibly* one or more such challenges abroad.

Adversaries *will* continue to plan and execute attacks designed to shock populations while inflicting maximum possible casualties. These attacks *may* be applied equally against military and civilian interests, but recent history has revealed a trend towards the latter.<sup>81</sup> Unfortunately, civilians and other non-combatants are routinely the primary targets of these attacks, as they are considered the “soft underbelly” of national *will* in most sovereign states in the developed world.

<sup>77</sup> Ibid., 87.

<sup>78</sup> UK, MOD, *High Level Operational Conceptual Commentary*, 1-3.

<sup>79</sup> Richter, “Conflict Scenarios, Airpower, and the Use of Force,” 157.

<sup>80</sup> Ibid., 170.

<sup>81</sup> Civilian skyjacking, hostage taking, terrorist bombing and other such attacks are often mistaken as modern post-September 11 disruptions, but these types of attacks have occurred with regularity since 1945. For a concise overview of international terrorism see Herfried Munkler, *The New Wars* (Cambridge: Polity Press, 2005).

Chemical, biological, radiological and nuclear (CBRN) weapons and technologies *will* persist and unfortunately *possibly* proliferate out to a wider number of users. By the year 2035 and beyond, it *will* become easier not only to build CBRN-type weapons but also to deliver them to their intended targets.

Future catastrophic attacks *may* also take the form of humanitarian disasters. These *could* occur either at home or abroad, and in both scenarios, the Air Force will *likely* be among Canada's first responders. Both kinetic and non-kinetic responses *will* be required to meet these challenges, and the future Air Force must be prepared to provide assistance and, if necessary, intervene to help stave off the worst of such disasters by providing stabilizing effects.

## DISRUPTIVE CHALLENGES

As with other forms of future conflict, disruptive challenges to Canadian sovereignty and national interests *will* come in many forms. These dilemmas *may* include everything from natural disasters to piracy to computer network attack; all of which are designed to degrade Canadian security by exploiting vulnerabilities within its society.

Natural disasters can seriously disrupt Canada's security and safety and put Canadian citizens directly at risk. In the last two decades, Canada's Air Force has responded to such disasters on a regular basis, whether it has been fighting forest fires on the West Coast, floods across the Prairies, ice storms in central Canada or hurricane level winds across the Maritimes. In the future, the Air Force *will* continue to provide rapid strategic reach and deliver precision effects across the country to mitigate the effects of natural disasters and to help ensure the safety of all Canadians.

In addition to providing safety and security at home, the Air Force *will* contribute capabilities to respond to the effects of natural disasters abroad. It can expect to be asked to assist with delivering relief supplies to practically anywhere in the world where people are in distress. Whether ravaged by fire, flood, drought or storm, the Air Force *will* help provide stability and contribute to the conditions needed for relief and eventual recovery.

As a trading nation, Canada depends on the security of its commerce. The future Air Force *will* provide security and safety for Canada's interests abroad, including deterring piracy, hijacking and other disruptive attacks against open lines of communication.

Finally, the future Air Force *will* project power through precision effects not only in the physical and moral domains but in the informational domain as well. To that end, the Air Force must consider its future role in influence activities, ranging from civil-military cooperation to computer network operations. The Air Force is a service whose people and processes depend greatly on collecting and analysing data; therefore, information and its protection *will* become paramount to the future Air Force. Adversaries already know this, and they *will* seek new and innovative ways to disrupt operations by disrupting, degrading, hacking and exploiting the Air Force's informational domain.

## AIR FORCES IN FUTURE WARFARE

Historically, air forces spent many of their formative years combating other air forces to gain air supremacy and to support the freedom of movement of friendly ground and naval forces, while denying that same freedom to the enemy. Additionally, air forces were employed specifically to degrade and, if possible, completely destroy an adversary's ability to fight by attacking both its national political will as well as the infrastructure that supported it. Finally, since the beginning of flight, air forces have not only provided strategic sustainment world-wide but also engaged in every activity from meteorology to search and rescue.

Thus air and aerospace power have always had a central role and *will* continue to have a central role, in all forms of warfare. In major combat operations, air supremacy remains and *will likely* remain a critical objective for strategic victory. In counter-insurgency operations, aerospace power increases stability and is essential to supporting ground and naval forces. In humanitarian operations, air forces are the critical link in providing rapid assistance and relief. In the future, at least to 2035, it is very *unlikely* that the Air Force *will* find itself replaced as the lead entity in fulfilling these roles.

The Air Force *will* also adopt many new roles. The Air Force can expect an ever-increasing requirement to deliver precision effects (greater than it has in today's inventory) as well as a wider range of non-kinetic effects. For example, new and/or improved capabilities (such as intelligence, strategic surveillance and strike, influence activities and advanced search and rescue) *may* all be needed to remain combat effective in the year 2035. Much *will* depend on the how the FSE and FOE evolve.

The future Air Force can fully expect to continue executing missions across the entire spectrum of conflict. The Air Force *will* find itself constantly challenged by the FOE and *will* always have to assess where aerospace power can be most effective, while at the same time avoiding its inappropriate application. The recent experiences of other air forces have demonstrated how the inappropriate employment of aerospace power *may* have an adverse effect on both operational and strategic objectives.<sup>82</sup> The future Air Force *will* need a balanced portfolio of capabilities at its disposal to avoid this pitfall.

Yet, without the longevity of experience enjoyed by both the Canadian Army and to some extent the Navy, it remains somewhat difficult to assess Canadian aerospace power trends over the long term and therefore determine exactly how the future Air Force *will* evolve. It is a given that advances in aerospace technology and information/communication technologies *will* continue at a rapid pace; however, it is less certain that these technological advances alone *will* create entirely new aerospace power paradigms. New technologies have constantly revolutionized how air forces fight, but new systems alone have less frequently affected the overall nature of air warfare itself.<sup>83</sup>

Still, the ever-increasing focus on advanced aerospace technologies (such as stealth technologies, electromagnetic spectrum dominance, fuel efficiency as well as precision and directed energy weapons) suggests that future air warfare *will* be conducted over longer ranges and with greater lethality. Next generation aircraft will *likely* appear more quickly, and variably proportioned manned and unmanned air force capabilities *will* become commonplace. Aerospace power presence and persistence *will* increase; the range of precision effects available to air forces *will* expand, and the ability to command and control these elements *will* improve even as they become increasingly complex.

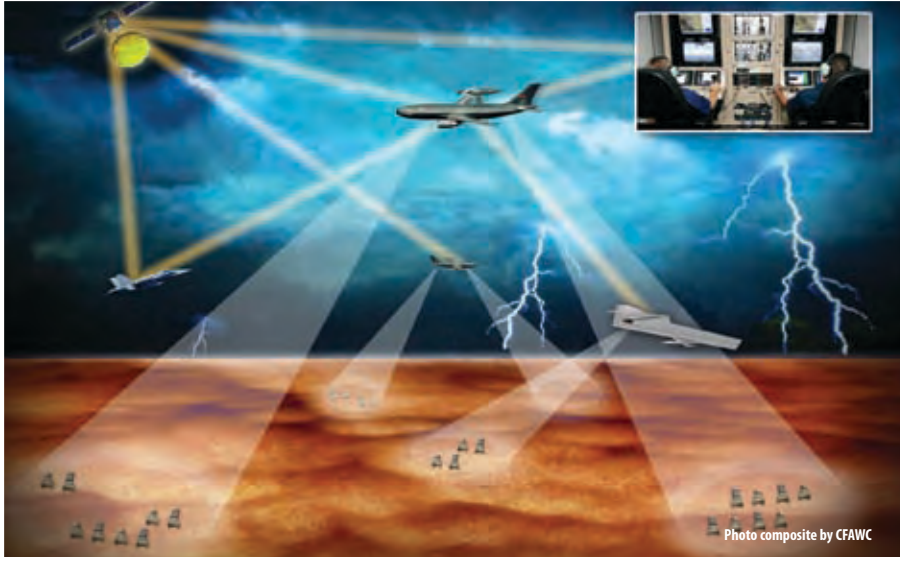
After a quick start, new generations of jet aircraft appeared approximately every two decades. Today, the time between new generations is approximately twelve years. With less and less time passing between the appearance of each new generation of aircraft, it is very *likely* that at least one if not more new generations *will* enter service by the year 2035. These new platforms *will* be characterized by advanced integrated electronic warfare systems, integrated communications, precision navigation and identification, advanced avionics and materials technology, centralized health monitoring and self-healing systems, fibre optics data fusion and transmission as well as advanced stealth technology.

The future Air Force can assume that more types of missions *will* be delegated away from piloted platforms over to its semi-autonomous platforms; while piloted and remote-piloted platform capabilities *will* shift more to increasingly difficult tasks not yet suitable

82 Following the 2006 Israel-Hezbollah War, the Israeli Air Force was greatly criticized for its misapplication of air power during the campaign.

83 For example, a more efficient jet engine *may not* necessarily on its own change how air forces fight; whereas the introduction of a new technology such as the global positioning system (GPS) during the 1980s fundamentally altered the very nature of air warfare itself.





for semi-autonomous decision making. This being the case, future air forces *will* continue to operate concurrently mixed fleets of manned and unmanned platforms, albeit in increasingly complex configurations.

Aerospace power persistence *will* increase from hours to weeks. New technologies *will* allow both manned and unmanned platforms to fly higher, longer and with increased ISR capabilities. Advanced propulsion systems *will* sustain longer flights, while other platforms *may* simply loiter over a preselected area of operations. Some of these platforms *may* be armed and networked, giving air forces the ability to provide persistent air support and air strike as required.

Advances in fuels, navigation and avionics promise the arrival of improved “stand-off” hypersonic weapons systems, meaning that future air forces *will* need to consider long range survivability as well as long range capability. At the same time, these advances *will* shape an air force’s ability to project power, deliver precision effects and provide air support and sustainment over longer distances.

It is a given that future air operations *will* remain complex in nature. The comprehensive approach to operations *will* expose the activities of air forces to a broader range of challenges and vulnerabilities, be they physical, psychological or reputational.<sup>84</sup> The operations of the future *will* be demanding, as aircrew *will* be entrusted with a vast range of tasks, from maintaining physical security to establishing human rights and arranging public communications to promoting law and order. Given the demanding nature of both the operating environment and the mandate, there is always a *possibility* of air operations failing to meet their objectives.

Strains imposed upon individuals *will* be amplified owing to greater dispersion, the unconventional nature of complex operations and the effects of constant media scrutiny. The latter *may* alter the perceptions of those outside the theatre of operation, and forces *will* need to pay greater attention to the psychological impact of future activities as social and technological trends influence personnel and the way in which they operate. The threat or use of weapons such as theatre ballistic missiles, directed-energy weapons (DEW) and CBRN is *likely* to have psychological effects that far outweigh the physical.<sup>85</sup> Threats from adversaries against will and cohesion are *likely* to increase in response to already high levels of physical protection.

<sup>84</sup> UK, MOD, *High Level Operational Conceptual Commentary*, 5-3.

<sup>85</sup> *Ibid.*, 6-11.

To mitigate such risks, air forces *will* need to be both flexible and agile. The Air Force *could* easily find itself in non-traditional environments and must consider the requirements of new operating environments such as urban, unconventional as well as on and perhaps even under ground. Future operating environments *will* demand increased care for legal considerations; collateral damage *will* be tolerated less. Furthermore, the judicious application of precision effects *will* dominate risk assessments and protection issues in the future.

Advances in technology that allow the non-lethal use of force and increased precision are *likely* to lead to stringent limitations on offensive action that *will* translate to tight rules of engagement and strict national caveats. In fact and whenever possible, there *may* be particular emphasis on the use of non-kinetic weapons as well as on proportionality and precision in the use of fires.

Given the many possible directions that future air warfare *may* take, it becomes necessary to broadly define future capability requirements through different lenses. Examining the FSE and FOE constitutes a first step, but to further refine the concepts presented, additional filters are required. Consistent with other arms in the Canadian Forces, the Air Force has developed its conceptual and doctrinal designs through five functions—specifically Command, Sense, Shape, Move and Sustain. These are useful tools through which ideas *may* be examined and analysed, and their application *will* assist in further identifying the portfolio of future air capability requirements.

## COMMAND

The future Air Force Command function *will* be supported by a rapid, network-enabled system where a clear understanding of the commander's intent *will* be the foundation for the effective and responsible exercise of delegated authority and power to realize effects. The delegation of authority *may* also be given to lower levels to allow responses to situations and opportunities to occur in near real time. This is not to suggest that such a system may be perfect or will completely eliminate the fog of war, only that continued advances in network-centric aerospace systems *will* give commanders, at any time, an ever-increasing range of choice regarding their level of engagement. In fact, it is envisioned that future technology, tactics and procedures *will* challenge the traditional tenet of “centralized command—decentralized execution.”

At the strategic level, future air forces can expect to be part of a government-led comprehensive approach to operations. This approach views the military instrument of national power as but one of the many tools needed to end open conflict and stabilize regions. It is important to note, however, that the synergistic and active participation other instruments and influences (such as other government departments [OGDs], NGOs and multinational organizations) are critical to achieving favourable outcomes. CA evolved to some extent from the effects-based approach (EBA) to operations and is characterized by a philosophy that the whole environment is a complex, unpredictable, adaptive system and that adversaries or opponents are but one (albeit crucial) feature. In turn, EBA leads to joint action, enabled by battlespace management and manoeuvre. Commanders responsible for the delivery of aerospace power must understand the effect of a far wider range of capabilities than is currently available.

In support of the maturing and evolving Canadian CA to operations, the Air Force *will* need to act coherently with the Navy, Army, OGDs and NGOs to achieve Canadian foreign and defence policy goals. This *will* entail ensuring interoperability with JIMP organizations within the context of an integrated campaign.

In the future, it is envisioned that a virtual combined air operations centre (CAOC) *may* command and control all aerospace operations. Near real-time imagery as well as sealed, self-healing, reliable communication *will* allow for the pairing of the “tactical general” with the “strategic corporal” when and where it makes sense to do so. This is not to suggest that all situations require or even merit such a connection, only that the next generation approach to both aerospace operations and platform design *will* make such linkages possible.



Rapidly deployable and interoperable air forces must be able to provide not only the command and control (C2) necessary to direct and monitor operations and force generation activities but also the facilities to support and interact with partners within a comprehensive approach. In the future, adaptive and decentralized C2 processes *will* resolve the tension between freedom of action and the requirement to align strategic and operational goals by synchronizing subordinate actions with higher-level intent so that freedom of action is restored to the lowest possible levels.

The human dimension of command *will* continue to evolve as increased agility and tempo require advanced intuitive capabilities and experienced commanders who are at ease with flat and dynamic command architectures. Trust *will* play a central role in achieving this goal, as familiarity and mutual confidence become essential for the synchronous command team. Yet above all else, there *will* be the need for flexible leadership styles and varied relationships between sensors, shooters and decision makers. Therefore, future commanders at all levels must:

- Be creative, innovative and prepared to anticipate change.
- Be capable of creating new courses of action, organizations or architectures.
- Think about evolution and be able to learn from their own experiences as well as the experiences of others.
- Have the skills for building trust that *will* serve as the foundation for harmonious, effective teams. This *will* be as important as tactical or operational skill—possibly even more essential. The future joint forces must have leaders who can adeptly form and lead effective coalitions.<sup>86</sup>
- Possess conflict management and team building skills for effective interaction to promote trust and cohesion at all levels and, at all times, to maintain mission focus and clarity of the commander's intent. In operations, external friction will diminish the power of one's force. Internal friction will also produce self-debilitating consequences.

It is expected that decisions and actions in future aerospace operations *will* continue being made in near real time; therefore, care must be taken that the information tempo does not outpace the decision-making capabilities of the actors and agencies involved.

