The Revolution in Military Affairs and Its Impact on Canada: The Challenge and the Consequences

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Abstract

This paper examines how Canada, and specifically the Department of National Defence (DND), has responded to recent changes in the military technological environment, changes that constitute a Revolution in Military Affairs (RMA). It argues that DND has been slow to explore the RMA, and has so far failed to identify a comprehensive strategy regarding it. However, the paper also reviews the operational missions of the Canadian Forces, and suggests that some of these missions partly negate the relevance of the RMA for Canada. The study also places the Canadian RMA experience in its broader context by examining how other Western countries have responded to it.

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Introduction

As the Canadian military prepares to enter the new millennium, uncertainties abound. These uncertainties include the roles, missions, size, composition, and guiding principles of the future Canadian defence force. However, over the last few years, an additional concern has arisen that raises critical questions regarding the Canadian Forces (CF) ability to function effectively in the future. That issue is the impact of advanced technology on the military/strategic environment, and the CF's capacity to adapt to an environment that prioritizes information and knowledge. This paper will examine these changes, which constitute a Revolution in Military Affairs (RMA).[1] It will consider Canada's role in the RMA, and specifically the challenges this country's military will face in a climate vastly different from both the one it is accustomed to and the one that is still (at least partially) in existence today. It will demonstrate that the Department of National Defence (DND) has been slow to explore the RMA, and has so far failed to identify a comprehensive strategy regarding it. The paper will also place the Canadian experience regarding the RMA in its broader context by examining how several other Western countries have approached it. It will reveal that while the RMA poses a serious challenge to all states, other countries have developed RMA strategies, and appear better prepared than Canada to adjust to the changes currently underway. This "preparedness gap" highlights the urgency of the matter, as the Canadian failure to act may soon result in a military divide between Canada and its allies that will become increasingly difficult to close.

This study will be organized into three sections. The first will examine what the RMA is, how it came about, and offer some preliminary observations on where it may be going. The second will examine how DND has responded to the RMA, and the challenges this country will face in the near-future, when the twin revolutions in information technologies and military affairs become fully realized. The third will explore how three other countries - specifically Britain, Australia, and Israel are adapting to these changes, and determine if they offer any useful lessons for Canada. Some final observations will be offered in a concluding section.

I. The RMA and Information Warfare: A Brief Review

Military revolutions are major discontinuities in military affairs. They are brought about by changes in militarily-relevant technologies, concepts of operations, methods of organization, and/or available resources. They transform the conduct of war and make possible order of magnitude gains in military effectiveness. The phenomenon is thus much broader in scope and consequence than technological innovation, however dramatic such innovation may be. A hierarchy of change normally links these revolutions with broader social, economic, and scientific transformations.[2]

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[1] Literature on the RMA is growing rapidly, and thus any list of current studies is essentially outdated before it can be completed. However, among the core works in the field, see Eliot Cohen, "A revolution in warfare," *Foreign Affairs*, vol.75, no.2, (March/April 1996); Joseph Nye, Jr. and William Owens, "America's information edge," *Foreign Affairs*, vol.75, no.2, (March/April 1996); Michael J. Mazarr, *The Military-Technical Revolution: A Structural Framework*, (Washington, DC: Center for Strategic and International Studies, 1993); Daniel Goure, "Is there a military-technical revolution in America's future?" *The Washington Quarterly*, vol.16, no.4, (Autumn 1993); Lawrence Freedman, *The Revolution in Strategic Affairs*, (London: International Institute for Strategic Studies, Adelphi Paper 318, 1998); John Arquilla and David Ronfeldt (eds.), *In Athena's Camp: Preparing for Conflict in the Information Age*, (Santa Monica, CA: RAND Corporation, 1997); Robert L. Pfaltzgraff, Jr. and Richard H. Schultz, Jr., *War in the Information Age: New Challenges for US Security Policy*, (Washington, DC: Brassey's, 1997).

[2] Michael J. Vickers, "The revolution in military affairs and military capabilities," in *War in the Information Age: New Challenges for US Security Policy*, p. 30. Perhaps a word can be added on the work done by Alvin and Heidi Toffler, who have popularized two critical notions: (1) that we are presently in the midst of a dramatic transformation in economic production, characterized by the growing utility of information technologies; and (2) historical epochs — and the wars that go with them - are characterized by revolutionary technological breakthroughs

Revolutions in the military have occurred with regularity over the past several centuries. Determining precisely how many revolutions there have been is the subject of continuing debate in the field, with estimates ranging from between four and 12 over the last five hundred years.[3] Indeed, according to many scholars the twentieth century has already witnessed two such periods of transformation. The first occurred in the 1920s and '30s, and was characterized by the changes of warfare on land, at sea, and in the air. The most recent one was the nuclear weapon/ballistic missile revolution of the 1940s and '50s.[4] By understanding the depth of change that these recent revolutions brought about, one can get a sense of the dramatic nature of RMAs.

The present RMA is based on the concept that the ability to collect, analyze, disseminate, and act upon information is the dominant feature in warfare.[5] The RMA thus depends on the interaction between systems that collect, process, fuse, and communicate information and those that apply military force.[6] The anticipated result is a military that can be directed in a decisive and lethal manner against an enemy still in the process of mobilizing resources and developing plans.[7] In short, the "new" way of war will supposedly allow its practitioners to detect and destroy an opposing force nearly at will.[8]

It is the interaction of several critical information technologies that is determining the precise shape and structure of the RMA. There is broad agreement on the technologies involved, which include: (1) technologies that allow actors to gather, process, and fuse information in a large geographical area in real time; (2) technologies that allow actors to transfer that information to military forces quickly and accurately; and (3) technologies that give actors the capacity to use military force with speed, precision, and with great effect over long distances.[9] The three advances thus lie in gathering intelligence, processing intelligence, and acting on intelligence. When combined, supporters argue that the three offer multi-dimensional capabilities that will strengthen the military dominance that Western countries — and in particular the US — currently have, and will pose an immense challenge to those actors lagging in both technology and information systems.[10]

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that cause "waves" of socioeconomic change. Elements of this thesis can be found in both *The Third Wave*, (New York: Bantam Books, 1980) and *War and Anti-War*, (Toronto, ON: Little, Brown and Company, 1993).

3 For example, Andrew Krepinevich has written that there have been ten military revolutions since the fourteenth century - the revolutions in infantry, artillery, sail and shot, fortress, gunpowder, manpower, land warfare, naval warfare, mechanization, and nuclear weapons. See "Cavalry to computer: The pattern of military revolution," *The National Interest*, vol.37, (Fall 1994), pp.31-36. Taking a more cautious approach, Martin van Creveld divides military history into four eras that correspond to RMAs: the "Age of tools," the "Age of the machine," the "Age of systems," and the "Age of automation." See *Technology and War: From 2000 BC to the Present* (New York: Free Press, 1989). The division of RMAs into "major" and "minor" revolutions is one explanation for the variance of estimates among scholars. See Steven Metz and James Kievit, "Strategy and the revolution in military affairs: From theory to policy," (US Army War College, 1997, http://carlisle-www.army.mil/ns).

4 Andew Krepinevich, "The Quadrennial defence review and military transformation," *National Security Studies Quarterly*, vol.3, no.1, (Winter 1997).

5 The present revolution in the military was first conceived by Soviet scholars and analysts, who predicted in the late 1970s and early '80s that a new era of warfare was approaching, one which would privilege the West because of its greater technological proficiency. As the Soviets saw it, this new warfare would capitalize on advanced technologies and ultimately result in conventional forces having the same level of effectiveness as nuclear ones. Marshall Ogarkov is often credited as the first to advance this notion. See N.V. Ogarkov, *History Teaches Vigilance*, (Moscow: Voyenizdat, 1985).

6 Freedman, *The Revolution in Strategic Affairs*, p.11.

7 *Ibid*., p.11.

8 John Arquilla, "The 'Velvet' revolution in military affairs," *World Policy Journal*, vol.14, no.4, (Winter 1997/98), p.33.

9 William A. Owens, "Foreword," in Stuart J.D. Schwartzstein (ed.), *The Information Revolution and National Security: Dimensions and Directions*, (Washington, DC: Center for Strategic and International Studies, 1996), p.x.

10 The central thesis of a paper recently completed at the American National Defense University is that states that are incapable of adapting to information technologies will see their military capabilities erode dramatically over the next decade. Thus, it is the advanced industrial countries of the West - the US, Western Europe, and Japan - that will see their military strength grow as the RMA becomes fully realized. See David Gompert, "Right makes might:

Among the specific technologies of the RMA are the following: fifth generation computers and advanced computer networks, which allow data to be gathered, shared, and analyzed nearly instantaneously; improvements in sensors, which can function independently or can be carried on Airborne Warning and Control System (AWACSs) and Joint Surveillance and Target Acquisition Radar System (JSTARS) aircraft[11]; unmanned aerial vehicles (UAVs); advanced munitions systems that depend on information to function effectively; electro-optical satellites with detailed image resolution and wide-area coverage; data products that process, manipulate, and tailor information; automatic target recognition capabilities; and integrated, high-speed, high-capacity battlefield communications via the Global Broadcast System (GBS) and the Global Command and Control System (GCCS).[12] Emphasizing the late 20th century context of the RMA, it should be noted that only one of these systems, UAVs, were widely deployed before 1990 (and in this case only by Israel), and all of them rely on advanced microchips and sophisticated electronics to function.

The term that has been identified to refer to changes in command, control, communications, and intelligence (C3I) made possible by the new technologies is the "system of systems," one originally coined by Admiral William Owens, former vice chairman of the US Joint Chiefs of Staff.[13] The "system" refers to a world in which many kinds of sensors — from satellites to shipborne radar — provide information to any user who requires it. According to this concept, then, the RMA consists of the ability to amass and evaluate enormous quantities of information in a given battle area and make near-instantaneous use of it. Further, improvements in C3I technologies posit leaps in the ability to quickly transfer information, imagery, and other data to operating forces in the field.[14] As Lawrence Freedman has recently noted, "the objective is to achieve 'Dominant Battlespace Knowledge,' a capacity to process information in such a way that the overall operational environment, and the key relationships between the military units within it, can be described in as close to real time as possible."[15]

Applied broadly, real-time surveillance and information management, modern communications capabilities, precision targeting, and autonomous weapons systems are the core around which combined arms campaigns and coalition warfare can be structured. These capabilities, properly organized and employed, have the capacity to allow a future military to see, shape, control, and seize the battlefield. As Martin Libicki has noted, "such knowledge permits more effective mission planning, prevents (countries from) being surprised, and permits imposing surprise on others."[16] Thus, information superiority may become more important than air or naval superiority are at present. Information may substitute for traditional means of force in war just as it currently substitutes for established factors of production in the economy.[17]

If this "system of systems" works, the use of force against an opponent equipped with advanced technology would essentially be suicidal. Moving targets generate copious radar signatures and well armed stand-off forces can intercept them with relative ease.[18] Further, an RMA-equipped force will have near-instantaneous battlefield knowledge, and will be able to concentrate and use its forces in the precise areas where the enemy is most vulnerable. Such a military will also be able to combine military operations in a manner not presently possible. Accordingly, it is widely believed that military engagements between RMA-equipped militaries and non-RMA militaries will end predictably in favour of the former, regardless of such

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Freedom and power in the information age," (Institute for National Strategic Studies, McNair Paper #59, May 1998, http://www.ndu. edu/inss/macnair/mcnair59/m59cont.html).

11 JSTARS is an airborne ground surveillance system. It can display the precise location of vehicles and associated targets within an area of 400 square km, and instantaneously relay that information to command authorities.

12 Ryan Henry and C. Edward Peartree, "Military theory and information warfare," in Ryan Henry and C. Edward Peartree (eds.), *The Information Revolution and International Security*, (Washington, DC: Centre for Strategic and International Studies, 1998), p.114.

13 Admiral William Owens, "The emerging system of systems," *US Naval Institute Proceedings*, (May 1995) and "Introduction," in Stuart Johnson and Martin Libicki (eds.), *Dominant Battlespace Knowledge: The Winning Edge*, (Washington, DC: National Defense University Press, 1995).

14 Nye and Owens, "America's information edge," p.24.

15 Freedman, *The Revolution in Strategic Affairs*, p.11.

16 Martin C. Libicki, "DBK and its consequences," in *Dominant Battlespace Knowledge*, p.28.

17 Eric R. Sterner, "Digital Pearl Harbour: National security in the information age," *National Security Studies Quarterly*, vol.2, no.3, (Summer 1996), pp.36-37.

18 Martin C. Libicki, "The emerging primacy of information," *Orbis*, (Spring 1996), p.265.

traditionally critical factors like timing and the achievement of strategic surprise[19] (this does not indicate, however, superiority in *all* forms of conflict; see Section II).

It was the 1991 Persian Gulf War that brought many of these changes into focus. While established weapons systems and high-yield explosives did most of the damage in Iraq and Kuwait, the war featured the use of advanced sensing, communications, targeting, and strike capabilities, all of which were facilitated by JSTARS and the NAVSTAR Global Positioning System (GPS). In addition, Precision Guided Munitions (PGMs), or so-called "smart bombs," were widely used and destroyed numerous targets in Baghdad without resulting in significant damage to other structures in the city. Further, Desert Storm was proclaimed as the world's first "space war", as at each stage of the conflict space-based systems provided not only intelligence, but also informed individual units where they were, what forces they faced, and what their commanders thought they should do.[20] In essence, RMA proponents argue that the war successfully revealed a series of technologically-dependent weapons systems that had never been used in combat before.[21]

In the years since Desert Storm, there have been orders-of-magnitude improvements in numerous systems and capabilities (many of which have been linked to advances in civilian-based technologies), thus providing further evidence to those who argue that a profound transformation is occurring. For example, the communications system used by Gulf War commanders to transmit messages could move a maximum of 2400 bits of information per second. In contrast, the commercially developed and operated Global Broadcast System transmits 23 million bits per second.[22] Hence, a message that took more than an hour to send in 1991 can now be sent in less than one second.[23] The convergence of digitized information, computers, networks, cellular communications, satellites, precision munitions, and data fusion technologies in the last few years has translated into significant improvements in both the quantity and quality of information available, command and control practises, and targeting capabilities. Indeed, if anything, the pace of technological change seems to be accelerating, and thus recent advances foreshadow even greater ones to come, which will result in an increasingly connected military that is capable of monitoring, deploying, and using force in less time and with greater effect.