The benefit of reliable communication and high-resolution imagery (in near real time) of the tactical situation presented at the strategic level *will* allow senior leaders to reach down to the tactical level and interact with local forces when it is crucial to do so. This *may* reinforce the paramount requirement for a shared understanding of the commander's intent. It *will* permit greater subordinate freedom of action and initiative to achieve objectives. However, when misapplied it *may* be abused and adversely affect mission objectives; therefore, the basic characteristics of leadership must never be forgotten or made subordinate to technological enablers.

<sup>86</sup> United States, Department of Defense, *The JOE (Joint Operating Environment) 2008: Challenges and Implications for the Future Joint Force* (Suffolk, VA: United States Joint Forces Command, November 25, 2008), 47. Available online at [http://www.jfcom.mil/about/fact\\_joe2008.html](http://www.jfcom.mil/about/fact_joe2008.html) (accessed April 30, 2009).



## COMMANDER'S INTENT AIR VICE-MARSHAL RAYMOND COLLISHAW, CB, DSO (BAR), OBE, DSC, DFC

Raymond Collishaw from Nanaimo, B.C. was the third highest scoring British fighter pilot of World War I with 60 victories, ranking fifth of all nations. He remained in the Royal Air Force (RAF) after the war and, in 1935, went to the Middle East to command RAF units in the Western Desert.

As Air Officer Commanding Egypt Group, Air Commodore Collishaw faced a daunting situation on the eve of World War II. His motley force was equipped with obsolete aircraft and suffered from severe shortages of pilots and spare parts. Worse, there was a lack of coordination between land and air units in the region and the extremes of climate and geography created additional challenges. Reinforcement and resupply of his force was difficult as Italy firmly controlled the western Mediterranean. Superior Italian forces in neighbouring Libya had marked advantages in numbers and types of modern aircraft.

Despite these major handicaps and against all odds, Collishaw inspired and enabled his men through realistic training to give them the skills, freedom and confidence to seize the initiative. He understood the necessity of achieving air superiority over the battlefield and clearly articulated his strategy for securing airfields and ports against Italian attack. He taught his men to combine the virtues of the fighters' speed with the punch of bombers and to cooperate closely with ground forces.

Fixing realistic objectives and prioritizing targets, he instilled a sense of disciplined initiative in his subordinates while building inter-service cooperation. He established secure and reliable communications over the vastness of the desert and gave his force flexibility and reach by building adequately supplied forward airfields. Above all, he safeguarded his meagre resources, never risking men and material unnecessarily.

Lacking signals intelligence and radar to inform him, and hampered by poor radio communications, Collishaw was on his own. However, the efforts of the men were focused by a complete understanding of their tasks. They went into battle with their skills, courage and initiative channelled by a full appreciation of the mission and of what their commander expected of them. They acted as the physical extensions of his will in the battlespace in fulfilment of their commander's intent.

Despite overwhelming odds, results were immediate when hostilities commenced in 1940. Under Collishaw's leadership, his small group prevailed over a larger, better-equipped adversary. The Italian Air Force was knocked out in the first weeks of the campaign and the Italians were forced onto the defensive. Collishaw's squadrons continuously harassed the routed enemy, giving outstanding support to British ground forces, helping give the Allies their first real hope of victory after a series of discouraging setbacks in other theatres.

Commander's intent remains relevant today. In the assessment by General James Mattis, Commander of US Joint Forces Command and NATO's Supreme Allied Commander Transformation, when battle operations commence, information and command and control systems are likely to be overwhelmed and collapse, and high technology will fail. "When they do, only 'commander's intent' will be there to guide soldiers and officers in the field."<sup>87</sup>



Source: Wikipedia

CFAWC wishes to acknowledge the contribution of Mr. Stéphane Guevremont of the University of Calgary in the preparation of this vignette.

87 Steve Coll, "The Future of Soldiering," *The New Yorker*, June 1, 2009, <http://www.newyorker.com/online/blogs/stevecoll/2009/06/the-future-of-soldiering.html> (accessed September 24, 2009).

## CONTROL

By the year 2035, traditional command and control architectures are also *likely* to change. The typical J1 to J9 staff positions *may* be replaced by more generic effects-based organizations or cells. In fact, some evidence of a movement towards this trend is already visible today. Lower echelons *will* be expected to work easily with these organizations to recognize and rapidly exploit opportunities without lengthy or detailed forward planning. Instead, an agile, networked-enabled, open, synchronized architecture should encourage leaner and more modular command and headquarters solutions in the future.

Advanced modeling and simulators *will* allow for complete and precise mission rehearsal down to tactical effects. This *will* give understanding and shared awareness within the operating space, and it *will* continue to create confidence in a rational decentralized execution of the commander's intent.

As opponents *will* attempt to disrupt, destroy and penetrate systems and *will* have access to the same tools, it is also important that future networks are robust and protected. It is expected that future adversaries *will* be better equipped to disrupt, degrade and, at times, even destroy friendly networks; however, it is also expected that friendly networks *will* have some degree of self-healing, bypassing and preservation capabilities.

## COMMUNICATION

Robust, persistent and protected communications *will* remain a staple in future aerospace operations. Communications *will* remain essential in ensuring effective command and control. Telephone, radio, television and data (including government, financial and military systems) networks as well as the Internet *will* converge to share a common information infrastructure. Securing air-to-ground networks in such a pervasive and ubiquitous environment *will* become of the utmost importance.<sup>88</sup>

Commanders must also place particular emphasis on creating and influencing public perception. They must be alert and ready to counter enemy efforts to create and communicate their own messages. The enemy's ability to operate within the local cultural and social fabric *will* complicate our efforts. This puts at a premium the ability to understand the perceptual lenses through which others view the world. Commanders must be media and communications competent as the information tempo, official and unofficial, *could* outpace decision-making freedom.

## SENSE

The key to the success of military operations in the future *will* be information. Not only *will* the Air Force rely on sensor fusion and knowledge management to conduct its missions, it *will* exploit the advantages that accrue from possessing the coveted high ground and its approaches within all battlespaces. Additionally, the Air Force *will* collect, filter, fuse, analyse and disseminate knowledge to improve, as much as possible, shared situational awareness.

In the future, most air-breathing platforms *will* be capable of conducting extensive ISR, and all sensors *will* be connected directly to the command and control system by a sealed, self-sustaining network. In the future, for example, a network *may* consist of micro, unmanned aircraft, large manned and unmanned aerospace platforms and rapid-response microsattellites that are all controlled by a semi-autonomous AI machine that is able to fuse the data into useable knowledge at near real-time speed.

<sup>88</sup> Sloan, "The Role of Aerospace Power 2018 and Beyond," 152.

## COLLECTION

In 2035, nearly all data collection *will* be routine as pervasive sensors become a ubiquitous feature of globalization. Everything from large-scale orbital and high-altitude surveillance and reconnaissance platforms such as satellites and aerostats to nanotechnologies, such as smart dust, *will* be available to collect data. The amount of collectible data *will* only be limited by the systems designed to collect the information and the actors who must operate and maintain those systems once in service.

Countering vulnerabilities in the collection process *will* also become more difficult in the future, underscoring the continued requirement for robust and secure access to communications. Data transfer facilities *will* need to be hardened against manipulation, interference and suppression.

Through cyberspace, data collection *will* only be limited by the size and scope of content on the Internet. Collectors *will* identify and seize opportunities and, at the same time, mitigate the reciprocal risk of using open-source software and tools to exploit intellectual and emotional capital. By 2035, analysis and filtering of open source electronic material *will* be a routine defence activity and *will* be further augmented by new sources evolving out of web 2.0 and web 3.0 applications. These applications *may* include, and are certainly not limited to, collaborative analysis tools, client generated value-added content, self-sustaining and evolving networks, advanced Really Simple Syndication (RSS) feeds as well as semi-autonomous smart decision-making agents.



## FUSION

The Air Force of the future *will* still face challenges with knowledge management and fusion. Some of these challenges *will* be technology-based and will require new technological solutions (such as electromagnetic spectrum warfare integration and interoperability); other fusion challenges, however, *may* be procedurally based. In the latter case, communities of interest *will* become increasingly important in the intelligence cycle. For example, shared situational awareness (SSA) of friendly forces (based on an efficient, joint system fused with



knowledge of both opponents and third parties) becomes more essential to all operations. Finally, it *will* also be essential to work with other non-traditional information sources, in matrices of varying degrees of formality, to rapidly share knowledge where appropriate.

The Air Force *will* need to have an intuitive cultural understanding of countries and situations we seek to influence. This *will* be enabled through specialist human science analysis and advice in interpreting the socio-cultural fabric of society and people of interest. This *will* be the key to identifying the motivation and vulnerabilities of opinion-formers, power brokers, influencers as well as their allies and opponents. Expertise, intellect and intuition *will* still be required to effectively exploit this information. By 2035, AI *will* effectively assist in this function but *will not* replace the human component entirely. Common toolsets to ensure that the art of analysis is enabled by science *will*, however, become increasingly commonplace.

For maximum agility, security risk management—not risk avoidance—*may* be required based on the assessment of consequences of release of information and intelligence. Information flow, with discrimination and precision in time and space, *will* be essential for success, particularly in urban and populated landscapes.

## THE HUMAN DIMENSION

The human dimension of future air sensing *will* remain a paramount feature of its success. Without people at the centre of all knowledge discovery and exploitation, no mission can be successful. Future knowledge architectures must put people first and must communicate efficiently at strategic, operational and tactical levels and be CA conducive. To operate effectively, future sense operators *will* require persistence, precision and discrimination in challenging environments. These qualities *will* underpin the ethical, legal and moral framework in which they *will* take action, either reactive or proactive. In the end, it is the human dimension that *will* determine most outcomes.

To build judgement, discretion and intuition and to give continuity, personnel *may* need to be employed in specific roles, locations and environments for longer periods. Therefore, it *will* be essential to identify, recruit and access personnel with broad language skills, cultural awareness and background as human intelligence (HUMINT) resources. Combined with other sensors, the human sensor *will* collect data critical to the intelligence cycle and *may* be able to do so continuously where other technological systems are unable to or are inappropriate for the task.

## SHAPE

If the Air Force of 2035 is to remain combat effective, it must be capable of shaping the battlespace. First, it must be able to shape all domains, be they physical, moral or informational. Second, the shaping must be precise, or the Air Force *will* risk or *possibly* even forfeit moral ascendancy. Third, the Air Force must be capable of decisively shaping the battlespace to permit maximum freedom of action to our forces while denying it to the adversary. Ever vigilant and ready to strike, the Air Force *will* shape the air environment while shielding and supporting forces operating in the land and sea environments.

This function *will* continue in the air and space environments and *will* extend into cyberspace. Commanders *will* be able to apply precise and rapid effects in the physical, moral and informational domains. Various unmanned systems *will* provide the bulk of the force structure for the commander as well as the required rapid response and persistence they need to shape the battlespace. Modularity, coupled with Plug and Play capability, *will* make the Air Force highly balanced and agile.

## PHYSICAL DOMAIN

Shaping the physical domain in the future *will* continue to demand the judicious application of precise, decisive and proportionate combat aerospace power. The future Air Force, therefore, *will* retain its tremendous advantage of being able to apply discriminate, lethal and non-lethal force to shape precisely the physical domain wherever required. As well, the future Air Force must continue to develop new ways to shape the physical domain.

Operational space *will* be less defined which will lead to intensive joint action within an effects-focused theatre. The future Air Force must be in a position to dominate air, land, sea and space to ensure freedom of manoeuvre of friendly forces within these increasingly constrained environments. Aerospace operations must be well-timed, be executed efficiently and decisively and guard against friendly and collateral damage.

Operations in dense urban areas *will* increase. Operating in urban areas, the future Air Force *will* require precise, decisive and proportionate combat power; a reliance on accurate and time-sensitive intelligence, surveillance, target acquisition and reconnaissance (ISTAR); a discriminatory weapon planning and execution capability; and, again, the absolute need to avoid or minimize all collateral damage.

Future fires *will* require highly efficient asset usage, a reduced dependency on organic fires and a reduced deployed footprint. Furthermore, they *will* feature precise, pervasive and persistent applications—including tuneable and variable power weapons as well as the ability to accurately and persistently engage moving targets. Joint fires *will* need responsive, high-capacity, near real-time networks to detect, track, identify and acquire targets.

In the future, the Air Force *will* conduct operations which demand shaping of the physical domain to create precision effects and intended consequences without causing disproportionate physical destruction. This *will* require the future Air Force to be able to tailor its effects accordingly.<sup>89</sup>



U.S. Air Force photo by Technical Sergeant Kevin J. Gruenwal

## MORAL DOMAIN

The future Air Force *will* shape the moral domain to produce desired cognitive effects that alter or influence perceptions. In its pure essence, air warfare is a human endeavour ultimately shaped by the people who are directly engaged in it.

<sup>89</sup> For example, the promise of future directed-energy weapon systems suggests a potential capability to provide a range of lethal and non-lethal effects from surgical strike to personnel denial without injury.

There *will* be intense, informed and immediate public scrutiny from friendly and hostile media. The Air Force *will* require greater capability to manipulate information to achieve physical impact, including computer network attacks (CNA). The future Air Force must also be capable of conducting a wide range of influence activities, as such activities are *likely* to identify, influence or even reduce other requirements that shape the physical domain.

## INFORMATIONAL DOMAIN

In addition to the physical and moral domains, the future Air Force *will* be expected to shape the informational domain. This *may* occur through a wide range of diverse influence activities, from civil-military cooperation to computer network operations. The ability to shape the informational domain *will* play a significant role in the outcome of air campaigns, and the future Air Force must see information as a tool of choice when shaping the environment through precision effects.

Finally, it is important to recognize what *may* be difficult or at times impossible to shape. For example, there are enduring factors associated with battle such as violence, friction, chance, chaos, uncertainty, risk, geography, climate, culture and lack of time, all of which at times *may* exacerbate a situation no matter how much information is collected, analysed, shared or disseminated.

## MOVE

A relevant and combat-effective Canadian Air Force must be able to project power globally. To do so it must possess speed, range, flexibility, precision and persistence. In the future, the Air Force *will* require improved speed, agility, persistence, survivability and stealth to successfully deliver precision effects (both lethal and non-lethal) anywhere in the battlespace and across the entire spectrum of conflict.



## FORCE PROJECTION

The ability to move and engage globally is vital to the CA. The future Air Force *will* be expected to be able to provide both regional and global move with both manned and



unmanned aerospace platforms. It must be able to project and sustain forces for close or remote operations, have a highly responsive intervention capability and expect to operate at longer ranges.

Air mobility *will* maximize, in all weather, the supply velocity to the end user in the global environment. As it *will* rely mostly on flexible-use aircraft, there *will* be a corresponding reduction in the importance of airports of disembarkation (APODs) as a force reception point. By 2035, inter-theatre airlift *might* be provided by ultralarge, long-range platforms that *will* be largely self-sufficient, powered by alternative energy sources and feature multilayer DAS. An aircraft capable of super-short take-off and landing (SSTL) *will* provide intra-theatre airlift and *will* be able to operate from a sea base and/or an aircraft carrier. Most lift assets *will* be equipped with highly precise, high-altitude airdrop capabilities and, if required, *will* be capable of large-scale distributed operations from beyond the theatre.

Access, basing and over flight privileges require long-term partnerships, preservation of international conventions and/or short-term arrangements such as the current Canadian Operational Support Command (CANOSCOM) development of “hubs and spokes” bases and operating locations for sustaining and projecting forces abroad. In the future, the battle for access *may* prove not only the most important, but the most difficult task for the Air Force. And since access is not assured, a robust and long-reaching combat capability is required. This capability *may* require long-range persistent systems, UAVs and “stand-off” applications.