While fully describing how advanced technology will influence the future battlefield is not currently possible (as many of the systems are not yet in their final form), some applications are already clear. For example, digital three-dimensional map representations today offer a complete picture of the combat area, updated as changes occur. Satellite imagery, or live video from a UAV equipped with a digital camera, is potentially available in real time to a soldier in the field with a laptop computer and a GPS receiver. Automatic target recognition systems currently in development may soon reduce the need for intelligence, directly calling for long-range precision strikes as soon as information is received from a sensor.[24] As a result of these (and related) developments, the decision cycles for both commanders and soldiers will be compressed, with critical implications for the tempo of military operations.[25]

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19 As Admiral Owens has noted, "the result will be an increasing gap between US military forces and any opponent in awareness and understanding of everything of military significance in any arena in which we may be engaged." "Introduction," *in Dominant Battlespace Knowledge*, p.3.

20 See Steven Lambakis, "Space control in Desert Storm and beyond," *Orbis*, (Summer 1995).

21 For a military analysis of the war, see US Congress, House Armed Services Committee, *Defense for a New Era: Lessons of the Persian Gulf War*, (Washington, DC: USGPO, 1992); Richard P. Hallion, *Storm Over Iraq: Air Power and the Gulf War*, (Washington, DC: Smithsonian Institution Press, 1992); Thomas Keaney and Eliot Cohen, *Revolution in Warfare? Air Power in the Persian Gulf*, (Washington, DC: USGPO, 1993); and Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War, Volume 4: The Gulf War*, (Boulder, CO: Westview Press, 1995).

22 Ryan Henry and C. Edward Peartree, "Military theory and information warfare," *Parameters*, vol.27, no.3, (Autumn 1998), p.127.

23 *Ibid*., p.127.

24 Henry and Peartree, "Military theory and information warfare," in *The Information Revolution and International Security*, p.114. Also see *Jane's Defence Weekly*, "USA rapid targeting reaches new heights," vol.29, no.9, (March 4, 1998).

25 For example, the US Air Force's Joint Situational Awareness System merges battlefield intelligence gathered by satellites, reconnaissance aircraft, AWACS, JSTARS, and UAVs. The information is processed and transmitted nearly instantaneously, with new data constantly incorporated into the assessment.

As Lawrence Freedman has concluded with regards to the promise of the RMA, "the vision is remarkable."[26] With an RMA-equipped force, time and space will become less significant factors in any military engagement. There will be an ability to strike with precision over great distances and with great accuracy. Enemy units within the battlespace will be engaged from outside it. Targets will not need to be attacked in sequential order of priority; rather, there can be "parallel warfare", as critical targets are attacked immediately and together. Search and destroy operations will become redundant if the enemy can be found electronically and destroyed from a distance. Further, the role of ground forces may be completely transformed; no longer needed to close with the enemy and seize territory, they will move with only the necessary firepower required for self-defence, and will call in additional firepower when required.[27] These latter changes describe a truly *revolutionary* future military force, as it will not only feature advanced technology but be structured and deployed differently. The ultimate aim of these changes is to eliminate (or at least reduce) the "fog" that is a factor in all military engagements, and to give units the capabilities required to achieve mission objectives quickly and efficiently.

It is important to emphasize, though, that the RMA is based on a larger information revolution which is dependent on technological advances that have increased our ability to collect vast quantities of data; to convert that data into intelligible information; and to rapidly transmit that data anywhere on the globe. This information revolution includes the changes brought about by the development and widespread use of powerful computers, software, computer networks, and advanced communications systems, all of which are themselves bringing about further changes and in their totality are having a transforming effect in a number of diverse areas. While this paper will not examine this "other" revolution, it is critical for readers to appreciate that *it is advances in civilian technology and information systems that has led to the present RMA, and that the majority of future military innovations are expected to originate in this sector as well.*[28]

One point of contention is whether current changes within the military constitute a "revolution" or an "evolution." Revolutionary change does not reflect a process of gradualism but rather one of profound transformation in which the status quo is fundamentally altered. It is an active process that requires effective adaptation by individuals and organizations for successful exploitation to occur.[29] Thus, it often takes time to appreciate that old systems and established procedures need to be restructured — and very often transformed — before the potential of new technologies can be realized. On the other hand, an evolution is the "logical progression of an existing system or framework."[30] It is, by definition, less a break with the status quo than an adjustment to it. It signifies gradual change over time, giving actors the opportunity to adjust.

Because there remains uncertainty over what the RMA entails, there is confusion over this very point. Views range from those who believe that current changes in the military are essentially the continuation of a long process of technical innovation (i.e., evolutionary change), to those who foresee a period of complete transformation in the use of military force. Related to this argument is the question of timing. For some, the revolution has already begun, while for others it is still several decades away and the identity of its participants remains an open question.[31] These and related concerns continue to attract debate, supporting those who maintain that the present RMA lacks consensus on many of its most basic questions.

Perhaps taking note of this dispute, critics of the RMA have raised numerous other objections. For example, they have argued that the RMA is technologically dependent, a characteristic that separates true military revolutions from more gradual changes.[32] In addition, many regard advanced technology with

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26 Freedman, *The Revolution in Strategic Affairs*, p.12.

27 *Ibid*., p.13.

28 It is surprising how poorly understood this point is. Much of the literature in the field overlooks the civilian genesis of the RMA, and thus does not comprehend its origins. One recent paper that does make this connection is Gombert, "Right makes might: Freedom and power in the information age."

29 Norman C. Davis, "An information-based revolution in military affairs," in *In Athena's Camp: Preparing for Conflict in the Information Age*, p.80.

30 Lt. Leo S. Mackay, Jr., "Naval aviation, information, and the future," *Naval War College Review*, (Spring 1992), p.7.

31 Vickers, "The revolution in military affairs and military capabilities," p. 31.

32 Both Lawrence Freedman and Colin Gray have argued this. Both believe that, while important, technology's effect is constrained by several factors. See Freedman, *The Revolution in Strategic Affairs*, and Colin Gray, "The continued primacy of geography," *Orbis*, (Spring 1996); "A rejoinder by Colin Gray," *Orbis*, (Spring 1996); and

scepticism, noting that prior advances have frequently not resulted in the benefits supporters initially believed.[33] Lastly, a common critique focuses less on the RMA thesis itself, than *where* it is coming from. Critics note that much of this debate has — at least to date — occurred within the US defence and strategic studies community. To these analysts, this is a red flag, and indicates the extent to which technology often takes the place of other more important considerations in American strategic discourse.[34]

Given this uncertainty, it is critical to establish the position of this paper on the issue. This author believes that both the information revolution and the RMA do indeed constitute "real" revolutions. The latter involves major changes that have occurred suddenly and which are spreading across institutions, doctrine, behaviour, and are affecting the ways in which we think about using military force. However, by no means is this revolution complete. On the contrary, changes in the military which can be tied to the introduction of information-based technologies are still in their infancy, and will grow more numerous and important in the coming years. It is precisely because of this continuing process that not all of the changes are presently understood, and it will be some time before the exact shape and structure of the RMA is finalized. *But the unfinished nature of the current RMA in no way detracts from its importance, for the process of change is now well underway and increasingly gaining momentum.*

Lastly, attention should be paid to a second element of the RMA, information warfare (IW), one that is frequently considered part of the RMA, but is, in fact, a separate component that should be studied on its own.[35] Indeed, while at present the US is pursuing advances in both areas, the two are, at least to some degree, antithetical. As Martin Libicki has noted, while the RMA aims to focus firepower more effectively on a variety of both traditional and non-traditional targets (thereby likely resulting in even greater physical destruction within the battle zone), information warfare aims at discretely attacking automated information systems and networks (resulting — at least in theory — in less physical damage).[36]

Essentially, information warfare is based upon the recognition that modern societies are dependent on information, and that dependence creates vulnerabilities. With computers tying the world together through a maze of land and satellite-based communications systems, many advanced countries depend upon the consistent and reliable operation of computer networks.[37] While the US is the world's most connected

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"The American revolution in military affairs: An interim assessment," *The Occasional*, no.28, (Strategic and Combat Studies Institute, 1997).

33 Many critics note that the idea of using military force with "precision" is hardly new. Indeed, the American fascination with it dates back more than 50 years, when the US believed that precision bombing could defeat Nazi Germany. A quarter century later, American military officials applied much the same strategy against North Vietnam, with equally disappointing results. Simply put, the technology of the times (in both the 1940s and 1960s) was not up to the task. Furthermore, past RMAs have frequently not "revolutionized" warfare as much as initial supporters believed. For example, the nuclear RMA, despite the enormous power of the weapons themselves, largely failed to discredit traditional notions of strategy. For a discussion of this point, see Martin C. Libicki, "Information and nuclear RMAs compared," *Strategic Forum*, no.82, (July 1996) and Colin Gray, "Nuclear weapons and the revolution in military affairs," in T.V. Paul, Richard J. Harknett, and James Wirtz (eds.), *The Absolute Weapon Revisited: Nuclear Arms and the Emerging International Order*, (Ann Arbour, MI: The University of Michigan Press, 1998).

34 In this regard, Gray has drawn a linkage with the "Golden age" of American nuclear strategy, the period from 1955-1965. While during this period strategists including Bernard Brodie, Albert Wohlstetter, and William Kauffman wrote their principal studies, their works were frequently criticized for ignoring the political context within which international relations occur, and hence for dwelling too much on the threat potential of the weapons themselves.

35 Literature on information warfare, like the RMA, has been growing rapidly in recent years. Among the critical studies, see Roger Molander, Peter Wilson, and Andrew Riddile, *Strategic Information Warfare*, (Santa Monica, CA: RAND Corporation, 1996); Richard Power, *Information Warfare*, (San Francisco, CA: Computer Security Institute, 1995); Colonel Richard Szafranski, "A theory of information warfare: Preparing for 2020," *Airpower Journal*, (Spring 1995); John Arquilla and David Ronfeldt, *The Advent of Netwar*, (Santa Monica, CA: RAND Corporation, 1996); Brian Fredericks, "Information warfare at the crossroads," *Joint Force Quarterly*, no.16, (Summer 1997); and Martin C. Libicki, "What is information warfare?" *ACIS Paper no.3*, (Canberra: National Defence University, 1995).

36 Martin C. Libicki, "Information war, information peace," *Journal of International Affairs*, vol.51, no.2, (Spring 1998), p.411.

37 Winn Schwartau, "An introduction to information warfare," in *War in the Information Age*, p.48.

country, many others are close behind. However, if information networks can be attacked and destroyed, there is the possibility that a domino effect might occur, as systems linked only through a common server go down together and in tandem. The resulting chaos could — at least theoretically — affect virtually every aspect of a country's infrastructure, from its economy and communications system, to even its military.

Thus, if the purpose of information is to make better decisions, then the purpose of information warfare is to induce the other side to make decisions that help you.[38] Broadly defined, information warfare covers the physical or electro-magnetic destruction of adversary command and control systems, the jamming of radio and radar links, the elimination of sensors and, most recently, illicit access to an adversary's networks and computers.[39] While operational definitions abound, this paper will adopt the one offered by the US Department of Defense, which has described information warfare as "information operations conducted during times of crisis to achieve or promote specific objectives over a specific adversary or adversaries."[40]

According to proponents, information warfare will not only give practitioners dominant awareness of the battlespace, but will also give actors the means to electronically manipulate, exploit, or disable enemy information systems. This affords the opportunity to knock an enemy literally senseless — putting him at the mercy of both conventional attack on the battlefield and psychological operations aimed at controlling his perceptions and decision-making abilities. According to the theory, public opinion can be shaped, leaders can be cut off from their citizenry, and the mind of the enemy can be directly penetrated and his strategy defeated.[41]

As with the RMA, it would be misleading to suggest that there is a consensus on what information warfare means or entails. This confusion is largely attributable to three factors; (1) the rapid pace of technological change; (2) the nature of information and information technology (which blurs the distinction between civilian and military targets); and (3) uncertainty about the nature of information itself.[42] As with the air power revolution of some 60 years ago, contemporary theorists are wrestling with a variety of uncertainties and unknowns, seeking clues as to how information operations might change the very shape of conflict.[43] It is a subject that, because of the rapid advances upon which it is based, lends itself to disagreements and debates over core points.

Because many of the elements of information warfare do *not* require a large information infrastructure, the question of vulnerability is one that is attracting considerable attention.[44] As advanced technologies proliferate, many observers believe that a wide range of actors will have access not only to information, but to the same technological systems that generated that information in the first place. This suggests that rather than giving Western countries an insurmountable strategic and military advantage, new technologies may in fact level the playing field somewhat, and allow developing countries to "leapfrog" generations of military and civilian technologies in one sudden jump. In short, some believe that it may become increasingly possible for adversaries to bypass confrontation with traditional military forces and attack other actors by interfering with their national information infrastructure.[45]

At present, concern over information/system vulnerability in the West is high, particularly in the US. Numerous studies and reports have concluded that the US *is* vulnerable, and that its information systems and networks need to better appreciate the dangers of the emerging environment. For example, in a recent exercise conducted by the Department of Defence (DoD), a group of "hackers" selected by the military

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38 Libicki, "Information war, information peace," p.417.

39 *Ibid*., p.417.

40 Department of Defense, *Department of Defense Directive 3600.1*, "Information operations," (Washington, DC: Department of Defense, 1996).

41 Henry and Peartree, "Military theory and information warfare," in *The Information Revolution and International Security*, p.108.

42 For an excellent review, see Libicki, "What is Information Warfare?"

43 Henry and Peartree, "Military theory and Information warfare," in *Parameters*, p.126.

44 Indeed, as many have noted, all that is required to wage information warfare is a computer, a modem, a reasonable level of technical training, and access to an information network. Because information technologies are commercially available and improve quickly, adversaries can keep up to date with the latest developments.