## THE BERLIN AIRLIFT: FORCE PROJECTION USING AIR POWER

On 24 June 1948, as tensions between the Union of Soviet Socialist Republics and its former Western Allies continued to escalate, the Soviets severed all surface routes to the Western-held sectors of the city of Berlin, an area that was more than 160 kilometres inside the Soviet-controlled zone of Germany. The Soviets estimated that the Western Allies would soon be forced to abandon the city and leave all of eastern Germany under their control.

The response was swift and daring. On 28 June, the Allies launched a massive airlift to supply West Berlin with sufficient food and fuel to sustain two million civilians and the Allied garrisons for an indefinite period. The around-the-clock airlift lasted 324 days, with many landings taking place at three-minute intervals. At the height of the operation, 16 April 1949, an aircraft landed in Berlin every minute. By the spring of 1949, an average of 8,000 tons was flown in daily. The aircraft were supplied and flown by the United States, United Kingdom and France with crews also coming from Australia, Canada, South Africa and New Zealand. Ultimately, 277,804 flights were made and 2,325,809 tons of supplies were delivered. Frustrated by this unexpected and successful demonstration of Allied resolve and air power, the Soviets abandoned their blockade at midnight, 11 May 1949. The airlift continued until 30 September, however, as the Western nations built up sufficient supplies in West Berlin should the Soviets attempt another blockade.



## NEW ENVIRONMENTS

The future Air Force must be prepared to project power in and through outer space. This *may* include the capability to move into and through suborbital as well as orbital space to provide and protect space mobility and even to exert local space control. As the drive to further exploit, militarize (*possibly* weaponize) and potentially control space widens, the Air Force must be capable of ensuring its own access to and freedom of manoeuvre in outer space.

Given current multilateral agreements and technical factors, the effective weaponization of space is *unlikely* before 2020. However, nations *will* seek to inhibit the use of space by opponents through a combination of electromagnetic manipulation, hard-kill from ground-based sensor and weapon systems, the targeting of supporting ground-based infrastructure and a range of improvised measures. At its most extreme, the weaponization of space *may* eventually include the development of space-based strike weapons capable of attacking ground-based and other space targets. However, this *will* remain extremely *unlikely* without the prospect of sustained and extreme deterioration in international relationships and *will* be technically difficult to achieve before 2020.<sup>90</sup>

The future Air Force must also be capable of ensuring its freedom of action in cyberspace. Effective and relevant joint action requires information assurance to enable and project influence. Though one can never expect to maintain any sort of total information “dominance,” it *will* be possible to coerce and influence with impunity given the right capabilities.

## SUSTAIN

Fundamentally, the future Air Force must be capable of sustaining itself to project power effectively and quickly, anywhere and at any time. Air Force sustainment must be mobile, robust, flexible, responsive, technologically superior and fully interoperable. It must balance capabilities and requirements for both material and personnel. In essence, it must be constant and consistent to be relevant and combat effective.

In the future, deployed forces *will* have highly increased self-sufficiency and *will* rely very little on host-nation support. They *may* employ alternative energy sources, AI and automation, human performance enhancements, on-site advanced manufacturing and/or miniaturization; the use of any of these advancements *will* greatly reduce manpower requirements. These systems *will* provide lean, globally interconnected, self-sustainable as well as energy-efficient logistics and sustainment for forces in all environments. Most important, these systems *will* depend on highly motivated, well-trained and experienced Air Force personnel to be successful.

## PHYSICAL EQUIPMENT

To project power both at home and abroad, the future Air Force must develop advanced capabilities for airlift, spacelift, air refuelling and sustainment.

US dominance in major platforms and systems as well as research and development *will* define our defence industrial landscape for the next 20 years. Therefore, the pressure for increased interoperability and, in some cases, employment of the same platforms among close allies is *likely* to increase. This *will* provide many advantages in the future; however, it is also recognized that singularity *may* present risks and produce single points of failure.

90 UK, MOD, *The DCDC Global Strategic Trends Programme 2007–2036*, 66.

Agile sustainment *will* provide material, facilities, services and other support to enable all operations. Traditional bureaucratic acquisition and service processes can delay a rapid effective response to disruptive technologies. A thorough and coherent reform of the acquisition process is required; otherwise, we face the risk that opponents *could* incorporate technological advances more affordably, quickly and effectively—with serious implications for our Air Force. Likewise, future sustain services must be robust and capable of responding quickly to unexpected challenges without being degraded by “the system.”



Photo composite by CFAWC

## OPERATION BOXTOP

Canadian Forces Station (CFS) Alert is the most northern, permanently inhabited settlement in the world. It is situated on the northeastern tip of Ellesmere Island in the Canadian Arctic Archipelago. Twice a year CFS Alert receives its fuel and major supplies via an air bridge called Operation BOXTOP.



CF photo by Corporal David Cribb

Op BOXTOP runs for two to three weeks every spring and fall. Using United States Air Force Base (AFB) Thule in Greenland as a staging point, large transport aircraft ship fuel and supplies from Canada to AFB Thule. The cargo is then broken down into smaller pallets for onward shipment via CC130 Hercules. Op BOXTOP typically requires a total of 100 personnel (including flight crews, maintenance technicians and mobile air movement personnel) and three CC130 aircraft to transport the fuel and supplies between AFB Thule and CFS Alert. The operation runs night and day and transports approximately 450,000 imperial gallons of fuel and 150 chucks of supplies.

With the short runways in the northern locales, very few types of transport aircraft have been able to land or take-off from places such as CFS Alert. Historically, the CC130 had been the only aircraft able to perform these types of missions. With some of today's aircraft, Op BOXTOP could become more efficient. In the future, large cargo airships that can airlift more than 20 tons, operate on short runways and travel distances of 2,000 kilometres or more would eliminate Canada's reliance on foreign airbases to support our Northern outposts.



## FORCE GENERATION

In addition, the Air Force must aggressively recruit and develop its most precious capability—people—through advanced recruitment, education, training and professional experience. Together, both people and equipment *will* successfully sustain future air forces in operations around the world.

Superiority in the cognitive or human dimension *will* be essential if our values and prosperity are to remain viable in the future. The requirement to reasonably anticipate and respond appropriately to the challenges of the future can only be met by developing and sustaining an intellectually adaptive, imaginative, intuitive, ethically-based Air Force. It should be confident that it possesses the skills, technology and support that enable it to operate effectively within a joint framework of absolute mutual reliance.

The Air Force must continue to present itself as an institution that inspires Canadians and motivates our citizens to be attracted to public service as they strive to have real meaning in their lives. Future members of the Air Force must be imbued with a sense of nobility of purpose. Recruitment *will* continue to be affected by changes in the domestic demographic landscape; thus, a greater emphasis on attracting, producing, accessing and retaining technically skilled personnel is critical. The future Air Force must also make better use of Reserve forces, especially to acquire specialist skills not otherwise readily available.

The future Air Force *will* need to consider innovative ways for recruiting and employing its people. For example, to further increase membership, citizenship *could* be offered in exchange for a fixed period of service in the Air Force, which at the same time would instil cherished Canadian values in a new citizen. Other ways *may* involve novel and highly flexible working arrangements, engagements, competitive incentive compensation as well as more comprehensive and agile terms of service. It is *likely* that future Air Force retention *will* depend on innovative recruitment strategies, flexible terms of service and alternative working arrangements at all levels.

## TRAINING

Future training for air forces *may* look radically different than it does today. With increased access to basic flight theory and training, the Air Force *will* no longer carry out first stage training and is *likely* to acquire more “off the shelf” skill-sets through schools and industry across all fields. Instead, the Air Force *will* overlay “militarization” and military culturalization aspects onto an already existing skill foundation in follow-on training after the person has joined the Air Force.

Aircrew *will* be trained and held at various degrees of readiness and *will* be balanced for response to a variety of different missions. This should produce forces that are robust, agile, versatile and adaptable to deal with the unexpected. Aircrew *will* increasingly train in conditions and environments *likely* to be encountered. The employment of virtual environments *will* be a key resource at all levels of training and education.

## HUMAN DIMENSION / MORAL COMPONENT

As critical as platforms are to aerospace power, future air forces *will* succeed or fail based on the willpower and morale of their personnel. Therefore, the future Air Force *will* not only need to be concerned that its personnel conduct themselves ethically and that their actions are legal but that health, safety and welfare concerns of its personnel at all levels are addressed so that airmen and airwomen can focus on the successful completion of their missions.

Morale and welfare for Air Force personnel must include appropriate compensation, programs and support to dependants that *will* ameliorate the stress associated with separation

for extended periods of service. There *will* be the need to provide increased physical and cognitive protection for Air Force personnel as well as their families.

On operations, a solid legal foundation *will* support the moral component of any mission. Duty of care and legal considerations *will* dominate risk assessments and protection issues in the future. The challenge *will* be in the context of discrimination, proportionality and scales of unintended collateral damage. Finally, the application of force *will* require human judgement if novel weapon systems are to remain lawful and legitimate under today's conventions.

Medical welfare *will* include protection from disease, CBRN and adverse environments in which Air Force personnel *will* be expected to operate. Acclimatization is essential to health. In the future, advances in drugs and technology that enhance resilience and resistance *will* be available and ethically acceptable. Nanotechnology and telemedicine *will* offer increased survival and recovery rates for injured and ill personnel. Finally, injury *will* occur in the air and on the ground, and the Air Force must be responsive to both scenarios.

## FORCE PRESERVATION

It is historically proven that aircrew who are appropriately trained to survive and who can reasonably expect rescue are more likely to persevere through adversity and risk to accomplish their mission. The future Air Force must address its requirement for survival, escape/evasion, resistance and extraction (SERE) training and combat search and rescue (CSAR) extraction capability. Without this training and capability, the Air Force jeopardizes the success of its mission and risks its greatest asset by placing constraints and conditions on aircrew survivability.

## CONCLUSION

Just as Part 1: The Future Security Environment attempts to explain potential future threats for Canada, this portion, the future operating environment, attempts to define how the Air Force *will* respond and function within that FSE. Based heavily on current and near future trends and drivers as well as acknowledging the potential impact of strategic shocks, Part 2 offers a possible picture of things to come. Further analysed in the context of the Air Force's five functions, the FSE and FOE have together revealed a broad portfolio of future capability requirements that will be needed to address the most serious risks presented to Canadian sovereignty, security and national interests both at home and abroad in 2035. The next part examines the future capability requirements in greater detail and forecasts what the Air Force of 2035 will require to be an effective instrument of national strategy.





## PART 3: FUTURE CAPABILITY REQUIREMENTS

*As any good knight will tell you, having the right weapons for the right fight is as important as the battle itself.<sup>92</sup>*

Anonymous

### INTRODUCTION

The overarching concepts and capability requirements for Canada's Air Force in 2035 are rooted in its strategy of today. Extrapolating from both the *Canada First Defence Strategy*<sup>93</sup> published in 2008 as well as the vision of the Chief of the Air Staff (CAS), these concepts and capabilities must both contribute to the Air Force's overall ability to **project power through precision effects**.

Canada's future Air Force must continue to evolve along this path and remain strategically relevant, operationally responsive and tactically decisive both at home and abroad, in any battlespace, across the entire spectrum of conflict. The future Air Force must be interoperable with other allied forces, able to contribute to operations on a global scale and play a central role in any Canadian comprehensive approach to crisis and instability.

From this concept, **effect** is the result, outcome or consequence of an action. In the broader sense, it results from applying kinetic or non-kinetic force to the physical, moral or informational domains. The term **precision effects** implies achieving the right effect (both kinetic and non-kinetic), in the right place (precision), at the right time (time criticality) in a cohesive manner that delivers the desired outcome with no or minimal collateral damage. The term **projecting power** implies the ability of a nation to apply all or some of its elements of national power—diplomatic, information, military and economic—to rapidly and effectively deploy and sustain forces in and from multiple dispersed locations (at home and abroad) to respond to crises, to contribute to deterrence and to enhance regional stability.

Given these parameters, and having now assessed the nature of aerospace power in both the future security environment and the future operating environment, this part will focus on those enabling concepts and future capability requirements that emerged from the FSE and FOE analyses. The portfolio outlined below constitutes a first look at what *may* contribute to achieving the future Air Force's desired operating concept. Though not all-inclusive or definitive by any means, the portfolio offered below covers a broad spectrum of proposed capabilities that should serve as a starting point for future detailed analysis and debate.

### METHODOLOGY

The 2007 CAS strategic vectors<sup>94</sup> are considered the enabling concepts (EC) that will navigate Canada's Air Force to see the CAS vision out until the year 2019–2020. Thus, the current strategic vectors form an excellent base from which to forecast the next generation of enabling concepts to address the FSE and FOE to the year 2035 and beyond.

92 The original source of this quote is unknown. It is also used in Michael Reff, "Basic Training: Gearing Up for Battle," Videomaker, <http://www.videomaker.com/article/10778/> (accessed May 1, 2009).

93 Available online at <http://www.forces.gc.ca/site/focus/first-premier/defstra-stradef-eng.asp> (accessed March 26, 2009).

94 Canada, Canadian Air Force, *Air Force Strategy: the Flight Plan for Canadian Forces' Aerospace Power* (Ottawa: Director General Air Force Development, 2007 [Version 3.0 dated 9 Nov 07]).

The methodology used to develop Part 3 is based in part upon the results of a Canadian Forces Aerospace Warfare Centre working group conducted in November 2008. The working group consisted of experts from the Air Force’s research and development community, select Canadian aerospace power theorists and internal Air Force subject matter experts.<sup>95</sup> During the working group, the FSE and FOE were reviewed in order to determine which of the current Air Force concepts and capabilities would still be relevant in the year 2035. Considering the Air Force’s overarching concepts and capability requirements, a list of enabling concepts for Air Force 2035 (See Table 3-1) was then generated by dropping some of the current ECs (from the CAS strategic vectors), retaining others and, finally, adding new ones.

SER	ENABLING CONCEPT
EC 1	Networks and Data Fusion
EC 2	Air and Space Regulation
EC 3	Capitalizing on Industry and Civilian Learning Institutions
EC 4	Expeditionary Air Force
EC 5	Interoperable, Agile, Modular and Balanced Air Force
EC 6	Advanced Weapons
EC 7	Rapid, Reliable and Secure Mover
EC 8	Occupation of Choice
EC 9	Force Preservation
EC 10	Pervasive Semi-autonomous Systems
EC 11	Persistent High-resolution Surveillance

Table 3-1: Air Force 2035 Enabling Concepts

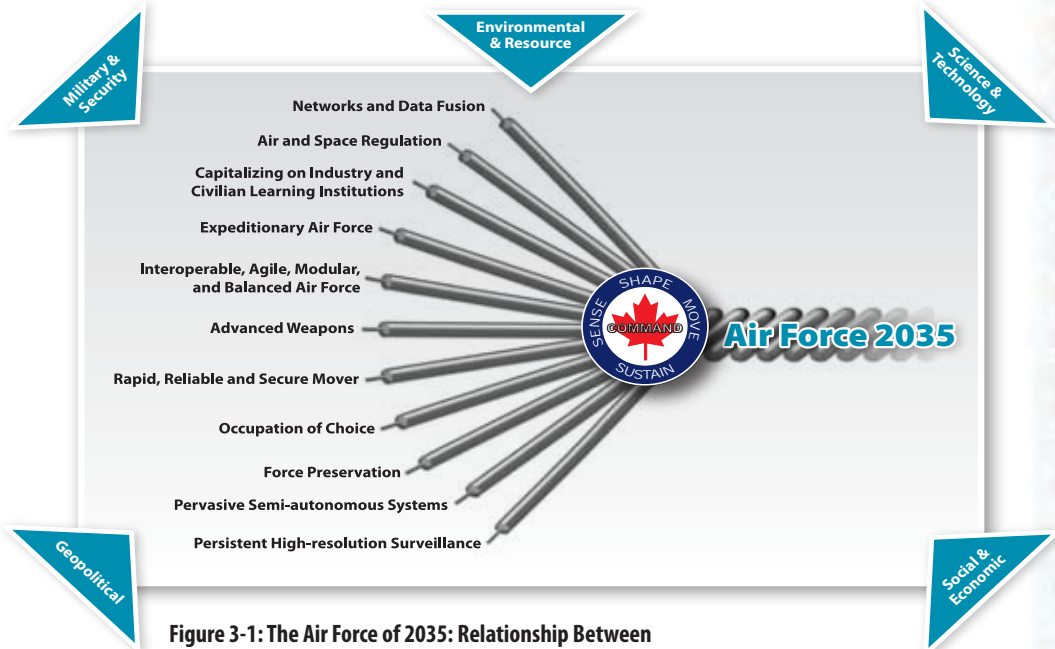
TRENDS AND DRIVERS

FSE trends and drivers (such as geopolitical, military and security, environmental and resource, science and technology as well as social and economic) are the influences that will shape the FOE. To address the future challenges the Air Force will *likely* face in light of the FSE and FOE, ECs were identified to enable Canada’s Air Force to evolve into an organization that can effectively continue to **project power through precision effects** to the year 2035 and beyond.

ENABLING CONCEPTS

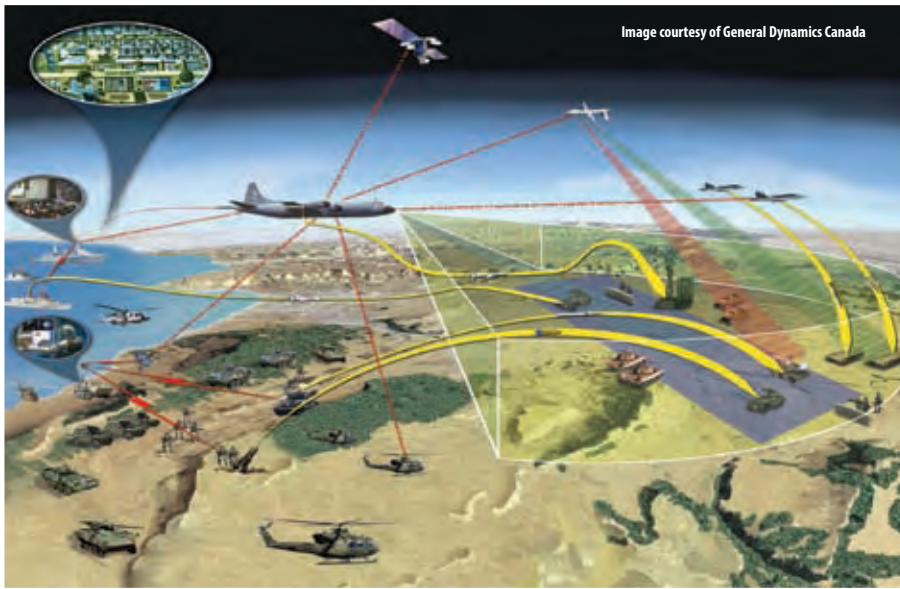
An EC is a transformational instrument that will position the Air Force to succeed in dynamic and novel environments. The following ECs were derived from projecting the five Air Force functions—Command, Sense, Shape, Move and Sustain—to the year 2035. It is important to note that the ECs discussed in this study are not in any specific order of priority and refer specifically to the FSE and FOE of 2035. Although some concepts *could* be applicable today or in the near future, these ECs are discussed within the context of the 2035 timeframe. As illustrated in Figure 3-1, the Part 1 trends and drivers are having an impact on the ECs, which when filtered through the CF aerospace functions will weave our view of the Air Force of 2035.

<sup>95</sup> Air Force 2035 Working Group was held at Canadian Forces Aerospace Warfare Centre Trenton 17–18 November 2008. Participants were LCol J. Fernandes, LCol N. Gagne, LCol D. Lachance, LCol J. MacAleese, Maj P. Dion, Maj M. Gagnon, Maj T. Gushue, Maj K. Rodzinyak, CWO R. Mercer, Dr. J. Fergusson, Mr. G. Geling, Dr. A. Godefroy, Dr. R. Pigeau and Dr. S. Wesolkowski.



**Figure 3-1: The Air Force of 2035: Relationship Between Trends and Drivers, ECs and the CF Aerospace Functions**

## EC 1: NETWORKS & DATA FUSION



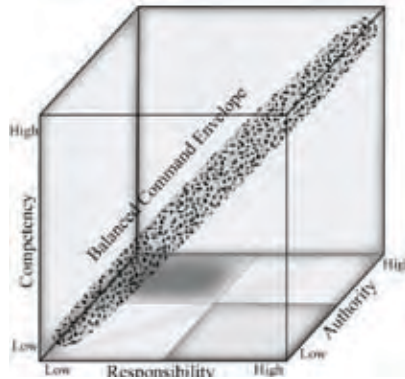
Networks in 2035 *will* consist of an intelligent military World Wide Web that provides real-time connectivity between various next generation systems. These include systems that are managed by the CF, Government of Canada (GoC), civilian agencies, international agencies and other military forces. Next generation networked systems *will* include mainframes; databases; advanced simulators; artificial intelligence; air-, ground-, sea- and



undersea-based platforms; as well as space-based platforms and systems. The radical evolution *will* be the smart interfaces which seamlessly connect users to the appropriate system and allow them to transparently exchange relevant data.

Future data fusion *will* witness the improved convergence of all types of data into formats best suited to any particular situation. For example, commanders and their analysts *will* receive all forms of data in real time with scalable resolution and fidelity. This *will* further enable the pairing of the strategic corporal with the tactical general when and where it makes sense to do so to achieve more immediate and lasting precision effects.

**Advantages.** In the complex world of 2035, precision effects *will* require precise on-site execution paired with immediate access to the appropriate authority. The tools resulting from advanced networks and data fusion *will* provide a strategic-level commander (civilian or military) with real-time access to any subordinate in the field and, most importantly, with what that subordinate sees, hears and senses. Further assisted by AI systems and other decision-making agents, networks *will* greatly assist competent teams with the authority and opportunity to execute an effect. In the background, advanced connectivity *will* reach back into appropriate systems and push all relevant data forward as well as across lateral, collaborative command chains. As identified in the Pigeau and McCann competency, authority and responsibility model (see Figure 3-2), this EC *will* situate future teams at the optimum location within the balanced command envelope.<sup>96</sup>



**Figure 3-2: Competency, Authority and Responsibility Model**

Combined with data fusion, the operations planning centres of all Air Force units *will* be folded into a virtual command system (a virtual CAOC).<sup>97</sup> This EC *will* allow for more responsive and flexible control of any Air Force, joint or comprehensive approach mission. CAOC commanders and Air Force staff *could* be located anywhere globally and still actively work in the virtual CAOC. This would allow a wider selection of trained personnel to be immediately available in times when surge capabilities are required for mission success.

Networks and data fusion *will* enable all future force generation training (individual, collective, tactical and operational) to be conducted, as needed, in synthetic and dispersed environments. Though not entirely replacing “hands-on” in-person training, education and evaluation, it *will* significantly reduce preliminary training costs.

<sup>96</sup> Ross Pigeau and Carol McCann, “Re-conceptualizing Command and Control,” *Canadian Military Journal* 3, no.1 (Spring 2002): 53-64. Available online at <http://www.journal.dnd.ca/vo3/no1/index-eng.asp> (accessed May 5, 2009). This concept is also discussed in Chapter 6 of Allan English and John Westrop, *Canadian Air Force Leadership and Command: The Human Dimension of Expeditionary Air Force Operations* (Trenton, ON: Canadian Forces Aerospace Warfare Centre, 2007). Available online at [http://www.airforce.forces.gc.ca/cfawc/eLibrary/eLibrary\\_e.asp](http://www.airforce.forces.gc.ca/cfawc/eLibrary/eLibrary_e.asp) (accessed April 24, 2009).

<sup>97</sup> In order for a virtual CAOC to be a viable possibility, absolute surety of connectivity is required. Revisionary methods must be in place to backup the virtual CAOC.

Networks *will* also allow campaign and future operational planning to be more thoroughly prepared before they are executed. Future networks *will* take advantage of collective wisdom and expertise to produce higher quality end products.

**Considerations.** Networks and data fusion *will* assist effective decisions to be made by any leader in the comprehensive approach to operations where timing will be most critical. Missions *will* demand near real-time decisions to address targets of opportunity for defensive and offensive engagements as well as pre-emptive missions. Finally, networks and data fusion *will* assist the decision makers to develop the political, legal and moral substantiation required to execute decisions quickly and effectively.

**Future Implementation.** Networks and data fusion *will* be implemented within the comprehensive approach to missions. The standardization of technical protocols for all military and non-military land, air and sea platforms (across the CA and with allies) *will* enable common network systems to be employed more effectively. This common network system with reachback capabilities (into various databases such as DND, GoC and Royal Canadian Mounted Police [RCMP]) *will* enable a virtual command system for the Air Force's flying assets as well as other all other assets and enablers.

## EC 2: AIR AND SPACE REGULATION



All military aerospace platforms (both manned and unmanned and regardless of size) that operate in or near controlled airspace *will* continue to be regulated (with respect to airworthiness, licensing the platform and operators as well as controlling access to the airspace) by Canada's Air Force. This enabling concept *will* continue to be shaped by the legal tenets of both national and international aerospace law. For example, this EC *will* drive the need for future command and control structures that must be able to cope with new aerospace platforms, many of which *will* be piloted by nontraditional air operators. Note that controlled airspace *will* include FL180 up to FL600.<sup>98</sup> Consequently, all non-civilian<sup>99</sup> aircraft and objects that regularly traverse this airspace (FL180 to FL600 above Canada) *will* also be regulated by Canada's Air Force.

98 FL180 is 18,000 ft above mean sea level. FL600 is 60,000 ft above mean sea level.

99 Non-civilian aircraft and objects include all manned and unmanned assets not licensed with NAVCANADA.

**Advantages.** Air and space regulation in 2035 *will* ensure a comprehensive and verifiable system involving policies and procedures that are in place to govern the expanded regions of air and space above Canada. It *will* include a comprehensive system of statutory law and have corresponding links to similar international controlling agencies. Canadian sovereignty *will* be exercised over all platforms transiting through Canadian aerospace. Therefore, all traffic—manned and unmanned—in Canadian aerospace *will* be governed by and subject to Canadian law and not solely the laws of the country or agency of origin.

**Considerations.** Air and space law *will* evolve to the point where an ICAO-type body *will* be established to govern outer space as well as uncontrolled areas between Class A airspace and outer space.<sup>100</sup> This EC is important to Canada's Air Force because of the growth of UAVs and the forecasted increased traffic into the higher-level regions above FL600. By having the Air Force take the lead in this realm, Canadian interests *will* be secured. Furthermore, a governing framework for the new Canadian space laws *could* be quickly implemented, as Canada's Air Force is already highly integrated with higher airspace controlling agencies such as NORAD.

**Future Implementation.** Air and space regulation by Canada's Air Force *could* be implemented by a planned, strategic extension of existing Canadian air law into the higher regions of space. Canada's Air Force should drive the procedural initiatives to lead the changes to the *Aeronautics Act* of Canada. These initiatives would build upon existing strengths and alliances that Canada's Air Force already has with other air and space controlling agencies. Once the *Aeronautics Act* of Canada is amended (to give the Chief of the Air Staff the airworthiness responsibilities for military aerospace platforms), the legal foundation for space control by CAS *will* have been implemented.

### EC 3: CAPITALIZING ON INDUSTRY AND CIVILIAN LEARNING INSTITUTIONS



CF photo by Sergeant Frank Hudec

<sup>100</sup> That is all altitudes above 60,000 ft.



In 2035, nearly all first-stage training (such as flying, maintenance and logistics) *will* be conducted by industry and civilian learning institutions. Canada's Air Force *will* administer first stage training quality assurance to confirm the relevance of the civilian training standards to Air Force requirements.

**Advantages.** It is believed that a significant number of Air Force positions can be saved by redeploying Air Force members to work in front-line areas that absolutely require a uniformed person. Teaming with industry and civilian learning institutions *will* strengthen the critical and mutually beneficial relationships among the Air Force, aerospace industry and learning institutions.

**Considerations.** Demographic projections indicate that by 2035 there *will* be fewer Canadians in the traditional age range from which to draw recruits. Consequently, teaming with industry and civilian learning institutions *will* be an important means for redirecting Air Force recruits into essential frontline Air Force positions. First-stage training *may* be more cost effective if provided by civilian agencies. The through-put time for military training *will*, therefore, be significantly reduced; at the same time, the production rate can be increased. This will transition qualified civilians into operational positions in a much shorter timeline and recognize the expertise that they bring to the Air Force.

Industry and civilian learning institutions are better positioned to conduct many tasks that are not central to the Air Force's prosecution of its operational missions. The Air Force, aerospace industry and civilian learning institution symbiotic relationship ensures that all will reap the benefits of cutting edge technology. This concept is not limited to first-stage training, but may also be applicable to other activities such as supply management, provided that the core operational capabilities are protected. In fact, many support and administrative capabilities will also benefit from technological advances and more agile, commercially available systems.

**Future Implementation.** Many aspects of this EC are already accepted. A phased approach of this EC with regular assessments to ensure that operational requirements are met is essential to ensure that the correct balance of outsourced and Air Force capabilities is established.

#### EC 4: EXPEDITIONARY AIR FORCE



CF Photo by Warrant Officer Serge Peters

An expeditionary Air Force capability enables global force projection and ensures that the Air Force can execute all types of missions anywhere and at any time. In the Canadian context, it *will* satisfy the following requirements:

- **Defending Canadians at Home.** This requirement includes advanced search and rescue as well as policing the air and space. It is envisioned that next generation ISR capabilities, many of which *will* reside in high altitudes or outer space, *will* be used to conduct the surveillance and policing activities across Canada's vast land and extended coastlines.
- **Arctic Air Force.** Satisfying this requirement *will* ensure that Canada's Air Force is able to operate permanently in arctic locations and, therefore, able to defend our territory and respond to sovereignty and emergency incidents throughout this region.
- **Sustainable Battle Rhythm.** Canada's Air Force units *will* be required to adopt a common, efficient and sustainable battle rhythm. This will ensure that units are at various readiness levels which will allow the Air Force to respond rapidly to all taskings and to sustain indefinitely any type of mission.
- **Space Capabilities.** Canada's Air Force must take a leading role in all Canadian space-based systems and programmes. By doing so, not only will the CF be interoperable with its allies, but the gap between air and space operations (in the areas above Canadian Class A airspace—above FL600) will be bridged.

**Advantages.** Expeditionary capable air forces will be the foundation for military relevance in the year 2035. The FSE and FOE indicate trends towards international missions in the urban and littoral regions within the arc of instability. The FSE also calls for a greater military presence in Canada's Arctic region. An expeditionary force *will* give Canada rapid, agile and balanced options when dealing with humanitarian situations as well as mounting operations anywhere along the spectrum of conflict.

**Considerations.** The Air Force *will* have to develop robust and variable capabilities in order to conduct expeditionary operations. With the heightened political interest with the Arctic, the Air Force *will* need to be prepared for the challenges that climate change *will* bring to this strategically important region of Canada. The increased transit of air, surface and subsurface vessels *will* increase Canadian domestic demands for search and rescue, surveillance and monitoring, border control, law enforcement and disaster response. The Air Force *will* need to consider the effectiveness of military systems, capabilities and platforms when operating in demanding environments.<sup>101</sup> The Air Force *will* be required to increase Arctic surveillance missions. Current Air Force forward operating locations (FOLs) in the Arctic may *possibly* become main operating bases (MOBs) in order to support the envisioned increase of air traffic.

**Future Implementation.** This EC *will* involve a gradual and successive adoption of expeditionary concepts. An expeditionary transformation plan for the Air Force which addresses issues (such as operations, support, administration and career paths) *will* have to be prepared. Furthermore, detailed conceptual and doctrinal designs for this capability *will* be needed.