45 Sterner, "Digital Pearl Harbour: National security in the information age," p.44.

entered literally thousands of Pentagon computers and were detected only a handful of times.[46] In dozens of cases, they entered command and control computer networks and attained system administrator status. Such threats, when extended to power grids, phone systems, and financial markets, have raised serious alarm bells within the US political and security establishment.[47]

> In a critical 1996 report, the Defense Science Board Task Force on Information Warfare warned that "offensive information warfare is attractive to many because it is cheap in relation to the cost of developing, maintaining, and using advanced military capabilities. It may cost little to suborn an insider, create false information, manipulate information, or launch malicious, logic-based weapons against an information system connected to the globally shared information infrastructure."[48]

Similar conclusions have been reached by other US committees, including the Committee on Critical Infrastructure Protection, which recommended the creation of a new national security infrastructure to guard against such threats.[49] Anecdotal evidence further suggests that foreign interest in acquiring the weapons of offensive information warfare has increased dramatically in the last few years, indicating that other countries believe the US is particularly vulnerable to such attack.[50]

Having reviewed the vulnerability thesis, there is reason to doubt it. First, simply because advanced technology is commercially available does *not* mean that any actor who purchases such a system will be able to use the technology effectively. As the experience of developing countries that have acquired advanced military equipment demonstrates, recent history is fraught with examples of states that have found that their limited technological infrastructure does not permit them to derive the full benefits of such hardware.[51] Second, countries that develop computer systems and networks have a built-in incentive for designing adequate protection measures. Indeed, companies in the developed world are currently identifying market opportunities in providing information security, and are pursuing these markets skilfully and aggressively.[52] Lastly, there is growing recognition that the multiplication of channels through which information passes can be an effective immunisation against attack. According to this argument, unlike finite resources which can only be moved to where they are needed by specific forms of transport, information is much easier to generate, transmit, and collect. There are thus few information "choke points", no centre(s) of gravity that

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46 David J. Rothkopf, "Cyberpolitik: The changing nature of power in the information age," *Journal of International Affairs*, vol.51, no.2, (Spring 1998), p.347.

47 One statistic that has attracted much comment in the last few years relates to the amount of sensitive information that flows through commercial networks - it has been estimated that 95% of all military communications in the US travel over such systems. Henry and Peartree, "Military theory and information warfare," in *The Information Revolution and International Security*, p.116.

48 The Board consisted of respected scientists and engineers. Office of the Under Secretary of Defense for Acquisition and Technology, "Report of the Defense Science Board Task Force on Information Warfare Defense," (November 1996, http://jya.com/iwd.html).

49 The Commission noted that "open interfaces and common communications protocols will make intrusion easier by standardizing targets and simplify the propagation of attacks from one location in the network to other parts of the architecture." President's Commission on Critical Infrastructure Project, *Critical Foundation: Protecting America's Infrastructure*, (Washington, DC: USGPO, October 1997).

50 On the vulnerability of US networks, see the Office of Science and Technology Policy, "Cybernation: The American Infrastructure in the Information Age," (January 1, 1998, http://www.whitehouse. gov/WH/EOP/OSTP)

51 See, for example, Paul Bracken, "Command and control technologies in the developing world," in W. Thomas Wander, Eric Arnett, and Paul Bracken (eds.), *The Diffusion of Advanced Weaponry: Trends, Regional Implications, and Responses*, (Washington, DC: American Association of the Advancement of Science, 1994) and Stephen Biddle and Robert Zirkle, "Technology, civil-military relations, and warfare in the developing world," *The Journal of Strategic Studies*, vol.19, no.2, (June 1996).

52 The emerging market in encryption - which aims to make data safe from third party observation and/or tampering - demonstrates that information technologies may contain the seeds necessary to guard against attempts to disrupt further innovation.

present an efficient, and particularly damaging, target.[53] Overall, then, the vulnerability thesis, while certainly deserving of further study, has not yet been proven.[54]

In sum, advances in technology have set the stage for both an RMA and an increase in information warfare. The information revolution promises the military an extraordinary extension of battlespace awareness, information dissemination capabilities, and "smart" weapons.[55] However, technology alone will not drive the RMA, for there needs to be a clear understanding of what military power is for, and corresponding changes in doctrine, tactics, and strategy. As was the case during the Cold War, there is a need to appreciate that technology alone cannot become a substitute for strategy. At present, this recognition seems to be lacking, although this is undoubtedly linked to the fact that many of the core technologies of the RMA are still quite new, and many of the applications utilizing them are still not fully understood. This point will be developed at greater length in the concluding section.

II. Canada and the RMA

To say that Canada — and more specifically the Department of National Defence — has approached the RMA in a slow and deliberate fashion would be an understatement. While in the US intensive study of changes in the military began shortly after the Gulf War, in Canada it is not until the last year or so that the subject has begun to generate substantive comment. This section of the paper will examine how DND has approached the RMA, the ability of the Canadian technology sector to provide a base for high technology military applications, and the implications of the RMA for the anticipated future missions of the CF. It will demonstrate that Canada's participation in the RMA will be limited both by its modest military establishment and niche-oriented civilian technology sector, which appears poorly suited to supplying DND with technology platforms for advanced weapons systems. Thus, it is not entirely clear whether and how Canada can participate in the RMA, as these concerns raise doubts about our military's ability to function effectively in an information/ technology environment.

DND's Current Understanding of the RMA

DND's lack of attention toward the RMA is revealed by the department's near-total failure to comment on the subject. This failure was first made apparent in the *1994 Defence White Paper*, a document that continues to be official policy despite important political changes since the time it was written. While completed at a time when commentary — particularly in the US — on the RMA was growing (and three years after the Gulf War had brought these changes into focus), the White Paper failed to even *mention* the changes that were having a profound impact on the use and threatened use of military force.

Rather, relying on a conventional analysis of the post-Cold War world, the White Paper concluded that Canada should continue to field multi-purpose, combat capable forces that could be used in a variety of conflict scenarios. With regards to new weapons and combat systems, the report stated that fiscal restraint would prevent significant capital improvements, and that, moreover, "new equipment will be acquired only for purposes considered essential to maintaining core capabilities of the Canadian Forces."[56] Indeed, the only reference to any element of the RMA in the White Paper came near its end, in a short section on "Operational Air Forces," where it was noted that a "small number" of precision-guided munitions (PGMs) would be purchased for Canada's CF-18s. However, this reference to PGMs was in the context of a procurement recommendation, and thus cannot be considered a legitimate reference to the capabilities and/or properties of the weapon system itself.

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53 Freedman, *The Revolution in Strategic Affairs*, p.59.

54 Observations on vulnerability have also been offered by H. Bradford Westerfield, "Theorizing war in cyberspace," (paper presented at the International Studies Association conference, Minneapolis, MN, March 1998).

55 Henry and Peartree, "Military theory and information warfare," in *The Information Revolution and International Security*, p.114.

56 Department of National Defence, *1994 Defence White Paper*, (Ottawa, ON: DND, 1994), p.41.

The near-invisibility of the RMA has continued in more recent departmental statements and documents. For example, in the *1997 Canadian Defence Planning Document*[57] there is no reference to either the RMA or the impact it is having on the projected use of force. Further, the impact of technology more broadly is not discussed, nor is the possible impact that advanced technology may have on future force structure, an issue that one would think would generate widespread concern — and comment — within DND. Lastly, one might note that the RMA has not been the focus of any ministerial or official statement (by any government department), thereby revealing that the issue has failed to generate any broader interest.

In contrast to the enormous amount of literature that the US DoD has produced, this author could find only five DND documents/reports that contain direct references to the RMA, all of which were completed in the past year.[58] A brief review of each of these studies will reveal the department's view of the RMA, and the principal challenges that DND believes it raises for the CF.

The first, a short paper titled "Canada and the Revolution in Military Affairs,"[59] was completed by the Research and Development (R&D) Branch of DND in June 1998. The report notes that "the specific implications of the RMA for Canada, and, in particular, the Canadian Forces remain to be clarified." That said, however, it states that the key concern facing Canada will be to ensure that "Canada can maintain interoperability with its allies and continue to play a valuable role in coalition operations." It notes that "ideally, a fully integrated, seamless approach can be achieved, ranging from an agreed-upon strategic plan, to capability identification, to science and technology, to the acquisition process, and finally into operations." Thus, while cautious, the study assumes that the RMA does not raise any critical challenges for Canada or DND. The report concludes that the RMA cannot be divorced from the emerging strategic environment, and thus when studying it one keep in mind Canada's larger security framework.

The second document is a speech given by General Maurice Baril, Chief of the Defence Staff (CDS), at the Canadian Forces Command and Staff College in September 1998.[60] While the speech touches on many areas of Canadian defence — including its history, leadership, and the importance of military education — it contains some brief references to the RMA. Baril notes that an RMA is occurring in the US, and this will necessitate changes for both allies and opponents of the US. For the former group, the key challenge will be a "major inter-operability gap, unless they too pursue aspects of the RMA."[61] However, Baril recognizes that pursuing the RMA will require a major investment, one that some countries "may not be able or prepared to make at this time."

Baril suggests that the key in implementing the RMA in Canada lies in education, and in particular understanding what the RMA entails and the changes it will necessitate. He warns that failure to study and appreciate the RMA could have "immeasurably grave" consequences for Canada. While he does not make specific recommendations, Baril endorses the analysis of an unnamed American defence analyst, who recently noted that future military officers will need a "broader spectrum of concepts and skills." More specifically, future officers will need to determine "what kind of structures will be necessary and appropriate for the future environment," and be able to show greater initiative and ability for independent thought. While interesting observations, Baril does not develop them, and thus his comments are essentially introductory ones to a complex subject.

A more intensive examination/comment on the RMA was recently completed by the Canadian Navy. In a 1998 paper titled "Adjusting Course: A Naval Strategy for Canada,"[62] the Navy addresses issues that it

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57 Department of National Defence, *1997 Canadian Defence Planning Document*, (http://www.dnd.ca/eng/dp/Key_Pol/DefPln97).

58 Three of these documents - the Naval study, the speech by General Baril, and the RMA primer document - were found by conducting a search of the Department's web site. The document "Canada and the Revolution in Military Affairs," was located at the Staff College Library in Toronto, while the DSTRAT study was circulated at the DND-RMA conference, held in Ottawa, Nov. 30-Dec. 1, 1998.

59 Defence Research and Development Branch, Department of National Defence, "Canada and the revolution in military affairs," (Issues in Defence Science and Technology, no.5, June 1988).

60 "Speaking notes for General Maurice Baril, Chief of the Defence Staff, at the Canadian Forces Command and Staff College," (September 4, 1998, http://www.dnd.ca/ egn/archive/speeches).

61 *Ibid*.

62 "Adjusting course: A naval strategy for Canada," (prepared for the Canadian Navy, 1998, http://www.dnd.ca/navy/marcom/acreqe. htmnl).

believes will shape both maritime security and naval operations in the future. The paper examines issues as diverse as changes in the global environment (including sections on trade, democratization, population growth, and weapons proliferation), national security, emerging threats to naval forces, and future technology trends. It concludes that Canada's armed forces are likely to be operationally busier in the 21st century given continuing global instability. However, the report suggests that the primary challenge facing the Navy — and DND more generally — is to persuade an otherwise disinterested populace that large capital investments will be required to ensure that Canada can undertake the military missions that its political representatives deem necessary (one might note that the same observation has held true since at least the late-1960s!).

The paper features a section on "Future technology trends for modernization" that is of considerable interest for this study.[63] Recognizing that advances in sensors, weapons technology, and computer developments "seem likely to transform the conduct of traditional military operations at sea and especially on the land," the paper observes that the RMA's impact will be considerable, particularly in the areas of command and control and situational awareness. Regarding the former, the study notes that improvements in information processing and communications technology will gradually blur the line between tactical, operational, and strategic activity. Further, it predicts that future local commanders may be able to conduct their own long-range surveillance using sensors based on small robotic platforms.[64] The paper suggests that these developments offer the potential to "redefine" traditional command and control arrangements. It concludes that the flexibility of new communications systems will allow "ad hoc" arrangements to be created on short notice, even suggesting that there may be occasions when Canadian Forces' units may operate under the command of other government departments.

Like the other documents discussed above, this report also examines the problem of operability for the CF. It recognizes that in multilateral operations, national regulations concerning engagement raise the possibility of unintended or inappropriate use of military force. To avoid this problem, the paper suggests that "interoperability with the [United States Navy] will be critical to the future effectiveness of Canada's naval forces." However, the tone of the paper is such that the same observation would seem to hold for all three of Canada's military services. The report concludes that future military operations will occur with such speed and fluidity that it is critical that procedures for engagement be developed well in advance. As with the other department studies, then, the paper does not identify any special challenges that the RMA poses for Canada, and thus Canadian participation is believed to be largely a matter of national choice.

A fourth study, "The revolution in military affairs: A primer," was placed on the Department's web site in November 1998.[65] Intended to help frame the discussion at a DND-sponsored RMA conference/symposium recently held in Ottawa (see below), the report briefly reviews the evidence that an RMA is underway. This report cautions, however, that the RMA remains poorly understood, and it is unclear how military forces will ultimately be transformed. Shifting its attention to Canada, the report notes that "examining and understanding the [RMA] is vital if Canada is going to successfully compete in the future international environment," and that more "free thinking" and "experimentation" is required if DND and the CF are to better appreciate the need for change. The report concludes that the RMA has the potential to "touch all areas of our military structure," and that it is important not to become "overwhelmed" by it or become fixated on only one of its aspects. While the suggestion that there is a need for greater intellectual freedom and less operational rigidity within the department is an interesting one, the short length of the document (i.e., two pages) again lessens its overall importance.

Lastly, the most comprehensive review of the RMA yet done by the department is a paper written by Dr. Elinor Sloan, a policy analyst in the Directorate of Strategic Analysis.[66] This study, "The US and the RMA," examines what the RMA entails, changes to weapons systems that may result, and how the US is adapting to these developments. Its examination of the current US military debate is instructive, and the author is clearly familiar with recent American procurement and force structure discussions.

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63 Canadian Navy, "Future technology trends for modernization," in *Adjusting Course: A Naval Strategy for Canada*.

64 *Ibid*., p.2.

65 "The revolution in military affairs: A primer," (produced by the Vice Chief of the Defence Staff, http://www.vcds.dnd.ca/vcds/dgsp/dda/ rma/primer_e.asp).