101 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 38.

## EC 5: INTEROPERABLE, AGILE, MODULAR AND BALANCED AIR FORCE



Photo composite by CFAWC

Canada's Air Force needs to be able to operate seamlessly with all other CF elements, Government of Canada organizations, other militaries and NGOs. The Air Force command and control systems need to be modular so that they connect seamlessly with all these organizations. Furthermore, the systems need to be sensitive to differences in security, culture and communications. This EC *will* be achieved when the Air Force is:

- **Agile.** All units within Canada's Air Force must be agile enough to shift quickly from one mission type to another (i.e., peace support and counter-insurgency) and be able to sustain that operation until directed otherwise.
- **Modular.** Modularity is the evolution of interoperability. A modular Air Force provides basic building blocks for tailoring both Air Force development and capability. Every Air Force unit and individual must be postured (training, procedures and equipment) to seamlessly integrate into any JIMP functions within the CA. Both the individual and the unit *will* have the ability to fully integrate as needed.
- **Balanced.** Canada's Air Force must have a sufficient critical mass of key assets and resources (for example, trained people, effective equipment and reliable support systems) with a sustainable battle rhythm to participate in any type of operation for an indefinite period of time. Operations include regular and irregular warfare, domestic missions and missions in the space and cyberspace environments.

**Advantages.** This EC makes Canada's Air Force (both units and individuals) completely interoperable with all comprehensive approach players. A balanced readiness posture of command, units and individuals *will* position the Air Force to sustain indefinitely high-priority missions.

**Considerations.** Interoperability at the command, unit and individual level *will* be the key to success within the comprehensive approach. Greater interoperability (in terms of



communications, tactics, language, protocol and planning systems) among military allies *will* become an absolute requirement. All FSE and FOE analyses indicate that Canada *will* be a coalition member in future large-scale international operations. These analyses indicate that Canada's Air Force must always be ready to respond to a multitude of situations, from regular to irregular warfare as well as domestic, cyber and space operations in the physical, moral and informational domains. Responding to any combination of these situations *will* require an Air Force that is agile, modular and balanced.

**Future Implementation.** One of the most important elements of agility, modularity and balance is the alignment of battle rhythms. Canada's Air Force units *will* be required to adopt a common and efficient battle rhythm (which incorporates various levels of readiness) so that the Air Force can respond rapidly to and sustain indefinitely any type of mission.

## EC 6: ADVANCED WEAPONS



Photo composite by CFAWC

The advanced weapons of the year 2035 *will* be intelligent, accurate and lethal devices. The key to success in this EC *will* be keeping up with rapidly developing technologies and applications. Advanced weapons in the year 2035 *will* include fewer of the traditional “dumb” weapons and a greater number of sophisticated tools such as DEWs, highly directional electromagnetic pulse (EMP) weapons and intelligent DAS. All of these systems could be located under sea, on ground, in the air or in outer space.

**Advantages.** By operating from a high elevation point, the Air Force can deliver advanced weapon systems with precision effects (both kinetic and non-kinetic) to any location (ground, maritime [surface and subsurface], air and space) at any time. This precision will enable the Air Force to conduct military operations with the appropriate force, causing minimum collateral damage and thus avoiding public criticism. In fact, the ability to deliver kinetic power with surgical precision (i.e., absolute minimal collateral damage possible) *will* become the baseline standard for every modern military Air Force in the West.

**Considerations.** Public opinion *will* dictate that every military mission be capable of delivering kinetic and non-kinetic precision effects. The use of imprecise kinetic effects that incur collateral damage *will* increasingly become an impediment to any future mission. Advanced weapons *will* deliver precision effects. In order to optimize the continuous use of advanced weapon systems, a strategically managed support system throughout their lifecycles *will* be required.

It is envisioned that the Air Force *will* continue to be involved—along with the United States Air Force (USAF)—with defending the North American continent from both air breathing and non-air breathing threats.<sup>102</sup> Consequently, a suitable air interceptor platform *will* continue to be required. Any such platform should meet the following three key criteria:<sup>103</sup>

- It must contribute significantly to an air defence capability in North America.
- It must be interoperable with the USAF.
- When protecting Canadian expeditionary forces in operations both at home and overseas, it must be able to provide precision effects.

Finally, precision delivered support *will* become the new logistics of the future. Militaries are becoming more closely tied to defence contractors' logistics systems. Precision delivered support *will* make the Air Force more efficient, effective and agile. This EC becomes a force multiplier effect for EC 5 – Interoperable, Agile, Modular and Balanced Air Force.

**Future Implementation.** The mechanics for implementing this EC are already in place. The ongoing advances in technology and support systems *will* guide the progression of future capabilities that are derived from this EC.

## THE FIRST JET AIRCRAFT

Best known as a late-war weapon, the *Messerschmitt Me 262* was designed in April 1939 and became the world's first operational jet fighter. Although it received mixed support from many influential *Luftwaffe* officers, the Me 262 beat the first Allied jet into the skies by nine months.

Entering service in April 1944, the Me 262 was used in two primary roles. The Me 262 A-1a *Schwalbe* (Swallow) was a defensive interceptor, while the Me 262 A-2a *Sturmvolgel* (Stormbird) was a fighter-bomber. Although more than a thousand Me 262s were produced, only 200-250 ever made it to frontline squadrons due to shortages in fuel, pilots and parts.

With the end of hostilities in May 1945, the Allied powers scrambled to claim the remaining Me 262s. After studying that revolutionary aircraft, many design elements were subsequently incorporated into future fighters.

Despite its early design challenges, the Me 262 clearly signaled that piston-engine aircraft were no longer the dominant fighting machines. Once airborne, the Me 262 could accelerate to speeds in excess of 800 km/hr (which was 50 km/hr faster than any Allied fighter in the European theatre of operations).

The jet engine revolutionized the aircraft industry. It ushered in a new technological era that initiated the race to develop faster aircraft with newer capabilities. The rapid advances in aerospace technology spawned new tactics and ultimately changed the way militaries developed their campaign plans.



<sup>102</sup> Air breathing threats consist of jet-engine propelled platforms, while non-air breathing threats are rocket propelled platforms.

<sup>103</sup> Alexander Moens, "Canadian Domestic and Foreign Policy Determinants in 2020," in *The International System, Canada, Armed Forces and Aerospace power: 2018 and Beyond* Silver Dart Canadian Aerospace Studies, vol. V, ed. James G. Fergusson (Winnipeg, MB: University of Manitoba, Centre for Defence and Security Studies, 2009), 124.



## EC 7: RAPID, RELIABLE AND SECURE MOVER

Canada's Air Force is the provider of choice for the CF, GoC and CA teams; it can quickly move cargo, personnel and unique capabilities (such as the Disaster Assistance Response Team as well as major air disaster, communications and intelligence equipment) to any location in the world whenever tasked. Only the Air Force will be able to guarantee the reliable and uncompromised delivery of high-value cargo. The emphasis in the future *will* be placed on rapid and precision delivery. The choice of future platforms *will* be determined by the mission parameters such as cargo type, delivery time and threat environment.

**Advantages.** The ability to rapidly move personnel and supplies to any location in the world can only be achieved by the Air Force. Strategic airlift of the future *will* focus on precision delivery. Tactical airlift *will* be required in theatres of operations to safely move personnel and equipment within the theatre. All FSE and FOE resources indicate that the insurgents of the future *will* continue to use improvised explosive device (IED)-like weapons against UN, NATO and Western-led military ground forces operations. Hence tactical airlift of the future *will* require adequate DAS and protection.

**Considerations.** The military cannot continually lose personnel to IEDs during what *will* be considered routine movements. Therefore, casualties currently caused by IEDs *could* be reduced by future tactical airlift that features intelligent DAS.

The future support and resupply systems for international operations *will* involve strategic alliances to create a hub and spoke system for airlift as well as sea and land transportation centres.

At home, until land and sea routes are established, a combination of strategic and tactical airlift *will* be the only means to transport large amounts of personnel and supplies to the new communities and military establishments that *may* eventually open in Canada's Arctic.

**Future Implementation.** The hub and spoke system for airlift *will* be implemented around the world and *will* be used by various allied militaries. This system *will* include sea and land transportation links to connect all supply lines. In this manner, airlift (strategic and tactical) *will* be used to sustain military and CA missions.





## EC 8: OCCUPATION OF CHOICE

Canada's Air Force in 2035 must address human and cultural factors to overcome the recruiting challenges caused by educational and demographic trends, immigration and language. Infants of 2017 *will* be the new recruits of year 2035. FOE sources indicate that they *will* be born into a very fast-paced, network-enabled environment that is continually bombarded with excessive (both valuable and useless) information. Air Force occupations must therefore continually evolve to adapt to the technological, demographic and societal changes occurring globally.

**Advantages.** Being viewed by the general public as an occupation of choice *will* be the key feature that attracts new recruits into the military. The Air Force *will* remain a highly technical career option; however, given current demographic projections, attracting sufficient competent talent *will* pose a greater challenge. Retaining qualified personnel *will* continue to be important for the Air Force. Providing a consistently challenging and rewarding environment and being known as an occupation of choice *will likely* increase the retention rate of highly skilled Air Force personnel.

**Considerations.** Recruiting methods *will* have to be innovative, attractive, aggressive and bold. Appealing to potential recruits during air shows and air demonstrations *will* be exceedingly important. Reduced indigenous birth rates coupled with high immigration *will* continue to change the demographics of this country. Recruiting campaigns *will* be required to target all potential recruits regardless of gender, culture and background. Increasingly more military personnel who stay in the Air Force after completing their initial engagement *will* have broader family commitments. Additionally, many military spouses who are not in the CF have careers that are equally important, and sometimes more important, to the overall family well-being.

**Future Implementation.** Many novel human resources (HR) techniques *will* have to be implemented. Offering citizenship in exchange for a fixed period of service in the CF would be a positive method to increase the size of the Forces while at the same time instilling cherished Canadian values in new citizens. Other techniques *may* involve novel and highly flexible working arrangements, engagements and terms of service. Furthermore, retaining highly skilled personnel *will* have to be addressed through HR programs such as equitable and competitive pay, more predictable career progression and a balanced quality of life.

## EC 9: FORCE PRESERVATION



Future air forces delivering precision effects globally are *likely* to be more dispersed and consequently more vulnerable to asymmetric threats. Protection of personnel, resources and critical nodes at home and abroad *will* be pre-eminent. As the most valuable asset in the Air Force, personnel must be afforded every form of protection available to them. This necessity *will* drive the need for the future development of new force preservation capabilities, such as SERE, CSAR and other advanced methods for traditional SAR.

**Advantages.** Protecting critical nodes at home *will* enable the Air Force to succeed in all its missions. The critical nodes are those elements that directly provide key capabilities. FSE and FOE indicators suggest that terrorist tactics *will* utilize unrelenting and aggressive influence activities and *may* even target the families and other dependants of airmen and airwomen. Protection in deployed locations is another key enabler to sustaining deployed operations. The Air Force *will* have to provide CSAR capabilities for all Air Force personnel.

In the informational domain, protection against cyber attacks *will* enable the Air Force to continue operations through this medium. Any compromised node in the informational domain has the potential to degrade the quality and flow of information communications and, most importantly, the capability for accurate and timely data fusion.

**Considerations.** Novel methods of protecting against advanced weapons *will* be required. As a result, CSAR capabilities *will* become increasingly important as future operations *will* put more and more aircrews directly in harm's way. Finally, force protection at home *will* be key to sustaining all Air Force capabilities. Terrorist tactics *will* continue to evolve into more sophisticated and novel capabilities. For example, indirectly attacking a critical friendly node *will* perhaps generate better effects than attacking the force itself. The Air Force has to be able to provide protection against such threats.

**Future Implementation.** A comprehensive analysis of the critical nodes of each capability must be conducted. The results need to be mapped out to ensure that each future capability is protected and can be sustained.

## EC 10: PERVASIVE SEMI-AUTONOMOUS SYSTEMS



Photo composite by CFAWC

As technological applications become increasingly autonomous, not just in equipment but also in areas of its command, control and execution, the concepts of human agency and technology *will* evolve. Pervasive and overarching semi-autonomous systems *will* become increasingly interconnected and multi-tiered. Furthermore, highly intelligent semi-autonomous systems will all be controlled by key individuals, who are paired to the appropriate decision-making authority. This level of semi-autonomy *will* be achieved through effective knowledge management and data fusion that has a reachback capability into joint command and support systems.

**Advantages.** Autonomy provides greater stand-off capability. Fewer humans are placed in harm's way. Strategic effects (from the CA) can be realized quickly. Autonomous platforms and systems and data fusion *will* give strategic commanders the ability to tactically engage strategic targets that have a time-limited window of opportunity.

**Considerations.** Semi-autonomy or, in certain cases, complete autonomy *will* be a feature of all future platforms and systems. For this reason, a human agency (human in the loop) needs to be applied to ensure safety, accuracy, judgement and ethics. Since semi-autonomous and autonomous sensors and equipment are at the heart of systems that collect data and assist in its fusion, human agency *will* continue to be a part of the controlling process of those systems.

**Future Implementation.** Ensuring that there is a human in the decision-making loop *will* address the current and future concerns over who has the authority to deliver—and who is responsible for delivery of—effects.



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## IMPORTANCE OF THE HUMAN IN THE LOOP

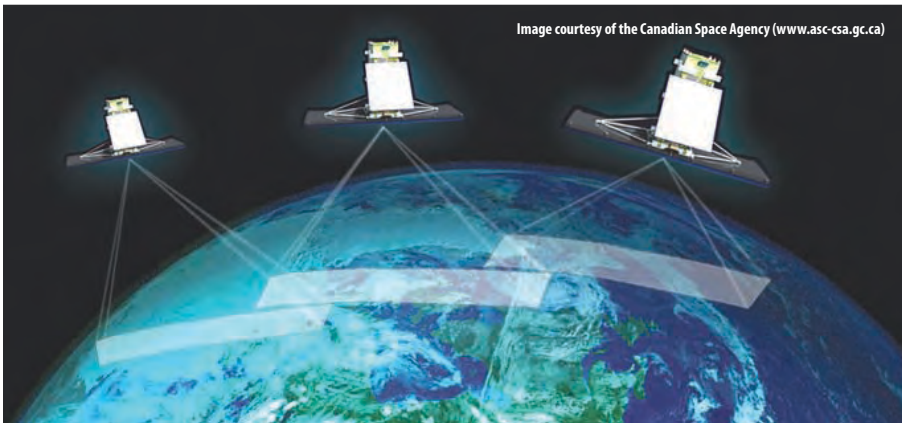
On 3 November 2002, the US Central Intelligence Agency (CIA) carried out an air strike against suspected al-Qaeda operatives in Yemen. The CIA used an RQ-1 Predator UAV that was equipped with surveillance equipment and armed with AGM-114 HELLFIRE air-to-surface missiles against a civilian automobile located 160 km east of the Yemeni capital of Sana'a, a location where al-Qaeda is considered active.

The HELLFIRE missile destroyed the vehicle and killed six suspected al-Qaeda terrorists. Riding in the destroyed vehicle was Qaed Salim Sinan al-Harethi (a prominent al-Qaeda leader in Yemen), Ahmed Hijazi (a US citizen) and four other people.

The CIA claimed that al-Harethi and his traveling party were military targets and used the Presidential authority to carry out covert missions against "combatants."

Some Western news agencies applauded the success of the mission and referred to it as a missile strike against al-Qaeda terrorists. On the other hand, other Western news agencies likened the event to that of an unauthorized assassination. As controversial as it was, the UAV had a controller with a live camera feed. In essence, a human—not the UAV—ultimately made the decision to fire the missile. The event exemplified the importance of a human in the decision-making sequence. Even though the UAV had a monitored live camera feed, legal concerns and accountability issues could never have been allayed without the human in the loop making the launch decision.

## EC 11: PERSISTENT HIGH-RESOLUTION SURVEILLANCE



Canada's Air Force sense requirements in the year 2035 *will* be vastly different than today's. Foreign aerospace, land and sea platforms *will* challenge Canadian sovereignty, and Canada *will* need an ability to sense these challenges. Many smaller sense platforms *will* replace traditional large-scale ones. Hence, there *will* be a greater need to monitor more individual and diversified targets. The projection of effects depends on actionable intelligence; therefore, advanced, persistent, high-resolution sense capabilities are essential.

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**Advantages.** Persistent, high-resolution, aerospace-based surveillance data provides the military and GoC with critical information that is strategical, operational and tactical but, where appropriate, are all merged together seamlessly. Persistent data equals “eyes in the sky.” It often provides the moral and legal precedence for initiating actions. With persistent and exploitable high-resolution data, the Air Force, other services and our government can protect Canadians and consistently make more effective decisions at the strategic and tactical levels.

**Considerations.** Persistent, high-resolution data provides a critical part of the actionable intelligence needed for initiating decisive action. In the air-to-ground role, long-loitering UCAVs are considered a highly promising instrument of force for combating counter-insurgency and counterterrorism in the future.<sup>104</sup> The 2006 US *Quadrennial Defense Review Report*<sup>105</sup> called for less emphasis on major new platforms and an increased emphasis on mobility, special forces and UAVs.<sup>106</sup> Future surveillance assets *will* be able to provide both raw and highly refined data for fusing with information and knowledge from various assets in all environments.<sup>107</sup> Considering the length of Canada's borders, the scope of its national waters and airspace, the value of both airborne and maritime trade and the impending opening of the Northwest Passage, the importance of maritime and aviation security *will* only increase.<sup>108</sup> The Air Force *will* be called to provide surveillance or assist other services in patrolling **all** our coastlines in order to protect both continental and international trade routes from disruption.

**Future Implementation.** Persistent, high-resolution data *will* be developed incrementally by exploiting the advances in various technologies. The Air Force must exploit sensors, autonomous UAVs, space-based systems and other sense collection capabilities to achieve and maintain its strategic, operational and tactical advantages.

## FUTURE CAPABILITY REQUIREMENTS

As a key instrument of the Government of Canada and the Department of National Defence, Canada's Air Force in 2035 *will* need to project power through precision effects. In order to achieve this, Canada's Air Force must be combat effective and agile and be capable of playing a central role in the comprehensive approach to operations. The Air Force *will* have to deliver many of the capabilities listed in Chapter 5 of the 2007 version of B-GA-400-000/FP-000 *Canadian Forces Aerospace Doctrine*<sup>109</sup> as well as a number of new ones that will result from the capability requirements identified through the 11 ECs.

The precise platforms, equipment and resources that Canada's Air Force *will* require in the year 2035 cannot be absolutely defined today. However, the trends and drivers mentioned in the first two parts of this study *will* ultimately influence the development and implementation of future concepts and doctrinal designs that the future Air Force will probably pursue.

The future capability requirements list simply proposes what the Air Force *will* require to remain strategically relevant, operationally responsive and tactically decisive in the FSE and FOE. The following section is not intended to be all-inclusive or exhaustive in nature. Its only intent, however, to summarize the key capabilities that Canada's Air Force would have

104 Sloan, “The Role of Aerospace Power 2018 and Beyond,” 148.

105 Available online at <http://www.defenselink.mil/qdr/> (assessed March 30, 2009).

106 Richter, “Conflict Scenarios, Airpower, and the Use of Force,” 160.

107 Canada, DND, *Objective Force 2028*, 12/19.

108 Canada, DND, *Future Security Environment 2008-2030 Part 1*, 19.

109 Available online at [http://www.airforce.forces.gc.ca/cfawc/cdd/Publications/B-GA-400-000-FP-000\\_e.asp](http://www.airforce.forces.gc.ca/cfawc/cdd/Publications/B-GA-400-000-FP-000_e.asp) (accessed March 30, 2009).

if the 11 enabling concepts are implemented successfully. Using the Air Force functions as the framework, FCRs are discussed in terms of:

- new capabilities that will be required;
- current capabilities that will no longer be required; and
- current capabilities that will continue to exist in 2035, but that will undergo significant changes.

## THE ARROW VERSUS THE BOMARC – SELECTING THE RIGHT WEAPON SYSTEM



*The government . . . has made a thorough examination in the light of all the information available concerning the probable nature of the threats to the[sic] North America in the future years, the alternative means of defence against such threats, and the estimated cost thereof. The conclusion arrived at is that the development of the Arrow aircraft and Iroquois engine should be terminated now.<sup>110</sup>*

- Prime Minister Diefenbaker, February 20, 1959, Announcement in the House of Commons

Canada's response to the Soviet Union fleet of long-range bombers was the CF105 Arrow. Designed and built by Avro Aircraft Limited, it was considered to be both an advanced technical and aerodynamic achievement for the Canadian aviation industry. The Arrow held the promise of Mach 2 speeds at altitudes higher than 50,000 feet.

Unfortunately, the development and deployment of large numbers of intercontinental ballistic missiles (ICBMs)—that could not be intercepted by any technology available at the time—made visions of squadrons of Arrows streaking in over the Arctic obsolete. Furthermore, the Boeing aircraft company was developing the Bomarc anti-aircraft missile which was promoted as a cost-effective alternative to manned interceptors to defend against intruding bombers. (It too could not intercept ICBMs.) With the signing of the NORAD agreement in 1958, Prime Minister Diefenbaker committed Canada to buying the Bomarc missiles while tentatively retaining the Arrow program. It was said that Canada could afford the Arrow or the Bomarc, but not both.

In 1959, the government abruptly cancelled the Arrow and its accompanying Orenda Iroquois jet engine program and ordered the scrapping of all planes. The reasons given for the Arrow's cancellation are diverse and depend on who is asked. Rising costs and the perceived shift from a Soviet bomber to an ICBM threat are often cited as the main reasons for the cancellation.

"Reading" the future is not an easy task. Lieutenant-General Guy Simonds, who had just retired as Chief of the General Staff, argued that the Arrow would be obsolete before becoming operational because of advances in missile technology. As it turned out, the Bomarc program was plagued by many technical difficulties and never proved effective. As for manned interceptors, it is likely that they will still be around until at least 2035.

110 Carl Moore, "The CF-105 Arrow Story: Destruction of a National Dream and a Nation's Pride." Avro Aircraft, <http://novaonline.nvcc.edu/cli/evans/his135/Events/Arrow59/Arrow59.html> (accessed April 30, 2009).



## COMMAND

There *will* still be a need to have direct or implicit command authority in the decision-making loop in the Air Force of 2035. In the high-paced tempo of active operations where connectivity cannot be assured nor decisions made in “real time,” reliance on commander’s intent *will* give the decisive advantage. Nascent AI and semi-autonomous systems *will not* yet have the required fidelity or the moral foundation to be permitted to proceed autonomously. Future commanders *will* be required to be multi-skilled, broad-minded, imaginative and culturally intuitive and to have a full understanding of the breadth of joint, coalition, combined and OGD operations within a comprehensive approach. Furthermore, commanders *will* require the training and skills that *will* allow them to contribute to and to lead, when necessary, these operations. In the future, professional development to prepare senior commanders *will* have to be interdisciplinary and involve all government departments, NGOs and other partners working collaboratively.

For the doctrine of commander’s intent to have relevance, all levels of the organization *should* be imbued, through professional development and practice, with the spirit and vision of the commander so that individuals and teams are enabled and encouraged to react intuitively and appropriately in the absence of orders. In the purest application of commander’s intent, subordinates *will* intuitively seize the initiative, exploit opportunities and react rapidly as the physical manifestation of the commonly understood commander’s will in the battlespace. The unity of a clear appreciation of the commander’s objectives, empowered and capable subordinates, operating within a shared situational awareness, *will* give that entity the confidence, vigour and agility to deal rapidly with unforeseen and unforeseeable opportunities and situations. All must become capable of operating in a flattened, matrixed command structure. The fundamental precondition for realization of commander’s intent is the establishment of unquestioned mutual reliance—trust. Once this desired preparatory end state has been achieved, commanders must be prepared, whenever appropriate, to delegate large elements of discretion and authority to subordinates.

Joint headquarters facilities at the strategic, operational and tactical levels *will* have to be rapidly deployable and interoperable to meet the operational needs of the future. The headquarters *will* provide the command and control necessary to direct and monitor operations and force-generation activities, as well as the facilities required to support and interact with partners within the comprehensive approach.<sup>111</sup>

The Air Force of the future *will* require a virtual CAOC. Reliable and real-time communications and imagery as well as effective data fusion *will* enable the real-time sharing of multiple databases (such as military, RCMP, GoC and NGO). Accessing these databases in real time when a target of opportunity is “on screen” *will* provide the commander or GoC authority with the actionable intelligence needed to immediately execute the most appropriate decision by reaching out directly to the shooter on the ground. This concept essentially teams the tactical general with the strategic corporal when and where it makes sense to do so. However, in the absence of assured and reliable connectivity, a solidly-established commander’s intent will be the best and most effective approach to utilize in both a high- or low-data, live-fire environment.

The required governance of all aerospace vehicles, due to their profusion and capabilities, *will* compel all sovereign states to agree to a common control agency for aerospace objects above their territory. Eventually, air and space law *will* evolve to a point where a national and ICAO-type body *will* govern Canadian assets in space and the uncontrolled area between Class A space and outer space.

111 Canada, DND, Objective Force 2028, 10/19.

The Air Force of 2035 *will not* have the need for traditional landing systems. Technological advances in navigation and reliable, semi- or fully-autonomous landing systems *will* displace traditional military and civilian ATC systems at airports (i.e., terminal radar, VOR/ILS, etc.). Emerging technologies in these areas *will* include self-deconflicting with self-healing capabilities within the next generation of satellite-based airport landing systems. These *will* provide real-time 3D positional updates and ground-based systems such as Automatic Dependent Surveillance-Broadcast (ADS-B) and its successive developments. These emerging technologies *will* be revolutionary or disruptive in nature, not only displacing the existing hardware platforms but also the people that control them. Once incorporated, these disruptive technologies *will* obviate the need for the traditional air traffic controller. There *will*, however, be a need for rapidly deployable military aircraft landing systems for operating in remote and austere areas.

New Command Capabilities	Current Command Capabilities With Significant Changes	Current Command Capabilities No Longer Required
Virtual CAOC	Commander's Intent	Traditional Landing Systems
Lead Controlling Agency for Canadian Military Space Platforms and Equipment	Deployable Landing Systems	
Real-time Command versus Semi-autonomous Systems	Joint Headquarters Facilities	
	Commander's Intent and the CA	

Table 3-2: Command Future Capability Requirements

SENSE

The ability to sense across the informational domain has to be maintained and *will* need to adapt to rapidly emerging and increasingly sophisticated threats in the future. The sensing capabilities in this domain *may* focus on pre-empting cyber attacks against Air Force information systems. This ability *will* be a subset of the CF's strategies and activities in the cyber domain.

Considering the size of Canada's coastline, the value of maritime trade and the distinct possibility of the greater opening of the Northwest Passage, the importance of maritime security *will* also increase. The Air Force *will* be called on to provide surveillance or assistance to other services in patrolling all coastlines in order to protect both continental and international trade routes from disruption and to maintain our territorial sovereignty.

The full spectrum of data *will* be delivered seamlessly from any node in the comprehensive approach to any operating location and *will* be managed by an AI machine operating in a sealed, self-healing network. The exchange of the full spectrum of data from small battlefield and airborne sensors, immediate operational and tactical planning information, as well as information residing in CA team databases to various environmental, logistical and technical databases *will* be processed in near real time. Intelligent AI systems *will*

extract relevant information and *will* make this real-time information available to those who need it. The networked data that is pushed to or pulled from the system *will* be highly refined and discriminantly filtered by AI systems to ensure maximum fidelity. However, human judgement and intuition *will* still be required to translate this refined data into reliable, actionable information, particularly when highly-consequential decisions are based on it or when the use of lethal force is a potential consequence. AI *will* augment, not replace, commanders' and staff decision making.

As outlined in Part 2: The Future Operating Environment, ISR collectors *will* be smaller and *will* deliver more and higher-resolution data. There *will* be a requirement for tactical, micro, unmanned, airborne sensors possessing networked and swarming abilities. Flexibility and full spectrum coverage *will* be possible by employment of these sensors singly or in semi-autonomous groups, or as augmentations to manned airborne sensing / command and control platforms.

Manned airborne sensing platforms used solely to conduct airborne surveillance at altitudes up to FL400 *will not* be required. In their place there *will* be high-altitude, unmanned, airborne sensory platforms (self-positioning and long-enduring) that conduct persistent surveillance at altitudes up to FL400 over Canadian territory and theatres of operations. These *could* be located in near-space or in space, as well as on civilian and/or military satellites. Persistent surveillance (real-time situational overview of the environment) *will* drive the change toward unmanned vehicles. Manpower formerly dedicated to these tasks *may* be reallocated to the deployment and data exploitation of these systems on the ground. The flexibility and freedom of movement given by the reach of these platforms into more high-risk scenarios *will* be a valuable force multiplier and capability extender where the high-probability loss of sensing platforms *will not* entail the loss of the lives of a crew.

Common Modular Sensing Systems *will* be installed on all aerospace platforms (manned and unmanned) and *will* be interoperable with those of our allies. The flexibility that their modularity provides *will* enable real-time data collection from any platform and *will*, therefore, continuously build a real-time common operating picture anywhere air and space platforms are operating. This capability *will* be a force multiplier as improvements in the availability, speed and loiter times of sensing platforms are increased.

New Sense Capabilities	Current Sense Capabilities With Significant Changes	Current Sense Capabilities No Longer Required
Seamless Network Architecture	Common Modular Sensing Systems	Manned Airborne Sensing Systems
Real-time Data Fusion	Maritime Surveillance	
ISR Collectors		
Informational Domain		

Table 3-3: Sense Future Capability Requirements



## SHAPE

The precise delivery of lethal and non-lethal weapons in crowded urban and littoral regions *will* be needed. Ground- / air-to-space weapons that deliver precision effects *will* employ advanced sensing capabilities and the use of overwhelming firepower in a “shock and awe” scenario *may* only be useful when dealing with concentrated hostile forces. Proportionality and the inflicting of minimal collateral damage, not just on non-combatants but—increasingly—no more than is necessary to neutralize hostile combatants, *will* be decisive in winning and retaining the “hearts and minds” of those supportive of our efforts, those who are neutral, or even those who are presently hostile. For all these reasons, the Air Force *will* increasingly use DEW as part of the achievement of precision, proportionality and minimization of collateral or unacceptable damage. As well, multi-tiered airborne systems that include mostly unmanned platforms *will* also provide reachback capabilities to link front-line forces with command elements.

In order to operate in the comprehensive approach and with allied nations, a modular and interoperable Air Force *will* be required. This capability acts as a force multiplier by exploiting existing capabilities and allowing them to be employed more effectively in a wide variety of areas. As a result, Canada *will* have more options when projecting its air power. It is already known that the Air Force *will* be required to increase Arctic surveillance missions. To meet this requirement, current Air Force FOLs in the Arctic may *possibly* become MOBs in order to support the increased air traffic and the relocating/forming of a SAR unit in the Arctic, which could *possibly* become a necessity as populations and traffic increase. The Air Force *will* also have to develop a robust capability to conduct operations in emerging environments, such as cyberspace and outer space.

The activities associated with persistent surveillance and lengthy loiter times *will* be conducted more effectively by space-based and unmanned aerospace platforms, eliminating the need for manned aerospace platforms that currently conduct long-range antisubmarine warfare missions. Advances in technology, coupled with the increased rejection of the risk of loss of human life, *will* make possible and desirable the full exploitation of unmanned combat aerial vehicles for dangerous missions. This *will* encourage the development of unmanned aerospace platforms to conduct most routine missions or “high-risk delivery of kinetic effects.”