66 Elinor Sloan, "The United States and the revolution in military affairs," (Ottawa, ON: DND, DSTRAT Project Report no.9801, February 1998).

The report, like the other DND documents, concludes that an RMA is occurring, but that "there is some reason to doubt" that it is presently at hand.[67] This is because there remains confusion over how military forces will ultimately be re-structured, and until this issue is resolved changes will primarily revolve around issues of technology. With time, however, the author argues that a more comprehensive vision will emerge, and advanced technologies will combine with new concepts of operations to create a truly revolutionary military force.

Emphasizing the concern with operability that is evident in all the DND studies, the paper notes that "America's pursuit of the revolution in military affairs could create a situation in which the US is increasingly unable to operate — as a result of technological, doctrinal, and/or organizational differences — with its allies and potential coalition partners."[68] The study concludes that if an operability gap develops, questions about the future viability of multilateral coalitions will be raised, not the least of which would revolve around the inability of US allies to perform alongside American military forces. This prospect raises the possibility of different "tiers" of Western allies in the future — a first tier consisting of the US (which would be capable of undertaking all future missions), a second which would include many European countries (capable of performing many, but not all, advanced warfare tasks), and a third consisting of all other allies (largely incapable of participating). While the report does not comment directly on Canada's RMA future, it does suggest that it is "imperative" that Canada begin to take the necessary steps that will allow this country to perform a wide array of future defence missions and tasks. Unlike the other DND studies, then, this is the only one to recognize that the RMA may pose a challenge to Canada, although the study is not precise as to the nature of the challenge or its specific causes or consequences. Still, its general tone of caution should be acknowledged.

While these five documents do not constitute a comprehensive department position, it is apparent that, at the present time, interoperability with the US is the dominant concern of DND. The department has concluded that the US leads the way in both defining and in introducing RMA-related technologies, and thus the main concern for the CF is to ensure that Canada should be able to play a part in future multinational coalitions. However, unless weapons, communications, and information systems are designed to be compatible with emerging American system architecture, this will not be possible. In short, DND thinking has focused on ensuring that the CF can "plug into" American systems and equipment.

Having noted that, though, DND has not yet offered a definition of what "interoperability" means for an RMA-equipped military, nor has it stated, in specific terms, how interoperability with the US military will be achieved. Rather, two assumptions are implicit in current DND thinking on the issue: (1) interoperability is a simple process of buying the right technology; and (2) interoperability poses few difficulties for either the US or its allies. While these assumptions may, in fact, be true, no evidence is presented that substantiates them. More troubling, however, is the fact that none of the DND studies examine what force requirements future coalitions may have (with the partial exception of Sloan's report), or how these requirements may be altered by concepts like "precision engagement" and "dominant manoeuvre", concepts that the US has identified as critical in future warfare operations.[69] Further, as noted, only one of the five studies recognizes the possible challenge that the RMA may pose for Canada. Rather, the principal — though largely unstated — assumption is that Canadian participation in the RMA poses no special difficulties for DND or the CF.

Perhaps recognizing that its lack of action and study needed to be addressed, in May 1998 the Canadian Defence R&D Branch and the Director General of Strategic Planning (DGSP) gave a presentation to the Defence Management Committee on the RMA. The following month, an operational working group was formed.[70] Most critically, a November 1998 DND-sponsored conference brought together about 200 military, civilian, and industry representatives, in an attempt to determine what Canada's RMA policy and approach should be. Based on the findings of the conference, the department is planning to produce a

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67 *Ibid*., p.vii.

68 *Ibid*., p.18.

69 These terms were identified in *Joint Vision 2010*, a 1996 document prepared by the US Joint Chiefs of Staff. Other key concepts examined in the document include "full dimensional protection" and "focused logistics." The study argued that when combined the four concepts would offer the US a degree of superiority over any other military force. See General John Shalikashvilli, *Joint Vision 2010*, (Washington, DC: DoD, 1996).

70 Telephone interview with Dr. Scott Robertson, member of the RMA Working Group, (September 29, 1998).

Concept Paper, titled "Canadian defence beyond 2010," to be completed by mid-1999.[71] But these steps cannot conceal the fact that DND has approached the issue late, and has yet to determine a comprehensive Canadian response or long-term RMA strategy. Section III of this paper will place the Canadian RMA experience in its broader context by examining how some other countries have approached the issue.

Canadian Defence Research and Development

The notable lack of DND comment on the RMA should *not* be interpreted to indicate that advanced information technology more generally is being ignored at DND. On the contrary, the department is keenly aware of the importance of technology in future combat operations, and the challenges that this poses for small states like Canada.[72] As one of the documents discussed above indicates, the department maintains a Research and Development Branch that provides defence science and technology research intended to improve Canada's defence capabilities. A brief review of the branch will reveal, however, that its focus lies more in improving the current operational capabilities of the CF, and not in pursuing advanced information/technology research that is expected to sustain military operations in the future.

Established when the Defence Research Board (DRB) was disbanded in 1974, the Defence R&D Branch currently employs about 1,200 people, many of whom are scientists and engineers. The branch's total budget is about $200 million, or about 2 per cent of the total annual DND budget. According to its mission statement, the Defence R&D Branch: (1) facilitates and enhances DND's ability to make informed decisions on defence policy, force development, and procurement by providing expert science and technology knowledge; (2) contributes to the success of military operations by pursuing R&D activities that provide improved support, knowledge, protection and response to potential threats; (3) enhances the preparedness of the Canadian Forces by assessing technology trends, threats and opportunities and by exploiting emerging technologies; and (4) supports government objectives by contributing to the creation and maintenance of a Canadian defence science and technology industrial capability that is internationally competitive.[73]

The Defence R&D Branch maintains five separate Defence Research Establishments (DREs) where research is conducted — DRE Atlantic, DRE Valcartier, DRE Ottawa, DRE Suffield, and the Defence and Civil Institute of Environmental Medicine, in Toronto. Of the five, it is the Valcartier and Ottawa bases that conduct the most high technology-relevant research, as the former is the main centre for R&D related to combat systems, surveillance, and command information systems, while the latter carries out research in electronic warfare, radar, space systems, and telecommunications.[74]

According to the Valcartier base's web site, Valcartier's activities are primarily concentrated in three areas: electro-optics and surveillance, weapons systems, and command and control information systems.[75] While interesting and CF-relevant research is conducted at Valcartier, it is questionable whether it is

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71 Chapters of this paper will include "Operational issues," "Science and technology," "Material requirements," and "Canadian industry." As discussed by Dr. John Leggat, Chief, Defence Research and Development Branch, at "Canadian defence beyond 2010" conference, Ottawa, November 30, 1998. The conference featured speakers with considerable experience with the RMA, including Dr. James Blaker, former senior advisor to Admiral Owens, and Mr. Martin Earwicker, who spoke on the UK's Strategic Defence Review (see Section III). The Canadian Minister of National Defence, the Honourable Art Eggleton, also spoke at the conference, where he noted that Canada "started rather late" in exploring the RMA, and that decisions "which cannot be ignored and must not be deferred" were quickly approaching.

72 Indeed, DND has recently formed a Directorate Infrastructure in Information Technology. This directorate may have the department's most confusing mission statement - "to support the delivery and life-cycle management of departmental infrastructure through development and implementation of construction engineering information technology processes and services that respond to demands for integrated infrastructure management at the operational, tactical, and strategic levels of the Department of National Defence and the Canadian Forces." (http://www.dnd.ca/ admie/dgcps/diite).

73 Defence Research and Development, "The Branch Mission," (http://www.crad.dnd.ca/branch).

74 Defence Research and Development Board, *Science and Technology for the New Century*, (Ottawa, ON: 1996, http://www.dnd.ca/dinfo/ dgpa/st/defence-e.html), p.4.

75 DRE Valcartier, "Defence research establishment Valcartier," (http://www.drev.dnd.ca/capab_e.html).

particularly RMA-relevant, as few of the base's specializations figure prominently in the emerging "system of systems." For example, only two are directly related to sensor technology, satellite systems, communications, or computer networks.[76] Rather, most seem relevant to the present operational missions of the CF, and thus appear aimed at improving and/or enhancing equipment that is *currently* deployed. Similarly, the same observation holds true for the Ottawa base, where research in the electromagnetic spectrum is conducted. The base's Fact Sheet[77] lists a total of eight areas of research specialization (including surface radar, radiation technology, electronic warfare, and navigation), each of which corresponds closely to a current requirement of the CF. While the research activities at Valcartier and Ottawa are hardly surprising (in that they meet one of the objectives of the Branch), they indicate that DND's focus appears to be on research that can pay immediate benefits for the CF, rather than on longer-term technologies and capabilities that go beyond current military requirements.

The 1996 study *Science and Technology for the New Century* (in the area of defence research and development) offered evidence of this emerging research distinction. The report lists a total of nine "defence system areas" that are currently addressed by the Defence R&D program: surveillance and target acquisition, electronic warfare, undersea warfare, command information systems, air vehicles, naval platforms, combat systems, human systems integration, and life support systems.[78] While important, only one of these areas — command information systems — has any direct bearing on the RMA. The others relate primarily to operational issues and concerns that are unlikely to increase the capability of DND (and the CF) to function in a combat environment which prioritizes information flows and knowledge-based systems. This suggests that DND appears content to leave such research to others (particularly the private sector, see below), and that the department expects to eventually purchase the relevant technology and/or systems by way of commercial transaction. This approach may be problematic, however, as without a workforce trained and accustomed to using advanced technology, the department may experience difficulties in fully utilizing the capabilities of such equipment. In addition, over time a form of dependence is likely to develop, whereby DND becomes reliant on (foreign) purchases to address weaknesses in technology applications. Thus, while meeting one of its objectives, the Defence R&D Branch is failing to meet another: enhancing the preparedness of the Canadian Forces by assessing technology trends and by "exploiting" emerging technologies.

If one examines the comparable American establishment, the Defense Advanced Research Projects Agency (DARPA), the differences between the two national defence research establishments become readily apparent. Besides having a substantially larger budget,[79] the US agency has a radically different focus. While the Canadian Defence R&D Branch channels its energy into meeting current operational requirements, DARPA's focus is in developing the technologies that will allow American military forces to dominate the future battlespace information environment. DARPA is currently conducting research in computing systems architecture, software technology, common interoperable services, scalable network technologies, system architecture, mobile computing and networking, system management, security and survivability technologies, and large-scale system design and integration technologies.[80] As this list makes clear, DARPA is *not* conducting research on currently deployed military systems. Rather, much of its research is related to technologies relevant to command and control and advanced information systems, and indicates that the US military establishment believes that these are the areas where future advances will have the greatest impact. It might also be noted that while each of these areas is of interest to the private sector (and is generating substantial private sector R&D), DARPA has obviously concluded that federal funding might advance the research timetable. Without wanting to dwell on the differences between the two agencies, these are the technologies that will determine the pace and structure of future military operations.

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76 The two specializations are in "Space systems and technologies for defence applications" (listed under electro-optics and surveillance systems) and "National level command and surveillance" (listed under command and control information systems). See *Ibid*.

77 Defence Research Establishment Ottawa, "DREO Fact Sheet Library," (http://www.dnd.ca/pages/factsheet/library).

78 *Science and Technology for the New Century*, p.3.

79 DARPA's budget is about $2 billion. Given the difference in size between Canada and the US, the budgets of the two agencies' are quite compatible (although less so given the disparity between the two countries' currencies, which reduces the Canadian program to $125 million US).

80 DARPA Information Technology Office, (http://www.darpa.mil/ito).

Canada's High Technology Sector

Canada's uncertain response and potential for the RMA is not simply attributable to DND's relative lack of attention and limited R&D base, however. Rather, an additional factor that must be considered when determining Canada's RMA future is this country's civilian experience, competence, and infrastructure in advanced technology and information systems. Indeed, in the US, commercial off-the-shelf technology (COTS) is driving the RMA, technology developed by private American companies.[81] This American convergence between the private sector and the military can be expected to continue in the future, as the information revolution strengthens still further. Thus, this section of the paper will examine Canada's civilian technology sector, in an attempt to determine whether it will be able to supply DND with the array of equipment, systems, and platforms upon which the RMA is based.

Any objective analysis of the Canadian technology sector must ultimately come to one basic finding — Canada lacks the high technology base of the US, and there is little indication that Canadian industry is successfully addressing this weakness. While this country has an active and growing technology industry, much of the work is in specialized niche areas and markets, not in the core technologies that offer the greatest potential. This does not bode well for DND, which may find it difficult to "borrow" technologies developed in the Canadian private sector, and will thus be forced to purchase American technologies. However, as noted above, DND may experience problems in operating and maintaining systems that: (1) were not developed in Canada; and (2) rely on civilian expertise that is not easy to generate.

If one examines the core technologies that are pushing the information revolution — computers, computer networks, digitization, software, and high-speed communications — it is evident that there is very little domestic Canadian research being conducted (with the partial exception of the last area). While there are isolated Canadian companies doing leading-edge research, the general picture that emerges from an investigation of the Canadian technology sector is one of uneven development and uncertain prospects, and hence one that has limited expertise to offer DND in its effort to become more technologically proficient. In many ways, the picture is unchanged from that of a decade ago, when a federal government study concluded that "Canada... has not seen technological innovation as a strong card."[82]

While fully documenting the size and structure of the Canadian technology sector lies outside the scope of this paper, there are several indications that suggest that this country has not developed a broad-based civilian high technology base. For example, Canada features only two major computer networking companies, Newbridge Networks and Northern Telecom, but the former is increasingly the subject of take-over rumours,[83] while the latter is a "mature" technology company that is trying (somewhat desperately, according to some) to reconfigure itself into an information one.[84] Canada also features just two principal

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81 There are so many leading-edge American technology companies that listing them would prove virtually impossible. However, some companies do stand out for the industry standard that they continue to set: Intel (chip design); IBM (large frame computers and information networks); Sun Microsystems (software); Cisco Systems (network applications); Lucent Technology (telecommunications and networking); Motorola (wireless and semiconductors); EMC Corporation (information and data storage); and, Texas Instruments (semicondutors).

82 Guy P. Steed, *Not a Long Shot: Canadian Industrial Science and Technology Policy*, (Ottawa, ON: Science Council of Canada, 1989), p.40.