Some current Shape capabilities *will* undergo significant changes to meet the needs of our future Air Force. With the introduction of new technologies such as ADS-B, the potential for threats against civilian aviation and public infrastructure *will* increase significantly. Consequently, the requirement to police civilian airspace in Canada *will* increase, so much so that air defence assets *will* be required near every major metropolitan area. The high-density controlled airspace *will* still require manned operators to conduct aerospace policing activities. It remains unlikely that developments in sensing technology can entirely replace the inherent tactical capabilities of a pilot (in an aerospace policing platform) in visual contact with the pilot of another aerospace platform.

Finally, Canada's Air Force *will* continue to be involved—along with the USAF—in defending the North American continent. Consequently, a suitable air interceptor platform *will* still be required for the foreseeable future. Any such platform should meet three key criteria:<sup>112</sup>

- be interoperable with the USAF;
- participate substantively in defending North America; and
- be able to provide protection and ground support to expeditionary forces in operations overseas.

112 Moens, “Canadian Domestic and Foreign Policy Determinants in 2020,” 124.

New Shape Capabilities	Current Shape Capabilities With Significant Changes	Current Shape Capabilities No Longer Required
Precise Application of Force  Modularity  Greater Permanent Presence in the Arctic Region  Capabilities in Emerging Environments	Policing of Civilian Airspace  Fast-Moving Manned Aerospace Platforms that have to Operate in Controlled Airspace  Air Interceptor	Manned Aerospace Platforms that Conduct Long-Range Antisubmarine Warfare Missions  Manned Aerospace Platforms that Conduct Most Routine Missions or High-risk Delivery of Kinetic Effects

Table 3-4: Shape Future Capability Requirements

## MOVE

The Air Force *will* be the provider of choice for the GoC, CF and CA team because of its unique capability to quickly move cargo and personnel to any location in the world. To meet its future taskings the Air Force *will* also require a near-space / space airlift that uses novel techniques and a system that *will* allow highly precise and accurate (both high and low altitudes) airdrops. Manned aerospace platforms that transport and deliver cargo into high-risk areas *will* be progressively replaced by UAVs and precise airdrop systems. The advent of new nanotechnologies, fuel sources, lightweight materials, lighter-than-air platforms (i.e., aerostats), exploitation of other strata—including orbital and sub-orbital—*will* all allow for expeditious placing and delivery of capabilities when and where required. In the foreseeable future, it is *likely* that personnel will continue to be moved with manned platforms, while UAVs *will* be widely used to transport and deliver cargo. Beyond 2035, it is *possible* that routine troop (and domestic airline) travel will be made by pilotless crafts.

Most sources and projections indicate that strategic airlift capability (which *will* include next generation aerospace platforms that traverse higher altitude to deliver heavy lift) *will* grow. These platforms *will* allow for high-volume, long-range and heavy-weight airlift. This capability *may* also include large unmanned aerial vehicles that can precisely deliver cargo into high-risk areas.

Indications are that tactical airlift capability requirements *will* grow. Future adversaries *will* continue to target troops and supplies moving via the ground. Hence, there *will* be an increased reliance on the tactical airlift of troops and supplies into austere locations. However, it would be unwise to think that determined efforts will not be made to frustrate those efforts. This *will* be enabled by the requirement for increased agility that *will* be addressed by hub and spoke logistics strategies that ensure rapidity, stealth, security, speed and precision, while reducing in-country footprint.

Air refuelling capability *will* still be required, but the type of platform and method of delivery (manned or unmanned) *will* be determined by the degree of persistence and reach that *will* be required to achieve the desired effects.

New Move Capabilities	Current Move Capabilities With Significant Changes	Current Move Capabilities No Longer Required
Comprehensive Approach Mover  Near-Space / Space Airlift  Air Drop	Manned Aerospace Platforms to Deliver and Evacuate Personnel  Strategic Airlift  Tactical Airlift  Air Refuelling	Manned Aerospace Platforms that Transport and Deliver Cargo Into High-risk Areas

Table 3-5: Move Future Capability Requirements

SUSTAIN

All Air Force systems, capabilities and platforms must be sufficiently robust to continuously operate in various environmental extremes in support of expeditionary operations. Hub and spoke logistical approaches *will* be a key sustain capability for the Air Force in 2035. Strategic political alliances *will* determine the placement of the hubs and the spokes, and therefore, the logistical support systems that will be employed for sustaining lengthy deployments.

The way the Air Force trains *will* also be changed in the years to come. The future Air Force *will likely* have nearly complete reliance on industry and civilian learning institutions for all types of first-stage training. There *will* still be a requirement for second-stage training systems and all follow-on training; however, for both individual and collective training, they *will* be increasingly replaced or enhanced by full spectrum synthetic simulators.

Most sources and projections indicate that there *will* be an increased need for force protection both at home and in deployed locations. The activities associated with this capability *will* have to be conducted by Air Force personnel and assets.

It is also envisioned that there *will* be an increased need for CSAR capability to support international operations. Responding to the future security environment in the urban and littoral regions throughout the arc of instability, Canada's Air Force *will* be expected to provide this capability to the CA team members in deployed areas.

Increased pressure to establish a real presence throughout the immensity of the Arctic, through military and commercial activity, to protect our sovereignty and discourage encroachment, points to greater future activity in this area. Given the distances and fragility of this environment, air assets *will* be required to connect and supply widely separated areas and to minimize ecological disturbance. The harshness of this environment demands that SAR resources be commensurate with the increased activity essential to support the continued economic and population growth, prosperity and connectedness of this area. This *will* entail changes in the current Air Force methods of search, if not rescue, in the years to come. Due to the ongoing nature of many missions as well as the persistence offered by space assets and UAVs, these platforms *will* displace the need for manned airborne searches. The rescue portion of the SAR mission, however, *will* still be carried out by manned aerospace platforms. Consequently, a combination of manned and unmanned aerospace platforms *will* be used to conduct domestic SAR.



Appealing to potential recruits during public outreach events and in the virtual world *will* become exceedingly important, as the Air Force *will* be competing for a shrinking segment of the labour force that *will* be eligible for military service. Air Force commanders *will* require greater interaction with Canadians to promote the Air Force as an occupation of choice and as an entity vital to the preservation of the social, economic and cultural interests of all Canadians.

New Sustain Capabilities	Current Sustain Capabilities With Significant Changes	Current Sustain Capabilities No Longer Required
Hub and Spoke  Integration of Defence, Industry, and Civilian Learning Institutions  Synthetic Environments  Force Protection  CSAR	Second-Stage Training Systems and all Follow-on Training  Domestic SAR with Permanent Expansion into the Northern Arctic Region  Air Demonstrations  Expeditionary Operations  Connecting with Canadians	Legacy First-Stage Training Systems  Manned Aerospace Platforms Used to Conduct the Search Portion of SAR Missions

**Table 3-6: Sustain Future Capability Requirements**



**In 2035, most traditional first stage training will be replaced by advanced simulator and virtual reality systems.**

## AIR FORCE CAREER FIELDS TO BE REFINED

All sources and projections indicate that Air Force career fields will also be affected by the trends, drivers and ECs discussed thus far. New career fields will emerge; some will be displaced by technology; others will evolve. This section highlights the career fields that are most *likely* to change.

The following new career field will emerge:

- **UAV Operator.**<sup>113</sup> The UAV operators must have a thorough knowledge of controlled airspace procedures and *will* be required to hold an appropriate license.

The following current career fields will be displaced by technology:

- **Flight Engineer.** The onboard flight engineer (FE) *will* no longer be required. The in-flight functions performed by the FE *will* be completely displaced by technology. The ground functions performed by FEs *will* be performed by ground crew as well as integral aircrew when access to ground support is limited.
- **Air Combat System Officer (ACSO).** This career field will be displaced as technological advances (including semi-autonomous AI systems) perform the flight navigation and combat systems functions.
- **Miscellaneous.** Various occupations that provide pure support services *will* be displaced by technology and non-military personnel. The need to employ “blue suits” in all positions that provide support functions (logistics, engineering, contracting, etc.) *will* have to be re-examined to determine the value these occupations provide. Due to the demographic challenges of 2035, all serving military personnel *will* be in high demand to fill front line positions. Consequently, behind the scenes support services *will* have to be provided by other means.

All Air Force career fields will continue to evolve to meet the Air Force’s current and emerging needs. Specifically, the following current career fields will, or have already started to, evolve:

- **Aerospace Controllers** *will* take on space control duties.
- **Pilots** of manned aerospace platforms and operators (i.e., ACSOs) of unmanned aerial vehicles *will* merge into one occupation with two related but distinct specialties.
- **Support Career Fields.** Key support occupations (aerospace engineers and logisticians) *will* merge into one occupation. Human resource specialists, currently grouped with Logistics, should merge with like career fields (such as training development and personnel selection) to form a human dimension career field that may also include health services. The advances in technology, the integration with industry and the shortage of personnel to recruit into the military *will* drive these changes. With the trends shifting towards more joint operations, the Air Force support trades *will* become more capable of interacting with all CF environments.

## CONCLUSION

All eleven ECs are the transformational instruments that will position Canada’s Air Force to succeed in the 2035 FSE and FOE. The ECs that hold the greatest momentum for transformational optimization are: Networks and Data Fusion, Air and Space Regulation as well as Pervasive Semi-autonomous Systems.

<sup>113</sup> Currently, the Air Force employs ACSO in this function. The future requirement may be a new classification of unmanned aerial vehicle pilot.

**Networks and Data Fusion** *will* transform traditional command and control methods into intelligent, real-time systems that can gather vast amounts of data, conduct critical analysis and instantly recommend optimum actions with the appropriate legal authorizations.

**Air and Space Regulations** *will* establish Canada's Air Force as the internationally recognized and legal entity that regulates and controls aerospace platforms that transit through the currently uncontrolled regions of air and space over Canada.

**Pervasive Semi-autonomous Systems** *will* inject the necessary "human in the loop" requirements to effectively utilize unmanned platforms, artificial intelligence and fully autonomous equipment.

This part has also identified many new capabilities that Canada's Air Force must possess to succeed in the future. The key elements within the new capabilities that enable Canada's Air Force to achieve its overarching concept include:

- **Strategic Pairing.** The key element inherent within the execution of all capabilities is strategic pairing.
- **Precision.** All capabilities *will* be delivered in a precise manner.
- **Persistency.** Based on the type of information being gathered, the need for persistency *will* determine the most appropriate platform for each mission.

Based on the FSE and FOE sources, it is inherently clear that the following capabilities *will* no longer be required by the year 2035:

- traditional ATC systems at military airports;
- manned aerospace platforms that are used to conduct routine or long-endurance data-gathering missions; and
- traditional Air Force activities (such as first-stage training, secondary and tertiary weapon system support functions as well as various administrative functions) that do not absolutely require "blue suit" personnel to conduct them.

The future capabilities of Canada's Air Force *will* be enabled by new and evolved career fields. The traditional onboard flying careers we know today *will* change into ones that focus on piloting manned, unmanned or outer space platforms. The traditional specialty occupations of logistic, engineering and support systems *will* evolve into one general weapons system support occupation. Human dimensions will emerge as a comprehensive, all-inclusive career field that addresses the full range (including, but not limited to, physical and cognitive aspects) of personnel employment and management.

Other significant items that deserve mention include the following:

- Canada's Air Force will transition to include space-based activities.
- There will be greater emphasis on protecting critical Air Force assets at home, in deployed locations, in the cyber realm and in space. Protecting critical assets includes those in the physical, moral and informational domains.
- A new command and control tool *will* be developed. The virtual CAOC *will* process real-time data and provide appropriate and timely decisions with the legal authorization to execute them.
- Interoperability *will* evolve to include modularity at the command, unit and individual levels. Headquarters, units and individuals *will* all have the necessary training, equipment and skills to immediately interface into any CA or allied mission.
- There will be greater Canadian presence in the Arctic.



This part has examined in some detail the broad range of future capability requirements that *will* drive future Air Force development. As the FSE and FOE further shape Canada's national security needs over the next two decades, the Air Force must be prepared to present a range of options in support of those needs for its own medium- and long-range development. The FCRs presented here *will* inform future Air Force conceptual and doctrinal design in broad terms and *will* provide a substantial baseline for further present day war gaming, experimentation and analysis. Above all else, these future capability requirements are demonstrative of a professional, volunteer Air Force that thinks ahead, anticipates risk and mitigates as much as possible the many challenges that lie ahead.

# CONCLUDING REMARKS

It almost goes without saying that the world is an ever-changing and dynamic place. As such, DND and the CF have committed themselves to adapt proactively as new challenges and risks to Canadian national security emerge, both at home and abroad, in both clear and uncertain circumstances. It is impossible to know with absolute certainty what challenges Canada's Air Force will face in the year 2035, but that uncertainty cannot serve as an excuse for not attempting to anticipate those challenges and mitigate those risks.

The presentation of conceptual and doctrinal ideas for debate, as well as the creation of future Air Force constructs, is critical to the long-term development of Canada's Air Force. Led by the CAS and executed by the Canadian Forces Aerospace Warfare Centre, conceptual and doctrinal design is fundamental to the development of force employment concepts and methods needed to validate future air power capabilities and requirements.

To this end, *Projecting Power: Canada's Air Force 2035* was written to assist Air Force leaders, thinkers, designers and their staffs. Beginning with a working group and further developed through broad ranging research and consultation, this study articulates a conceptual framework of what the future air environment *may* resemble in the year 2035. More importantly, it provides a foundation for reasoned speculation and debate and offers a think piece for considering future air enabling concepts and capability requirements.

Therefore, the following observations and recommendations are worth noting as the closing pages of this document are turned:

- A commitment must be made to creating an innovative, challenging, robust and sustainable strategic concepts and doctrinal design community within the Air Force, focused on future force development.
- The Air Force role is to act as an instrument of sovereignty and national will at home and abroad. To accomplish this role, Air Force missions fall primarily in the crucial areas of air defence, close air support to ground forces engaged in combat, ISR, tactical and strategic lift to theatre as well as tactical lift within theatre. Historically, these have been enduring missions; they are not expected to change in the future. However, how they are delivered in 2035 *may* be very different to what we are accustomed to seeing.
- Though human aviators *will* remain essential to the Air Force for decades to come, UAVs promise to progressively overtake traditional human piloting tasks in a greater number and variety of mission areas.<sup>114</sup>
- Perhaps not by 2035 but definitely by mid-century, unmanned flight—like many of today's subways that do not have an operator on the train—*will* have precedence in all operations that are routine (such as ISR as well as tactical and strategic lift) or that occur at extreme limits of human tolerance (such as extreme g-forces and long endurance). The Air Force is faced with the question: In a service that defines itself largely through its pilots, what would aerospace power become without them?<sup>115</sup>
- Moving further into the 21<sup>st</sup> century, it is clear that the importance of traditional manned aircraft *will* further decline. It is *likely* that fifth generation aircraft such as the joint strike fighter *will* be the last manned fighter aircraft that Canada *will* purchase for some time.

114 STRATFOR, "U.S.: An Existential Move for the Air Force."

115 Ibid.

- Emerging missions—from unmanned systems to outer space and cyberspace—are bound to play an increasingly pivotal role in the future beyond 2035.
- In the future, and given the increasingly globalized and interdependent world, each dimension in the web of conflict promises to encompass more actors, more motivations as well as more varied strategies and means of achieving the goals of those involved.
- Throughout human history—and far more so in the future than in the past—conflict and its conduct *will* continue to be defined less by actions within the physical domain; there *will* be more emphasis on activities within the moral and informational domains. In short, if the current trend continues, the conceptual and psychological *will* increasingly eclipse the physical as the main battlegrounds in future conflict. This *will* make the human dimension of conflict even more salient and significant.<sup>116</sup>

In conclusion, this study must not be perceived as the **final word**. Instead, it is a benchmark from which to **begin** the development of the future Air Force. Many other studies must follow this one, each further fostering a culture of Air Force innovation and creativity that is tolerant of new ideas and is willing to accept informed risk. Combined with imaginative and forward thinking leadership, the Air Force *will* ensure that it chooses its own destiny—as an instrument of Canada's will—rather than resigning itself to simply reacting ineffectively to inevitable global change.

116 "Broadsword or Rapier?," 2.



# IT'S YOUR AIR FORCE – GET INVOLVED IN ITS FUTURE!

*Projecting Power: Canada's Air Force 2035* is not the end of the debate; rather, it is only the beginning. The Canadian Forces Aerospace Warfare Centre depends on engagement from the entire Air Force community to achieve its force development goals. That means any Air Force member—aircrew or ground crew, operator or supporter—*may* play a positive and important role in the Air Force's overall development.

Hopefully this document has given you pause for thought, but more importantly, has stirred your desire to consider and debate the many issues presented within it. We encourage you to write or email us directly with your comments. As well, you can express both ideas and opinions on any aspect of the future Air Force in the pages of *The Canadian Air Force Journal* (available online at [http://www.airforce.forces.gc.ca/cfawc/eLibrary/Journal/Current\\_Issue\\_e.asp](http://www.airforce.forces.gc.ca/cfawc/eLibrary/Journal/Current_Issue_e.asp)).

## Further ideas and comments may be submitted in hard copy to:

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Alternatively, we can also be reached on the DIN at [http://trenton.mil.ca/lodger/cfawc/index\\_e.asp](http://trenton.mil.ca/lodger/cfawc/index_e.asp) and the internet at [http://www.airforce.forces.gc.ca/cfawc/index\\_e.asp](http://www.airforce.forces.gc.ca/cfawc/index_e.asp). Click on the Projecting Power 2035 button to submit your comments.

# GLOSSARY

The definitions contained in this glossary are derived from a number of sources. Where this publication is the source of a definition, no source is indicated. Definitions taken from other sources are indicated in parentheses at the end of each term, utilizing the following abbreviations:

AFTWG – Air Force Terminology Working Group;

B-GA-400 – *Canadian Forces Aerospace Doctrine* (B-GA-400-000/FP-000), found online at [http://www.airforce.forces.gc.ca/cfawc/cdd/Publications/B-GA-400-000-FP-000\\_e.asp](http://www.airforce.forces.gc.ca/cfawc/cdd/Publications/B-GA-400-000-FP-000_e.asp) (accessed April 20, 2009);

B-GJ-005 – Canadian Forces Operations (B-GJ-005-300/FP-000), found on the DIN at <http://cfd.mil.ca/sites/page-eng.asp?page=3488> (accessed April 20, 2009);

DTB – DND Defence Terminology Bank, found on the DIN at <http://terminology.mil.ca> (accessed April 20, 2009);

FSE – *Future Security Environment 2008-2030 Part 1: Current and Emerging Trends*. The current version is found on the DIN at <http://cfd.mil.ca/sites/page-eng.asp?page=5996> (accessed May 8, 2009);

JP 1-02 – United States Department of Defence Dictionary of Military Terms, found online at <http://www.dtic.mil/doctrine/jel/doddict/index.html> (accessed May 4, 2009);

RUSI – Royal United Services Institute's "Achieving Precision Effect in a Network Environment" by Martin Hodgkinson and Craig Smith, found online at <http://www.rusi.org/publication/defencesystems/ref:A4533B041124C6/> (accessed May 4, 2009); and

WB – The World Bank's Glossary of Key Terms, found online at <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALDEV/0,,contentMDK:21154393~menuPK:3291389~pagePK:64168445~piPK:64168309~theSitePK:3177395,00.html> (accessed April 20, 2009).

## aerospace environment

The environment that surrounds the earth and extends into space from the earth's surface. (DTB record 34894)

## aerospace platform

A vehicle through which aerospace power achieves effect.

Note: Aerospace platforms have inherent advantages of speed, reach and manoeuvrability in comparison with platforms that operate in the maritime or land environments. (DTB record 34077)

## aerospace power

That component of military power that is applied within or from the aerospace environment to achieve effects above, on and below the surface of the earth. (DTB record 34078)

Note: In contrast to air power, aerospace power is used in connection with flying assets, strategy and doctrine since the launch of Sputnik in 1957.

## Air Force (AF)

The branch of the armed forces charged with generating and projecting aerospace power in defence of the nation and its national interests and institutions.

Note: Although the Canadian Forces is a unified force comprising a single service, it has become common practice to refer to the three environmental commands as the Navy, Army and Air Force. (DTB record 34080)

**air power**

That component of military power that is applied within or from the air environment to achieve effects above, on and below the surface of the earth.

Note: In contrast to aerospace power, air power is used in connection with flying assets, strategy and doctrine associated with the early days of aviation, through World War I and World War II and up to the launch of Sputnik into orbit in 1957.

**arc of instability**

The region extending across western, central and eastern Africa, the Middle East and into south-east Asia that is characterized by a higher prevalence of weak, fragile, failing and failed states.

**asymmetric threat**

A threat by an opposing party to attack a nation by avoiding strengths, exploiting vulnerabilities, and employing unexpected or unusual techniques. (DTB record 19741)

**career field**

A group of closely related professional disciplines that usually share either common entry-level skills or a common philosophy.

Note: 1. A career field may branch into distinct specializations.

2. The use of this term encompasses the former trades and classifications as well as the current MOSID.

**collateral damage**

Inadvertent casualties and destruction in civilian areas caused by military operations. (DTB record 26989)

**combat operation**

A military operation where the use or threatened use of force, including lethal force, is essential to impose will on an armed opponent or to accomplish a mission. The actual level of force used will be in accordance with specified rules of engagement. (DTB record 21754)

**Command**

As an Air Force function, it is the act of directing, coordinating and controlling Air Force personnel and equipment to accomplish assigned missions. (B-GA-400)

**comprehensive approach (CA)**

The broad scope of actions undertaken in a coordinated and collaborative manner by national and multinational military forces, host nation and other civilian government agencies, international and intergovernmental organizations, non-governmental organizations or the private sector to achieve greater harmonization in analysing, planning, managing and evaluating coalition interventions in complex contingencies and emergencies. (FSE)

**continuum of operations**

The range of military responses (both combat and non-combat operations) to peace and conflict (including war). (B-GJ-005)

**conventional warfare**

Open, direct and often prolonged conflict between nations (or organized groups within nations) to achieve national objectives. (B-GA-400-mod)

**counter-insurgency**

Those military, paramilitary, political, economic, psychological, and civic actions taken to defeat insurgency. (DTB record 3941)



**data fusion**

The process of evaluating, correlating and combining data from multiple sources to establish the most conclusive data. (DTB record 13809)

**driver**

An event or human activity that provides impetus or motivation to fuel or sustain a trend.

**effect**

The result, outcome or consequence of an action. (JP 1-02)

**enabling concept (EC)**

A transformational instrument that will position an organization to succeed in dynamic and novel environments.

**failed state**

A state that has lost physical control of its territory and/or the monopoly on the legitimate use of force.

Note: 1. Other attributes of state failure include the erosion of the legitimate authority to make collective decisions, the inability to provide reasonable public services and the inability to interact with other states as a full member of the international community.

2. The continuum of state stability is weak, fragile, failing and failed. (FSE-mod)

**failing state**

A state that is at risk of becoming a failed state as a result of internal or external pressures such as economic (including resource disparity), security, health and social (including religious and ethnic identity).

Note: The continuum of state stability is weak, fragile, failing and failed. (FSE)

**fragile state**

A state whose government cannot or will not deliver core functions (including controlling their sovereign territory, providing public safety and security, managing public resources as well as delivering basic services) to the majority of its people.

Note: The continuum of state stability is weak, fragile, failing and failed.

**future capability requirements (FCR)**

The strategies, infrastructure and equipment necessary to function effectively in the future operating environment.

**future operating environment (FOE)**

The projected operating environment that will exist in a given future timeframe.

Note: The future operating environment will determine the methods and approaches required for operating effectively in the projected future security environment.

**future security environment (FSE)**

The projected security environment that will exist in a given future timeframe.

Note: The future security environment will establish the parameters of the future operating environment.

**globalization**

The process by which businesses and other organizations start to operate on a worldwide scale.

Note: Globalization is manifested by the increased flow and mobility of goods, services, ideas, information, people (including labour), technology and capital throughout the world. (COD and FSE both modified)

**hub and spoke**

A method of sustaining outlying locations and units from a centrally located and relatively secure position.

**human dimension**

Considerations relating to the capabilities of, impact on or contributions required from humans.

**humanitarian relief**

In the context of an operation, the use of available military resources to assist or complement the efforts of responsible civil actors in the area of operations or the work of specialized civil humanitarian organizations in fulfilling their primary responsibility to alleviate human suffering. (FSE)

**informational domain**

The domain in which information and data reside.

**intelligence, surveillance and reconnaissance (ISR)**

An activity that synchronizes and integrates the planning and operation of sensors and assets as well as the processing, exploitation and dissemination of the resulting information and intelligence.

Note: ISR is an integrated intelligence and operations function in direct support of current and future operations. (AFTWG)

**joint, interagency, multinational and public (JIMP)**

A domestic and foreign collaborative framework involving military elements and support organizations, other government departments (OGDs) and agencies (OGAs), one or more allies or coalition partners, and a variety of public elements including non-governmental organizations (NGO), public volunteer organizations (PVOs), the private sector, the media, commercial organizations and the citizenry, who cooperate at all levels of command to achieve shared objectives. (DTB record 34049)

**mission**

The essential activities assigned to a unit or force. It contains the elements of who, what, when, where, and the why (reasons therefore), but seldom specifies how. (DTB record 26667)

**moral domain**

The domain in which people interact on a psychological level.

**Move**

As an Air Force function, it is the act of rapidly deploying and maneuvering forces, equipment and supplies across the spectrum of conflict. (B-GA-400)

**non-governmental organization (NGO)**

A private organization that pursues activities to relieve suffering, promote the interests of the poor, protect the environment, provide basic social services or undertake community development.

Note: NGOs often differ from other organizations in the sense that they tend to operate independent from government, are value-based and are guided by the principles of altruism and voluntarism. (WB)

**non-state actor**

Actors at the international level which are not states.

Note: 1. Non-state actors can be beneficial or detrimental to the states in which they operate.

2. Non-state actors can include any of the following types of groups and organizations:

- a. non-governmental organizations;
- b. multinational corporations;
- c. the international media;
- d. armed groups (rebel opposition forces, militias, warlords, insurgents and private military firms);
- e. terrorist organizations;

- f. criminal organizations;
- g. religious groups;
- h. ecological organizations; and
- i. transnational diaspora communities.

### **physical domain**

The domain in which people live and work.

### **precision effect**

Achieving the right effect (both kinetic and non-kinetic), in the right place (precision), at the right time (time criticality) in a cohesive manner that delivers the desired outcome with no or minimal collateral damage. (RUSI-mod)

### **projecting power**

The ability of a nation to apply all or some of its elements of national power— diplomatic, information, military and economic—to rapidly and effectively deploy and sustain forces in and from multiple dispersed locations (at home and abroad) to respond to crises, to contribute to deterrence and to enhance regional stability. (JP 1-02 mod)

### **reconstruction mission**

The civilian and military activities that restore and rebuild a climate of order.

Note: A reconstruction mission typically includes the essential activities assigned to a unit or force in support of a stability operation.

### **Sense**

As an Air Force function, it is the act of collecting raw data and transforming it into usable information from which sound decisions can be made. (B-GA-400)

### **Shape**

As an Air Force function, it is the act of creating effects that alter the engagement space (both physical and moral) in a desired manner. (B-GA-400)

### **spectrum of conflict**

The spectrum of conflict describes the varying states of relations between nations or groups and the continuum of operations related to the range of military responses to peace and conflict (including war). (B-GA-400)

### **stability operation**

A tactical activity conducted by military and security forces, often in conjunction with other agencies, to maintain, restore or establish a climate of order. (DTB record 25515)

### **strategic corporal**

A front line combatant (such as a forward air observer) who has a clear, real-time view of the battlefield and whose actions at the tactical level have the potential for strategic consequences.

Note: When a strategic corporal is paired virtually with a tactical general, they execute a tactical effect that may have a high-level strategic impact.

### **strategic shock**

A sudden and/or unexpected and often powerful event or driver that causes the trajectory of a trend to significantly deviate from its existing course, causing an alternate outcome.

### **Sustain**

As an Air Force function, it is the ongoing act of raising, training and equipping air forces to meet current and potential tasks. (B-GA-400)



**tactical general**

The leader of an operation (such as the joint task force commander) who has the authority to make strategic decisions.

Note: When a tactical general is paired virtually with a strategic corporal, they execute a tactical effect that may have a high-level strategic impact.

**trend**

A tendency or a movement towards something or in a particular direction.

**weak state**

A state that is relatively stable but lacks in national power, wealth or resources leaving it susceptible to becoming a fragile state.

Note: The continuum of state stability is weak, fragile, failing and failed.

**youth bulge**

The demographic term used to describe the disproportionately large group of people between the ages of 12 and 24 years. (FSE)

# LIST OF ABBREVIATIONS

3D	three-dimensional
ACSO	air combat system officer
ADS-B	automatic dependent surveillance-broadcast
AF	Air Force
AFB	Air Force Base
AI	artificial intelligence
APOD	airport of disembarkation
ASAT	antisatellite
ATC	air traffic control
C2	command and control
CA	comprehensive approach
CANOSCOM	Canadian Operational Support Command
CAOC	combined air operations centre
CAS	Chief of the Air Staff
CBRN	chemical, biological, radiological and nuclear
CF	Canadian Forces
CFS	Canadian Forces Station
CIA	Central Intelligence Agency
CNA	computer network attacks
CSAR	combat search and rescue
DAS	defensive air suites
DEW	directed-energy weapon
DND	Department of National Defence
EBA	effects-based approach
EC	enabling concept
EMP	electromagnetic pulse
FCR	future capability requirements
FE	flight engineer
FL	flight level
FOE	future operating environment

<b>FOL</b>	forward operating location
<b>FSE</b>	future security environment
<b>GoC</b>	Government of Canada
<b>HR</b>	human resources
<b>HUMINT</b>	human intelligence
<b>ICAO</b>	International Civil Aviation Organization
<b>ICBM</b>	intercontinental ballistic missiles
<b>IED</b>	improvised explosive device
<b>ILS</b>	instrument landing system
<b>ISR</b>	intelligence, surveillance and reconnaissance
<b>ISTAR</b>	intelligence, surveillance target acquisition and reconnaissance
<b>JIMP</b>	joint, interagency, multinational and public
<b>MOB</b>	main operating base
<b>NATO</b>	North Atlantic Treaty Organization
<b>NGO</b>	non-governmental organization
<b>NORAD</b>	North American Aerospace Defense Command
<b>OGD</b>	other government departments
<b>PMC</b>	private military company
<b>RAF</b>	Royal Air Force
<b>RCAF</b>	Royal Canadian Air Force
<b>RCMP</b>	Royal Canadian Mounted Police
<b>RSS</b>	Really Simple Syndication
<b>SAR</b>	search and rescue
<b>SERE</b>	survival, escape/evasion, resistance and extraction
<b>SSA</b>	shared situational awareness
<b>SSTL</b>	super-short take-off and landing
<b>UAV</b>	unmanned aerial vehicle
<b>UCAV</b>	unmanned combat aerial vehicle
<b>UN</b>	United Nations
<b>US</b>	United States
<b>USAF</b>	United States Air Force
<b>VOR</b>	A very high frequency omnidirectional radio range, air navigational aid



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