83 Much of the takeover speculation can be linked to Newbridge President Terrence Mathews, who in September 1998 dramatically changed his public stance on the issue. Prior to that time, Mathews was adamantly opposed to any takeover, threatening to take his engineering staff with him in the event of a hostile buy-out. This "scorched earth" policy (as some analysts dubbed it) effectively reduced interest in a possible takeover for several years. However, after consecutive quarters of reduced profitability, Mathews stated in the fall of 1998 that he was not necessarily opposed to a Newbridge buy-out, and that if the right offer came along he would give it serious consideration. Since that time, the stock has been propelled by persistent speculation that either the German giant Siemens AG or Lucent Technologies of the US will buy the company.

84 Northern Telecom is a large company (1997 revenues of US$10 billion) that is attempting to redefine and broaden its products and services (away from its established telephone equipment and switching systems). Its May 1998 purchase of Bay Networks, a US-based networking company, demonstrated the company's resolve to broaden and

software companies, Corel Corporation and Cognos, both of which are having difficulty maintaining market share against much larger American competitors. Indeed, for several years in the mid-'90s, the fortunes of virtually the entire Canadian software industry rested with Corel, a relatively small company which owed most of its success to one product (CorelDRAW). When Corel attempted in 1996 to diversify its product line and challenge Microsoft in the core operating system and word processing markets, the results were predictable (i.e., unsuccessful). While there are other examples of domestic Canadian technology companies competing effectively — ATI Technologies, JDS Fitel, Discreet Logic, and Spar Aerospace to name a few — all of these companies have identified niche markets in which to specialize, and thus have not produced the "spin off" effect so common in the technology industry.[85] The net result has been a general lack — with three or four notable exceptions — of internationally competitive, publicly-traded companies, the most obvious manifestation of a healthy industry.

While Canada has succeeded in attracting successful American technology companies to form Canadian subsidiaries (much like the automotive branch plants in Eastern Canada), this cannot conceal the fact that there is a general lack of domestically-bred Canadian competitors. While IBM Canada, Microsoft Canada, Compaq Canada, and Dell Canada employ thousands of Canadians (and whose workforce numbers will undoubtedly grow in the years ahead), these "information branch plants" add little to the Canadian R&D base. As was the case with heavy manufactured goods, information branch plants do not conduct significant research and development, nor do they specialize in advanced product design. In addition, like all branch plants, any profits that these divisions generate return to the US head office.

Perhaps of even more concern is the failure of Canadian universities and post-secondary institutions to train and develop an adequate number of graduates in information technologies.[86] This failure has had two broad implications: (1) Canada has become a haven for foreign-trained technology specialists;[87] and (2) Canada has had difficulty developing a "critical mass" of technology companies, the level at which there is domestic expertise in most core areas. While Canada is hardly alone in having a shortage of information specialists (even the US accepts large numbers of foreigners to fill job vacancies), the costs of this failure are particularly high in Canada, as no other country features a technological colossus on its border which is able to attract the best graduates. Thus, not only does Canada not produce enough information technology professionals, but many are immediately enticed to work for American corporations.[88]

An additional concern in the overall technology picture is Canada's poor record in research and development, one that raises numerous questions, especially considering that it is widely acknowledged that R&D is the engine behind a successful presence in high technology. In this regard, by almost any measurement, Canada's R&D performance is unacceptable. In terms of total spending, the Canadian

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expand its market, but it is not yet clear if it has the technology or the resources to compete against US giants like Cisco Systems and Lucent Technologies.

85 The possible exception to this characterization is JDS Fitel, which is developing fibre optic technology for a wide range of possible applications. Other relatively successful Canadian technology companies like Geac Computer and the CGI Group are largely reseller and service companies which offer little domestic production or innovation capability. An additional concern is that Canadian companies pose attractive investment opportunities for larger competitors (as discussed in note 83 above). Perhaps the best recent example of this practise was the purchase of Toronto's Alias Communications by Silicon Graphics in 1997. Several years earlier, Canada's biggest computer support company, SHL Systemhouse, was bought by MCI Communications. Lacking both the size and market capitalization of their larger American rivals, Canadian companies have few options in resisting determined takeover efforts.

86 It might be noted that several government studies have concluded that a growing percentage of the Canadian work-force is moving steadily into the information technology sector, and that the Canadian economy is undergoing a period of dramatic structural change. However, none of the reports identify the precise make-up of the Canadian technology industry, and thus it is impossible to determine how the sector is defined. See, for example, Industry Canada, *The Knowledge-Based Economy: Shifts in Industrial Output*, (Ottawa, ON: Queen's Printer, 1997) and Industry Canada, *Building a More Innovative Economy*, (Ottawa, ON: Queen's Printer, 1994).

87 See "Canada a haven for foreign talent," *The Globe and Mail*, (October 8, 1998).

88 For some additional observations, see the Honourable Ronald J. Duhamel, Secretary of State for Science, Research, and Development, "Taking action: The IT skills crisis workshop," (speech given on May 21, 1998, http://info.ic.gc.ca/cmb/welcomeic. nsf).

government spent $3.5 billion in research and development in 1996, which represented about 2% of the federal budget (of approximately $150 billion).[89] In terms of total expenditures on R&D as a percentage of gross domestic product (GDP), Canadian spending has hovered around 1.5% for the last twenty years.[90] Both of these numbers do not compare favourably with other Western countries, particularly the US. For example, in 1995, the US government spent $61 billion in federally funded R&D, out of a total budget of roughly $1.5 trillion — representing about 4% of government expenditures.[91] Further, as a percentage of GDP, American expenditure on R&D averages around 3%, or roughly double the Canadian level. In fact, among members of the G-7, Canada ranks last in terms of R&D spending.[92]

While the federal government is increasingly aware of the problem — for example, the recent report *Science and Technology for the New Century* emphasized the importance of federally funded R&D — another critical difference between Canada and other advanced countries is this country's low level of R&D spending by industry. Canadian industry accounts for roughly half of all Canadian expenditures in R&D. While this represents an increase from the 30% figure in the 1970s, it still falls well short of the level of other major industrial actors (where industry R&D is often above 70%). Among the most frequently cited reasons for this failing are the relative small size of Canadian businesses, the resource emphasis of the Canadian economy, and traditional high levels of foreign ownership.[93] Regardless of explanation, Canada's poor industry-related R&D record is a source of concern, as it indicates a private sector failure to appreciate that future competitiveness will be at least partially dependent on the establishment and maintenance of a domestic innovation capability. It also indicates that Canadian companies are far less likely than their international competitors to pursue novel solutions to problems, a failing that may say as much about Canada as it does about Canadian industry per se.

Canada's mixed technology record is of particular concern considering that the Defence R&D Branch increasingly relies on the private sector for technologies that have defence applications. For example, over half of all defence research in Canada is now undertaken outside the department. According to *Science and Technology for the New Century*, "the private sector is looked to for applications of technology that can be translated into equipment and systems that will enhance the capability of the Canadian Forces and are affordable and technically competitive in the international market."[94] The report also notes that "there is a close linkage between expenditure on defence R&D.... and the growth of many high technology sectors." While DND's model of successful private sector-military cooperation is undoubtedly the US, the relationship is unlikely to be re-created here. Given Canada's small private-sector technology base, DND will not be able to rely on domestic private sector innovation for technologies with military applications, nor will it be able to encourage the symbiotic relationship between government and industry that has worked so effectively in the US.

This paper will not identify the steps that Canada can take to improve this situation, but it can briefly highlight some of the differences between Canada and the US that have resulted in such divergent technology prospects. In the US, a massive apparatus exists to fund and encourage cutting-edge science and technology research — not only in the defence sector, but in many other areas as well. The National Laboratories, the Department of Defense,[95] and the National Institutes of Health form an informal governmental network that

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89 Figure from Government of Canada, *Science and Technology for the New Century: A Federal Strategy*, (Ottawa, ON: Minister of Supply and Services, 1996), p.22.

90 Steed, *Not a Long Shot*, p.45.

91 Figures from "DoD Science and Technology," (Institute for National Strategic Studies, 1997, http://www.ndu.edu/ndu/inss/books/ dodsnt).

92 The US also spends an estimated 4% of GDP on information technologies, a figure that dwarfs that of all other countries. While no comparable figure is available for Canada, it is likely around 1.5% given the small Canadian technology base and generally poor R&D record. In terms of comparison, Sweden is second behind the US at 3.3%, while Britain is third at 3.2%. The EU as a whole spends 2.2% of GDP on information technology. See "Economic indicators," *The Economist*, (Nov. 14, 1998).

93 Steed, *Not a Long Shot*, p.45.

94 Defence Research and Development Branch, *Science and Technology for the New Century*, p.2.

95 Within DoD, the individual services maintain their own laboratories where further advanced research is conducted. For example, the Naval Research Laboratory employs 3,600 personnel, and in conjunction with the Office of Naval Research, conducts work in areas which might impact future naval operations. Nor are the services content with the

can identify areas of concern and initiate research. Furthermore, there is a secondary branch of universities and institutes of higher learning — most of which depend on private funding — that have established large-scale research facilities, and continually attract leading researchers. The combination of public and private resources in the US is unmatched, and ensures that the US drives the research agenda in most science and technology fields. Lastly, there is a business climate that encourages risk and which features an enormous amount of investment and venture capital. Together, these factors combine to give the US an enormous advantage in literally any field that prioritizes scientific-based research and development.[96]

Overall, then, Canada's limited civilian technological base, in combination with DND's small size and lack of study, does not bode well for Canadian participation/involvement in the RMA. However, before alarm bells should ring, the question of relevance needs to be considered. Specifically, DND's operational missions need to be examined, and there is a need for reflection on which missions are likely to become more important over the next several decades. In brief, if peacekeeping/low intensity conflict (LIC) can be expected to become the principal operational mission of the CF (as they seem to be at present), this raises important questions about the RMA's significance for Canada, as RMA-equipped militaries are primarily geared to fight high-intensity conflicts (HICs) against opponents using traditional forces and strategies (a point that will be developed below). Thus, it is critical to review the CF's missions, and determine how well they correspond to the RMA.

The Operational Missions of the Canadian Forces

As outlined in the *1994 Defence White Paper*, the fundamental mission of DND and the CF is to defend Canada and Canadian interests and vales while contributing to international peace and security. In the more recent *1997 Canadian Defence Planning Document*, three defence roles are identified: (1) the defence of Canada, which involves the protection of Canada's national territory and areas of jurisdiction; (2) the defence of North America in cooperation with the US, including the protection of Canadian approaches to the continent; and (3) contributing to international peace and security, which includes participating in a "full range" of multilateral operations through the UN, NATO, and other organizations and coalitions of like-minded countries.[97]

This list thus includes a very broad range of conflict contingencies, ranging from aid to the civil power and traditional peacekeeping to high-intensity combat.[98] While this range is impressive, it is peacekeeping that has been the most common operational mission of the CF in the post-war period, with the frequency of such operations increasing dramatically in the post-Cold War era. Thus, while Canada participated in 19 UN and non-UN peacekeeping missions between 1947 and 1986, the number has ballooned to more than 25 since 1988.[99] At the same time, this country's support for NATO and the defence partnership

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current level of R&D. In the 1990s alone, the US Air Force has established six new weapons labs that specialize in RMA-related applications. Further, US defence labs maintain close ties with the private sector, and can thus tap into a vast array of commercial companies and technologies.

96 For a recent assessment of these differences, see John Walsh, "The technological renaissance and the role of government in technology with special reference to the carbon dioxide problem," (September 1997, http://infoweb.magi.com/-dwalsh).

97 Department of National Defence, *1997 Canadian Defence Planning Document*, Section 2, p.1.

98 The White Paper discusses the need to maintain combat capable forces in some detail. As it notes, "the government has concluded that the maintenance of multi-purpose, combat-capable forces is in the national interest. It is only through the maintenance of such forces that Canada will be able to retain the necessary degree of flexibility and freedom of action when it comes to the defence of its interests and the projection of its values abroad." *1994 Defence White Paper*, p.13.

99 Alex Morrison has noted that there were 18 such missions between 1988 and 1993. Since that time, additional peacekeeping/ peacebuilding operations with CF involvement have included the UN Assistance Mission in Rwanda (UNAMIR), a Military Observer Group in the Dominican Republic, the NATO Implementation Force (IFOR) in the former Yugoslavia, the UN Mission in Bosnia-Hercegovina (UNMIBH), the UN Preventive Deployment Force in the Former Yugoslav Republic of Macdeonia (UNPREDEP), the NATO Stabilization Force (SFOR) in Bosnia, the UN Support Mission in Haiti (UNSMIH), the UN Transition Mission in Haiti (UNTMIH), and the UN Mission in the Central African Republic (MINURCA). See Alex Morrison, "Canada and peacekeeping: A time for reanalysis?

with the US (codified through NORAD, see below), has declined precipitously.[100] This has therefore resulted in a significant increase in the importance of peacekeeping relative to DND's other missions, a trend which seems likely to continue.

While the definition of "peacekeeping" has recently broadened to include assignments which, in the past, would have been regarded as war (as in Somalia and Bosnia), the need for such missions appears likely to increase. Indeed, considering that many scholars believe that ethnic conflicts are likely to multiply in the future,[101] and that weak states throughout the world appear set to implode,[102] it seems clear that there will be an ever-growing demand for forces that can both act as a barrier between warring parties and persuade these parties to return to the bargaining table. And unlike Canada's weakening alliance commitments, peacekeeping generates considerable support from the Canadian public, with Denis Stairs noting that the 1994 parliamentary reviews of defence and foreign policy "established beyond any doubt that there was massive support in the country at large" for peacekeeping.[103]

An important factor favouring a further increase in the number of Canadian peacekeeping missions is the broader conception of security that has become widely accepted by the Canadian government, particularly within the Department of Foreign Affairs and International Trade (DFAIT). Foreign Affairs Minister Lloyd Axworthy has championed this conception, which has focused on the phrase "human security." According to a 1997 article written by Axworthy, human security "includes security against economic privation, an acceptable quality of life, and a guarantee of fundamental human rights."[104] In a broader definition, the Minister goes on to note that "sustained economic development, human rights and fundamental freedoms, the rule of law, good governance, sustainable development, and social equality are as important to global peace as arms control and disarmament."[105] Axworthy has also discussed the importance of "soft security," a phrase that recognizes that security threats in many parts of the world do not come from conventional weapons platforms, but from a lack of shelter and adequate protection of human rights. Economic development is tightly woven into the term, as poverty and underdevelopment frequently represent tangible security threats to individuals.[106]

The emphasis on soft/human security is unlikely to diminish in the near future. In October 1996, DFAIT announced the launching of the Canadian Peacebuilding Initiative, a joint project between Foreign

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In David Dewitt and David Leyton-Brown (eds.), *Canada's International Security Policy*, Scarborough, ON: Prentice Hall Canada, 1995), p.217. For details on Canadian missions since 1993, see "Canada's military legacy," (http://www.dnd.ca/menu/legacy/global).

100 See Dean Oliver, "The Canadian military after Somalia," in Fen Hampson and Maureen Appel Molot (eds.), *Canada Among Nations 1998: Leadership and Dialogue*, (Toronto, ON: Oxford University Press, 1998). See also Joseph T. Jockel and Joel Sokolsky, *The End of the Canada-US Defence Relationship*, (Kingston, ON: Queen's University Occasional Paper, no.53, 1996).

101 Literature in this area has grown rapidly in the past few years. For a general overview, see V.P. Gagnon, Jr., "Ethnic nationalism and international conflict," *International Security*, vol.19, no.3, (Winter 1994/95); Michael E. Brown, *Ethnic Conflict and International Security*, (Princeton, NJ: Princeton University Press, 1993); Kamal S. Shehadi, *Ethnic Self-Determination and the Break-up of States*, (London: International Institute for Strategic Studies, Adelphi Paper 283, 1993); and Ted Gurr and Barbara Harff, *Ethnic Conflict and World Politics*, (Washington, DC: Westview Press, 1994).

102 Literature on the weak state phenomenon, while not as extensive as that of ethnic conflict, has also grown in recent years. For an introduction to the subject, see Kal Holsti, *The State, War, and the State of War*, (Cambridge: Cambridge University Press, 1996); William Zartman (ed.), *Collapsed States: The Disintegration and Restoration of Legitimate Authority*, (Boulder, CO: Westview Press, 1995); and Robert Jackson, *Quasi-States: Sovereignty, International Relations and the Third World*, (Cambridge: Cambridge University Press, 1990) and *Surrogate Sovereignty? Great Power Responsibility and "Failed States*, (Vancouver, BC: Institute of International Relations, University of British Columbia, 1998).

103 Denis Stairs, "The public politics of the Canadian defence and foreign policy review," *Canadian Foreign Policy*, vol.3, (Spring 1995), p.105.

104 Lloyd Axworthy, "Canada and human security: The need for leadership," *International Journal*, vol.52, no.2, (Spring 1997), p.184.

105 *Ibid*., p.184.

106 For a recent review/critique of Foreign Minister Axworthy's policies, see Fen Osler Hampson and Dean Oliver, "Pulpit diplomacy," *International Journal*, vol.53, no.3, (Summer 1998).

Affairs and the Canadian International Development Agency (CIDA). The aim is to develop a more comprehensive approach to peacekeeping/peacebuilding, and to strengthen Canada's overall contribution to it. According to DFAIT's web site, peacebuilding is defined as "the effort to strengthen the prospects for internal peace and decrease the likelihood of violent conflict. The overarching goal of peacebuilding is to enhance the indigenous capacity of a society to manage conflict without violence." In an addendum, it is noted that the definition covers peacebuilding in pre-, mid-, and post-conflict situations.[107] A range of possible peacebuilding activities are also listed, which represent a very broad range of conflict situations.[108]

Thus, the expanded notion of security in Canada, combined with the emphasis on peacebuilding, indicates a dramatic increase in the range of possible missions which might employ Canadian peacekeepers and/or ground forces. While the stated goal of peacebuilding is to reduce the likelihood of violence, the reality in much of the world is that resolving conflicts through the use of force is an accepted, albeit painful method of conflict resolution. And despite its relatively small size and military, Canada may feel obligated to contribute forces to UN missions given its public pronouncements and international profile. Indeed, as indicated by our expanded involvement in peacekeeping since 1990, this pressure can already be felt and is likely to increase as some larger countries (particularly the US) demonstrate an unwillingness to participate in such assignments.

While DND has reacted with apprehension to Axworthy's initiatives, the department realizes that, in the post-Somalia scandal-plagued military, it is DFAIT that is largely determining Canada's security policy. Thus, while the military would prefer to focus on the combat-oriented defence missions that the *1994 White Paper* identified, such assignments are growing increasingly unlikely given a federal government that either does not approve or understand the need for the CF to maintain a traditional combat-readiness posture.[109] Lastly, while there is reason to suspect that a Conservative or Reform federal government would disassociate (if not repudiate) much of DFAIT's current peacekeeping/ peacebuilding initiative, it remains difficult, given current electoral trends, to conceive of either of these parties achieving power in the near-term.

The question that is raised by this analysis, however, is to what extent is the RMA relevant in such missions, and has DND's relative lack of study (and action) had any substantive costs? In this regard, preliminary evidence indicates that RMA technologies are *not* geared for peacekeeping/LIC missions. As Steven Metz and James Kievit have noted,

> "emerging technology may improve the application of force in conflict short of war, but there is probably no imminent RMA in this arena. The changes in conflict short of war will be considerably less dramatic than in those projected for mid- to high-intensity combat, particularly when possible constraints or countermeasures are considered."[110]

As Metz and Kievit explain, there are a number of constraints on applying the RMA and its associated technologies to LICs. These include the lack of a powerful institutional advocate, a general shortage of money for the development of technologies specifically formulated for such missions, and the possibility that new technology may run counter to Western values.[111]

This finding has been repeated in several other studies. For example, a 1995 policy paper written for the American Institute for National Strategic Studies found that while some RMA technologies have a "dual use" capability, most are poorly designed to be used in operations other than war (OOTW). Indeed, recognizing that advanced technologies were unlikely to be developed for such missions, the paper concluded that "it is important that OOTW technologies have a warfighting application if they are to be developed and used."[112] The study suggested that those technologies that lacked this capability — for example, mine

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107 Department of Foreign Affairs and International Trade, "Canada and peacebuilding: The Canadian peacebuilding initiative," (http:///www. dfait-maeci.gc.ca/ peacebuilding/cpi activities).

108 Peacebuilding activities include early warning, environmental security, physical security, individual security, human rights, conflict resolution, social reconstruction, governance and democratic development, institutional/civil capacity building, policy development, and training. See *Ibid*.

109 For a review of the current state of DND-DFAIT relations, see Oliver, "The Canadian military after Somalia."

110 Steven Metz and James Kievit, "The revolution in military affairs and conflict short of war," US Army War College, (July 1994, http://carlisle-www.army.mil/usassi/ ssipubs/pubs94/rmacsw).

111 *Ibid*., p.2.

112 Institute for National Strategic Studies, "Operations other than war (OOTW): The technological dimension," (November 1995, http://www.ndu.edu/ndu/inss/books/ootw/ootwhome.html).

clearing and counter-mortar capabilities — would suffer as a result. More recently, two senior US military officials have concluded that the advanced technologies associated with the RMA are "not relevant to [missions including] peacekeeping, urban warfare, or asymmetrical threats." These officials believe that the RMA is narrowly focused on high-end warfare, and thus militaries based on it will be incapable of intervening in conflicts that do not correspond with the model.[113]

Perhaps the best known strategist to examine this question in detail is Martin van Creveld, who has argued that LICs, terrorism, and other small-scale operations will dominate conflict operations in the future.[114] This shift does not bode well for high technology weapons, which have previously been proven largely ineffective in such missions. As he has concluded,

> "the shift from conventional war to low-intensity conflict will cause many of today's weapons systems, including specifically those that are most powerful and most advanced, to be assigned to the scrap-heap. Very likely it will also put an end to large-scale military-technological research and development as we understand it today."[115]

While the RMA thesis strongly challenges — and I would argue repudiates — Van Creveld's prediction about the end of advanced military R&D, his observations on low intensity conflict appear to be accurate. Recent conflicts in Somalia, the former Soviet Union, and much of Sub-Saharan Africa all featured small arms and made relatively little use of sophisticated military platforms.[116] Further, conflicts within imploding/failed states and those driven by ethnic rivalries are likely to share these characteristics, as non-state actors have traditionally experienced difficulty in both acquiring and effectively using advanced military equipment (see note 51).

Thus, if one conceptualizes the utility of RMA technologies along a conflict continuum, LIC/peacekeeping operations would constitute one end of the scale, with large-scale warfare at the other end. This spectrum can be diagrammed as follows:

Figure 1. RMA Relevance Along the Conflict Spectrum

LIC	Terrorism	Peacekeeping Peacemaking Peacebuilding	Border Clashes	Conventional War	HIC

Less RMA Relevant — More RMA Relevant

As can be seen from the table, *the RMA is less relevant in precisely those missions that the CF is most likely to be called upon to perform* — peacekeeping, humanitarian intervention, and other LIC missions. The technological requirements of advanced technology, combined with the emphasis on sensing equipment, simply does not translate well into conflicts at the low end of the spectrum, and may even be counterproductive in some cases.[117] As but one example, in peacekeeping operations a significant physical presence lies at the heart of the operational mission, as personnel are present to enforce a peace through visibility and maintain local stability through facilitation and mediation.[118] There is therefore a basic

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113 Paul Van Riper and F.G. Hoffman, "Pursuing the real revolution in military affairs: Exploiting knowledge-based warfare," *National Security Studies Quarterly*, vol.4, issue 3 (Summer 1998), p.4.

114 Martin van Creveld, *The Transformation of War*, (New York, NY: The Free Press, 1991).

115 *Ibid*., p. 205.

116 More accurately, such conflicts featured a hybrid of both antiquated and modern military equipment.

117 Institute for National Strategic Studies, "Operations other than war (OOTW)."

118 Allen Sens, "RMA or EMA: Emerging technologies, Canadian security, and the Canadian armed forces," (paper presented to the 1998 Political Studies Students' Conference, Winnipeg, Manitoba, Feb. 1998), p.14.

contradiction between this type of mission and the use of advanced technologies that are intended to reduce the need for forces on the ground.

Overall then, despite attempts to portray RMA technologies as useful in LIC/peacekeeping operations, the reality is that such technologies are generally ill-suited to these missions. While precision targeting, real-time battlespace knowledge, and advanced command and control facilities will transform the concept of military force on the conventional battlefield, they do not have much relevance in environments where the opponent does not mass his troops (indeed, he may not have any troops), where the major weapons systems are generally small arms, and where the engagements are not carefully orchestrated joint weapons campaigns, but hit-and-run attacks and street shoot-outs. Whereas it is true that some RMA technologies also promise advances in forms of "non-lethal" warfare (which have the potential to deter and disarm through non-lethal means), this is still an area where much research needs to be done.[119] Thus, for the types of missions that the CF can be expected to be called upon most often, RMA technologies are of little utility.

While LIC/peacekeeping operations are an increasingly important part of DND's operational mission, they are by no means the only conflict scenario that the CF need be concerned about. A second critical mission that the CF performs is the defence of North America in cooperation with the US. This is largely done through participation in the North American Aerospace Defence Command (NORAD), a Canada-US command that continues to form the cornerstone of bilateral defence cooperation. Originally signed in 1958 to protect against a Soviet bomber attack, NORAD is an air defence system that has gradually been modified to reflect changing strategic realities. According to the 1996 renewal, NORAD's warning missions include the monitoring of objects in space, and the detection, validation, and warning of attack against North America whether by aircraft, missiles, or space vehicles, while its control missions include the control and surveillance of airspace of both Canada and the US.

Since the late 1970s, the operational mission of NORAD has changed to reflect an increased concern with space-based weapons and assets. In 1985, the Pentagon established the United States Space Command (USSPACECOM), a unified command that drew on the space assets of the three services, primarily the missile warning and space surveillance systems of the US Air Force Space Command (USAFSPACECOM).[120] The commander of USSPACECOM was also made the commander of NORAD. As a result, the distinction between traditional NORAD systems like the North Warning System (NWS) and other systems operated by USSPACECOM for ballistic missile warning or defence has gradually blurred, a process that has continued to the present day.

This interest with space has intensified in recent years. Indeed, according to the recent document *NORAD Vision 2010*, "space is key to NORAD providing a credible defensive shield over North America. Space-based assets have many advantages over conventional surveillance and communications systems, particularly in their continuous availability and global presence."[121] At present, USSPACECOM operates a series of space-based systems, including the Defense Satellite Communications System, the Defense Support Program, the Ground-Based Electro-Optical Deep Space Surveillance, the NAVSTAR Global Positioning System (GPS), the Milstar Satellite Communication System, and the Theatre Ballistic Missile Warning System (TBMW).[122] In addition, sometime within the next decade (perhaps as early as 2003), the US will likely deploy a national missile defence (NMD) system, one that will attempt to defend the continental US (and likely parts of Canada) from a limited ballistic missile attack.[123]

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[119] The 1995 American experience in Somalia gave impetus for research into technologies that can demobilize individuals without resulting in casualties. A Joint Non-Lethal Weapons Office was established, which to date has funded a total of 12 projects, ranging from foam applications to a portable vehicle immobilization system. See *Jane's Defence Weekly*, "Measure for measure," vol.29, no.25, (June 24, 1998). Also see Nick Lever and Steven Schofield, *Non-Lethal Weapons: A Fatal Attraction?*, (London: Zed Books, 1997).

[120] Joel Sokolsky, "The bilateral defence relationship with the US," in *Canada's International Security Policy*, p.178.

[121] "North American air and space defence," *NORAD Vision 2010*, (http://www.spacecom.af.mil/ norad/airand).

[122] See NORAD web site (http://www.spacecom.af.mil/norad/noardfs. htm).

[123] The system, which has avoided the publicity of its predecessor, the Strategic Defense Initiative, enjoys support from key Republican and Democratic representatives. While several components have not progressed as expected (in particular the Theatre High-Altitude Area Defense), the Pentagon continues to prioritize the program. See *Jane's Defence Weekly*, "USA seeks defence 'shield' sites," vol.30, no.21, (November 25, 1998) and *Jane's Defence Weekly*, "US work to fix THAAD problems enters overdrive," vol.30, no.15, (October 14, 1998). For a review of

In addition to the interest in space, *NORAD Vision 2010* outlines five new concepts "to meet the security challenges of the 21st century." The five are: (1) precision tracking; (2) precision engagement; (3) integrated battle management; (4) focused logistics; and (5) information superiority. It deserves emphasizing that *each* of these concepts is intimately connected to the RMA. Highlighting the revolutionary nature of these missions, *NORAD Vision 2010* notes that "a system of systems linking networks of sensors, command and control, and shooters will allow NORAD to... increase (its) combat power. Timely relevant information will provide highly accurate and near real-time shared battlespace awareness to create a seamless (action) loop."[124] As readers will recall from Section I, similar references have been made describing the changes in weaponry and military effectiveness that advanced technologies offer.

With NORAD's mission and tasks becoming increasingly relevant to the RMA, the lack of study and preparation in Canada could become a serious obstacle to continued Canadian participation in the command. Rather than a true joint command, NORAD might become bilateral in name only, with all of the space-based assets and RMA-relevant technology belonging to the US. Under this scenario, Canada would continue to operate a small number of radar posts and Northern bases, essentially offering a physical presence that would justify the continued use of the NORAD title — a political consideration that is likely to remain as important to the US in the 21st century as it was in the 20th.

However, should Canada wish to play a more active role in NORAD in the future, some difficult decisions need to be made. Significant investment and cooperation with the US in those technologies earmarked for the aerospace mission would be required. This would likely result in a considerable increase in DND's R&D infrastructure, and most likely affect the department's total budgetary request from parliament. Further, some organizational/procurement changes within the CF would also be necessary, as the military would have to prepare itself for a future role that is unlike the one it is accustomed to. A truly dedicated space structure within DND and relevant bureaucratic backing would be a necessary first step in such an endeavour, one that would require considerable cooperation with the private sector.

An enhanced NORAD role would raise further questions. For many years, Canadian support for NORAD has been declining, both in terms of assigned personnel and the Canadian financial contribution. With the end of the Cold War and the collapse of the Soviet Union, many analysts have wondered whether NORAD is not simply a relic from a different age, a veritable dinosaur in a time of changing governmental priorities and security threats.[125] There is no doubt that many bureaucrats at DFAIT agree with this assessment, as would several Canadian security scholars.

As was the case during the Cold War, though, continued NORAD participation may offer Canada benefits that are incommensurate with its costs. While during the 1960s and '70s participation afforded Canada privileged access to the US military, in the next century participation may offer Canada a front-row seat at the RMA (and NMD) table. Given Canada's military weakness and limited economic basis on which to modernize the military, this is an option deserving of careful study. Simply put, NORAD may offer Canada access to technology and military systems that it otherwise might not have, and might be unlikely to acquire. The cost however, at least according to some, may be unacceptably high — continued Canadian participation in a military organization that has outlived its usefulness, and that inextricably ties Canada to the defence policies of the US. This question is, of course, a political one, and thus it is in this arena where the issue will be determined.

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the NMD program, see James Fergusson, "Getting it right: The American national missile defence programme and Canada," *Canadian Defence Quarterly*, vol.27, no.4 (Summer 1998). In January 1999, it was reported that the US was planning to ask Russia to re-negotiate the Anti-Ballistic Missile (ABM) Treaty, so that a limited NMD system could be deployed by 2005. The US government also announced that it would spend $10 billion on developing the necessary technologies. See "US asking Russia to ease the pact on missile defense," *The New York Times*, January 21, 1999. Shortly after, reports bean to circulate that the US was planning to ask Canada to join the plan. In mid-February came additional reports that DND wished to allocate about $600 million in research associated with the program (in the Joint Space Project). Later that month the NORAD renewal talks began with NMD very much at the centre of attention. See "US missile-defence plans put Canada on the spot," *The Globe and Mail*, January 22, 1999; "Canadian military seeks Star Wars role," *The Ottawa Citizen*, February 3, 1999; and "Missile plan may complicate NORAD renewal," *The Globe and Mail*, February 26, 1999.

[124] "NORAD concept for 2010 and beyond," (from *NORAD Vision 2010*).

[125] These arguments were summarized in Jockel and Sokolsky, *The End of the Canada-US Defence Relationship*.

This, then, brings us to the third of DND's possible conflict missions, that of high-intensity conflict. It has already been noted that not only is the RMA directly relevant in such missions, but that the technologies that make it up were largely designed with such operations in mind. There are two possible contingencies in which the CF could be such engaged: (1) a situation where Canada is directly threatened by an adversary; or (2) Canadian participation in a multilateral coalition (i.e., as in the Gulf War).

With regards to the first contingency, few comments are necessary, as the prospect of this occurring is exceedingly remote. As has been the case throughout its history, Canada continues to derive enormous strategic benefit from its geographic location.[126] While during the Cold War there was the possibility of direct conflict involving the Soviet Union (albeit in the context of a global war), this prospect no longer exists.[127] Although modern technology — and particularly the proliferation of ballistic missiles — may make it increasingly possible for other countries to directly strike Canada, the chances of this occurring are slim. Further, at present and for the foreseeable future, Canada does not have any dedicated national enemies, nor does it have the kind of international profile that might appeal to terrorist organizations wishing to make a political statement through acts of violence. In sum, it is quite unlikely that Canada will find itself either directly threatened and/or attacked in the foreseeable future.

It is with regards to the second possibility that Canada needs to develop a comprehensive RMA strategy, and where the comments on operability and interoperability discussed earlier become relevant. As noted, DND currently believes that if it maintains an interoperability capability with its allies, i.e., an ability to "plug into" the American system of systems, this will ensure Canada's continued ability to participate in future multinational coalitions led by the US. On the one hand, this belief appears well grounded, as the success of multilateral operations in the future will be based on a seamless flow of information between coalition partners.[128] On the other, the reality may not be so simple, as the precise requirements of interoperability are presently poorly understood, and much depends on the specific characteristics of the technologies employed. As Carl O'Barry has recently noted, "functional interoperability among myriad warriors, command levels, and war-fighting 'appliances' require carefully developed and managed architectures, as does useful interaction among digital devices employed in the civil sector."[129] Indeed, *interoperability is a concern between the different military services of the US*, let alone between forces of different countries.[130] Simply put, it is not at all clear how interoperability between American and allied forces will work in practise, and consequently this is an area where much more research is needed.

Second, and perhaps of even greater importance, are basic questions regarding the impact of the RMA, questions that, to date, have not been addressed adequately. For example, if the US develops a capability to direct its military with precision, then an issue worth considering is whether there will even be a continuing requirement for large-scale conventional forces (and the multilateral coalitions composed of such forces). As discussed earlier, an RMA-equipped military will have the ability to attack targets from outside the battle zone, and to do so with great speed and accuracy. If this vision ultimately becomes reality, then the need for large-scale forces is obviously reduced. This suggests a lack of serious thought examining RMA capabilities and properties, and the long-term forces that might make use of those capabilities.

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126 The best strategic analysis of Canada's geography remains R.J. Sutherland's seminal study "Canada's long-term strategic situation," *International Journal*, vol.17, no.3 (Summer 1962).

127 For a review of Canadian security policy in the post-Cold War, see Jockel and Sokolsky, *The End of the Canada-US Defence Relationship*.

128 Sens, "RMA or EMA: Emerging technologies, Canadian security, and the Canadian Armed Forces," p.11.

129 Carl O'Barry, "Information technology: Convergence and connective potential," in *The Information Revolution and International Security*, p.155.

130 Admiral Owens has noted that advances in the key areas of the RMA — intelligence, surveillance, and reconnaissance (ISR), C4I technologies, and precision munitions — are occurring with such speed and fluidity *that even US forces seem unable to adapt quickly enough*. One indication of this is that each of the military services, while becoming familiar with the weapons systems in their own inventories, often appear confused by systems in other services, a worrisome development considering that an increased emphasis on joint operations lies at the heart of the RMA. See "Introduction," in *Dominant Battlespace Knowledge*. This point was also made by Dr. James Blaker in his address to the DND-sponsored RMA conference, "Canadian defence beyond 2010," (Ottawa, Nov. 30-Dec. 1, 1998).

Further, an additional concern relates to America's willingness to share sensitive information with its allies,[131] countries that are unlikely to field forces as technologically proficient as American ones, and thus may be more liable to rely on traditional demonstrations of force. If the US is not convinced of the technological competence of a country's defence force, it might be hesitant to share sensitive information with it. Lastly, there is the related issue of DND equipment and modernization, and the proficiency of the Canadian military to carry out missions that make use of American information. Simply put, the CF's overall combat capability continues to erode, and there are few indications that this trend will be reversed in the near future (with the exception of naval forces). This erosion is particularly noticeable in air and ground combat forces, precisely the areas where technological advances are occurring with the greatest speed. If DND capabilities are not modernized soon, then the entire debate mat become moot, as the force's equipment will simply not permit it to take part in sophisticated coalition operations. These and other questions point to the need for DND to develop a comprehensive RMA strategy, one that examines where Canada currently stands and the steps this country needs to take if it is to participate in the military changes currently underway.

In sum, this discussion indicates that DND has approached the RMA in a slow and deliberate fashion, and has to date failed to develop a comprehensive approach. Furthermore, the RMA has not even been mentioned in any of the major DND planning and guidance documents. Nonetheless, this failure has not yet had critical costs, for the current strategic reality of the CF at least partially negates the need for such a strategy. However, should the CF be called upon to perform an HIC mission (as part of a multinational coalition), or should the federal government decide to refocus its energy in this area, the prognosis is not favourable. Canada's small defence establishment, limited research and development infrastructure, and niche-oriented technology sector do not bode well for the applicability of information technologies in the defence sector.

Perhaps of even greater concern, though, is that many of our allies have not only developed more focused RMA strategies, but that they are also appear to be better positioned and prepared to adapt to an environment that prioritizes information and advanced technology. This is a result of several factors, including larger and better funded militaries, more dedicated research and developments programs, and greater high technology success in the civilian economy. The next section will focus on three advanced Western countries — Britain, Australia, and Israel — and how they have each laid the groundwork for the application of advanced military technologies. It will (indirectly) highlight the challenges facing Canada, and the growing military gap between this country and some of its allies.

III. The RMA and Advanced Western Countries: Some Preliminary Observations

Any researcher examining literature on the RMA cannot help but notice that most of the studies in the field have been written by Americans, and regard issues thought to be of importance to the US. This does not indicate that people outside the US think the RMA is unimportant, but rather indicates the enormous gap between the US and other countries in its study. However, as this section will make clear, several countries have carefully followed the RMA debate, and are well positioned to re-structure their militaries to benefit from dramatic changes in technology.

This section will examine how Britain, Australia, and Israel have approached the RMA. While any number of countries could have been selected in this study, the choice of these three was not entirely random. Britain was chosen because of its traditional importance, its close relations with the US and Canada, and also because it has become the technological centre of Europe. Australia was chosen both as a result of its comparable size to Canada and because of its geographic location, while Israel was selected because of its past success in incorporating advanced technology into its defence forces. Israel thus forms an interesting case of how a small but technologically proficient country is adapting to the revolutionary environment.

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[131] This issue was examined by Nye and Owens, who concluded that the US might form an "information umbrella" with other countries, whereby American information would be provided in return for security commitments and a greater willingness to "work with" the US. See "America's information edge," p.27.

Lastly, readers are cautioned that the comments that follow are primarily intended as summations of each countries' approach to the RMA, and are not meant to be comprehensive national reviews. Rather, the purpose is to highlight other countries' strategies, and as a result to place the Canadian experience in its broader international context.

Case Study #1: Britain

Britain has developed a comprehensive RMA strategy, and appears to be — behind the US — the country best prepared to transform and adapt its military to recent changes in technology. Besides being the subject of considerable study and analysis by the Ministry of Defence (MoD), steps have already been taken to ensure that the UK remains a leading military power into the new century. Britain also has a large, dedicated military research and development establishment — the Defence Evaluation and Research Agency (DERA) — that recognizes the importance of advanced research, and has thus been conducting experimentation in RMA-related technologies for some time.

Britain's concern with the RMA was highlighted in the *1998 Strategic Defence Review* (SDR), a document intended to shape the British Armed Forces well into the new century.[132] The SDR provides for a complete overhaul of the military, calling for greater emphasis on joint operations between the Air Force, Navy, and Army (through the establishment of a Joint Rapid Reaction Force), increasing the Force's ability for power projection (through the purchase of two new aircraft carriers), and eliminating or reducing roles that appear less relevant in the post-Cold War (for example, anti-submarine warfare). The SDR also suggests that significant re-structuring of the forces will be required as emerging technologies alter the ways in which the military can be used, although no specific recommendations are offered at present.

Technology played a prominent role in the SDR, and was the focus of one of the supporting papers written for it. This paper, "The impact of technology," specifically examined the RMA thesis.[133] It concluded that "it is clear that exploiting (information) technologies will lead to significant improvements in military capability." The report discussed specific equipment programs that are intended to take advantage of new technologies (i.e., advanced radars and PGMs), and highlighted new technologies that are likely to have a revolutionary impact on the use of military force. Particular attention was paid to the Joint Battlespace Digitization Initiative (JBDI), which aims to improve operational effectiveness by integrating weapons platforms, sensors, and C3I systems. Perhaps most critically, the paper recognized that traditional distinctions between military operations are breaking down, and that "by 2015, military operations will no longer be characterized as sea, land, or air, but will merge into a single battlespace in which the ability to conduct joint and combined operations will be fundamental."[134] The critical challenge, according to the SDR, "is to integrate sensors, weapons, platforms, and logistics... to deliver the desired military capability."[135]

The report discussed other elements of the RMA, including the vulnerability thesis (recall the discussion in Section I). On this issue, the SDR recognized that as computers and networks become more fully integrated, the integrity of the system can be compromised through unauthorized entry and tampering. While no specific conclusions or recommendations were offered, the paper stated that "appropriate resources" will be directed toward improving the ability to protect information networks. The issue of operability was also addressed, as it was noted that British defence equipment and systems must be compatible with those of its allies, particularly the US. The SDR recognized that if future multilateral coalitions are to be effective, common technology command structures will be necessary (see below).

As noted, British military research and development is conducted by DERA, which has a budget of approximately $1.8 billion (US) and employs some 12,000 people.[136] It offers a wide range of services, from operational studies and analysis, through various categories of basic and applied research, to advice on the procurement process and the test and evaluation of specific equipment in both the development phase and

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132 The aim of the Review is to provide the basis for a long-term defence programme up to the year 2015. British Ministry of Defence, "Strategic defence review," (July 1998, http://www.army.mod. uk/army/press/events/sdr).

133 Strategic Defence Review, Supporting Essay Three, "The impact of technology."

134 *Ibid*., p.3

135 For an analysis of the SDR, see Colin McInness, "Labour's Strategic Defence Review," *International Affairs*, vol.74, no.4 (1998).

136 Defence Evaluations and Research Agency, "Who we are," (http://www.dra.hmg.gb/html/who are).

during actual operations. It also funds a range of research projects at both the private and public levels. Ensuring that Britain remains on the cutting edge of military technology, part of DERA's mandate is to investigate technologies that might be required several decades in the future, and hence it funds both speculative research projects and those that are undertaken with the understanding that the final results may not be justified using standard cost-benefit evaluations.

An examination of some of the recent projects undertaken and funded by DERA indicates that the UK is conducting research in many of the core technologies of the RMA. For example, DERA has invested heavily in command and information technologies, including research in micro-electronics, software, systems architecture, nanotechnology, and computer networks. Indeed, British advances in silicon processing and design may lead to a new generation of processors and sensors that possess signal processing circuitry together with radio frequency transmitter technology, resulting in small mobile sensing systems that can be incorporated into a wide range of devices.[137] Another DERA initiative, the Combat System Technology Demonstrator Programme (CS1), aims to capitalize on developments in commercial information technology. Specifically, CS1 will encompass a series of studies examining how open-system standards and COTS hardware and software can be implemented and introduced in a variety of procurement programs.[138] DERA also funds extensive research into improving the current operational capabilities of the British Armed Forces, and thus a wide array of projects in aviation, land warfare, and naval operations are supported. Lastly, cooperation between DERA and British universities and institutions has resulted in extensive technology research, work that has led to considerable American investment (led by companies like Microsoft and Intel).

As in Canada, however, questions have been raised regarding the future missions of the British Forces, and the types of military equipment that are best suited to perform these roles. The SDR lists a total of eight missions, ranging from peacetime security to strategic attack on NATO. The missions on the "bottom end" of the scale — which include the security of the overseas territories, defence diplomacy, supporting British interests world-wide, and peace support and humanitarian operations — will not make much use of sophisticated military equipment. Conversely, those missions at the "higher end" of the conflict scale — including regional conflict both in and out of NATO, and large-scale strategic attack — require forces that make use of leading-edge technology.[139] Accordingly, there appears to be a continuing requirement for British forces to participate in high-intensity conflict missions, engagements that make use of advanced technology platforms.

An additional concern for Britain is its likely participation in any multinational coalition led by the US. British foreign policy since World War II has been strongly supportive of American goals and initiatives,[140] and this has been translated in the post-Cold War period into enthusiastic British participation in Western military coalitions (which was re-affirmed most recently by British participation in Operation Desert Fox, the US-led bombing campaign against Iraq in December 1998). Indeed, the SDR makes clear that joint operations and coalition-type assignments will constitute the most likely future missions for UK defence forces. Thus, it is critical that British forces (or at least those elements employed in multinational coalitions) have capabilities roughly similar to those of American forces, and that they have comparable operational capacities.

In point of fact, ensuring that there is no technology gap between American and British forces has become a de facto goal of UK defence policy. In a recent interview with *Jane's Defense Weekly*, Commander Philip Greenish, the Director of Operational Requirements for the MoD, noted that "we must learn to harness new technology more quickly and efficiently if we are to continue to maintain our significant role alongside [the US]."[141] Commander Greenish further noted that with rapid American advances in C3I

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137 See Defence Evaluation and Research Agency, "Electronics," (http://www.dra.hmg.gb/html/products /electron/esecsect.htm).

138 See *Jane's Defence Weekly*, "Sea change," vol.30, issue no.19, (November 11, 1998).

139 Defence missions as listed in the Strategic Defence Review.

140 Major works on post-1945 British foreign policy include David Reynolds, *Brittania Overruled: British Policy and World Order in the 20th Century*, (London: Longman, 1991); David Sanders, Losing an Empire, *Finding a Role: British Foreign Policy Since 1945*, (London: Macmillan Education, 1990); Mark Curtis, *The Ambiguities of Power: British Foreign Policy Since 1945*, (London: Zed Books, 1995); and John Baylis, *British Defence Policy: Striking the Right Balance*, (London: Macmillan, 1989).

141 *Jane's Defence Weekly*, "Sea Change."

and information-based technologies, the US runs the risk of "leaving its principal allies trailing in its wake," a development of particular concern given the UK's close cooperation with the US and internationalist orientation. It is this risk that is one of the primary motivations behind the UK's defence research program, one that the SDR reaffirms.

In sum, this discussion indicates considerable British study of, and preparation for, a revolution in military affairs. It should also be noted that Britain has become Europe's centre of high technology research, and thus the military can rely on extensive civilian expertise in many of the core technologies.[142] In short, Britain appears well prepared and positioned to modernize its military and to take advantage of emerging technologies.

Case study #2: Australia

Like the UK, Australia has extensively studied the RMA. This has resulted in a broad appreciation of the military implications and benefits of advanced information technologies. Further, Australia's dedicated military R&D establishment — the Defence Science and Technology Organization (DSTO) — has established a separate initiative, the Takari Program, which is aimed at ensuring that the Australian Defence Force will have an integrated C3I and information operation (IO) capability. This early preparation has placed Australia in a strong position to take advantage of the RMA.

The RMA first generated discussion in the Australian Defence Organization's *1994 White Paper*, which specifically identified command, control and communications, surveillance, and intelligence collection/evaluation as the key future challenges facing the Australian Defence Force (ADF). The paper noted that

> "The Australian Defence Force is committed to an integrated C3I Information Management System, including policy, procedure, and people, which provides all ADF commanders with relevant, reliable, and timely information for the conduct of ADF Joint and Combined Operations for the defence of Australia and other activities directed by the Government."[143]

While no specific recommendations were offered at the time, the early appreciation of the RMA indicated a military establishment that was keenly following the strategic discourse of the US.

The Directorate of Army Research and Analysis (DARA) offered its first observations on the RMA the following year. In a newsletter published in October 1995,[144] the implications of advanced technologies for command and control were discussed, and a possible new structure for the Land Forces suggested. The paper recommended the creation of a national surveillance, targeting, and communications system with a C3I structure that could support the distribution of intelligence on a national level. However, the paper recognized that information and system vulnerability could disrupt this achievement, and thus called for greater study. The newsletter also examined a critical 1995 US publication, *Seeing the Elephant*, a monograph that concluded that a new "battle dynamic" would soon become reality, and that US forces needed to digitize and become more capable of operating in an information-based environment.[145] The review noted that this requirement was not limited to American forces, and it suggested that the paper "be widely read throughout the Australian Army."

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142 As one indication of this, the city of Cambridge has experienced a profound transformation during the last decade. Information technology companies have opened advanced R&D facilities, which benefit from a very close relationship with the city's famed university. Confirming its new found status, the city was recently named one of the top ten high technology cities by Newsweek (one of only three non-American cities so named). See "The hot new tech cities," *Newsweek*, (November 11, 1998).

143 As cited by the Defence Science and Technology Organization, "The Takari program," (http://www.dsto.defence.gov.au/esrl/takari/index. html). Readers might note the distinction between this document and the publication of a White Paper in Canada the same year.

144 See Directorate of Army Research and Analysis, "Research and analysis," Issue #4, (October 1995, http://www.dod.gov.au/1wsc/ issue04.htm).

145 Gen. Gordon R. Sullivan and Lt Col. Anthony M. Coroalles, *Seeing the Elephant: Leading America's Army into the Twenty-First Century*, (Cambridge: Institute for Foreign Policy Analysis, National Security Paper #18, 1995).

A follow-up newsletter published the following year examined the RMA thesis in greater detail, with both supportive and critical essays.[146] The supportive paper[147] reviewed the array of technological advances that had occurred since the end of the Cold War, and concluded that the capabilities of conventional military forces were increasing dramatically. But the paper also placed the RMA in its larger context, recognizing that it was advances in the civilian economy — and particularly those in the computer/information sector — that were driving the RMA and seemed likely to continue to do so in the future. A second essay[148] offered a more critical view, noting that disagreements over what constitutes the RMA did not bode well for its eventual implementation. This essay raised further questions over the civilian lineage of the RMA, and the range of technologies that are frequently considered "proof" of its existence. The author found such assertions troubling, in that prior military revolutions have generally been based within the defence sector, while the current one is based, as discussed, on civilian technologies.

In June 1996, the Royal Australian Air Force held a conference on "Defence Challenges in New Era Security," where the RMA generated considerable discussion and comment. The Honourable Ian McLachlan, the Australian Minister of Defence, noted that extraordinary changes within the military were underway, and that they were "having profound effects on the way(s) countries will be able to wage war."[149] McLachlan explained that while few of the technologies of the RMA were genuinely "revolutionary," in combination the result was extraordinary and "points to a fundamentally different style of warfare. A warfare where there is no real distinction between front lines and rear lines; where distance offers no protection; where if a target can be found it can be destroyed; where the most precious military commodity will be information and the most deadly military weapon will be speed." The Minister concluded by noting that Australia was placing increased emphasis on the RMA, and that it was critical that the country's technological advantage over its neighbours be maintained into the next century.

Two 1997 documents, the *Defence Efficiency Review* (DER) and *Australia's Strategic Policy,* both further emphasized the importance of technology. The former concluded that if Australia is to sustain its technological edge, it needs to "build an increasingly technology-intensive defence force," requiring new equipment and upgrades that make better use of both existing capabilities and future technologies.[150] The DER's key recommendations on science and technology were that the ADF needed to initiate a program of concept and technology demonstrators; that the DSTO needed to further develop its advanced modelling and simulation capability; and that greater rationalization of the services' trial and evaluation facilities was needed. As for the *Strategic Policy* document, it similarly concluded that Australia needs to maintain and enhance its "knowledge edge," which was defined as the "effective exploitation of information technologies to allow us to use our relatively small force to maximum effectiveness."[151] The document concluded that "we will give a high priority to investments to ensure that our military forces gain the greatest advantage from developments in [emerging technologies]."[152]

The Takari Program has been the response of the Defence Science and Technology Organization to the challenge posed by information technologies. Launched in 1996 and involving 250 defence scientists and engineers from nine separate divisions, Takari is a framework program that includes all the activities designed to deliver a comprehensive C3I and IO capability to the ADF. Toward this end, the program has three major goals: (1) an improved information capability; (2) interoperability of command and control information systems; and (3) the introduction of an integrated C3I Information Management System by the

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146 Directorate of Army Research and Analysis, "Research and Analysis," Issue no.5, (March 1996, http://www.dod.gov.au/1wsc/ issue05.html).

147 Lieutenant Colonel Keith Thomas, "A revolution in military affairs," in *Ibid.*

148 Martin Dunn, "Revolution in military affairs? A contrary view," in *Ibid*.

149 The Honourable Ian McLachlan, "Defence challenges in new era security," (address to the RAAF Air Power Conference, June 1996, http://www.dod.gov.au/minister/m960611b.htm).

150 As cited in Defence Science and Technology Organization, "S & T key to sharper defence," (Autumn 1997, http://www.dsto.defence. gov/au/corporate/publicity/articles/adsn1719.html).

151 Australian Department of Defence, *Australia's Strategic Policy,* (Commonwealth of Australia, December 1997), p.56.

152 *Ibid*., p.55.

year 2010.[153] The program is based upon the recognition that "on the future battlefield, generating, disseminating, and exploiting information rapidly through the use of modern C3I systems will be the key to providing Commanders the knowledge needed for the superior deployment of forces."[154]

The program is organized into six inter-related R&D packages, including information networks; information management and command support; information acquisition; C3I systems issues; tactical environments and weapons systems; and information operations. To help achieve efficiency, the program is based upon a defence partnership with the private sector. Takari also involves the wider Australian defence community in its R&D planning, and provides a mechanism for tapping into industry R&D as much as possible.

Perhaps some additional comments can be offered on one of the R&D packages, information acquisition, to give readers a better sense of what the project involves. This package is concerned with the collection of information from sensors and other sources, and its analysis and fusion to generate intelligence and surveillance. As such, it covers R&D into the processing of information from the stage where it is first encountered, fusion of the information from multiple sensors and sources, the integration of surveillance information and intelligence into the C3I environment, and modelling and performance assessment at the system level.[155] The research is further divided into three categories — short-, medium-, and long-term, depending on current operational capabilities and domestic requirements. The intent is to ensure that the ADF will have access to information from a variety of sources, and will have the capacity to analyze and integrate that information in a timely manner.

In sum, Australia appears both well positioned and prepared to take advantage of the RMA. Early study has been combined with a comprehensive strategy to ensure that advanced technology is incorporated by the ADF. While Australia has a limited defence establishment, there appears to be little concern that equipping an RMA-capable military force is beyond the country's means. Rather, there is a consensus that Australia needs to ensure that it maintains a qualitative edge over its rivals, and the RMA offers precisely that prospect. As we will see, much the same concern is evident in Israel, the third and final country to be examined in this section.

Case Study #3: Israel

Unlike the other two countries reviewed, Israel does not openly discuss its preparations and/or understanding of the RMA. Clearly, a far more intense security environment influences what the government discloses regarding defence capabilities and requirements. Having noted that, though, there is substantial evidence that indicates that the Israel Defence Force (IDF) has studied the RMA intensively, and has implemented an extensive plan to introduce and take advantage of high technology military systems. Indeed, Israel is particularly well positioned because of its large civilian information/technology sector, one that is growing rapidly as people initially trained for jobs in the military leave for increasingly lucrative private-sector positions.[156] Overall, then, Israel is well positioned to take advantage of new technologies, a development which indicates that small countries can become full participants in the emerging military revolution.

Since the 1948 War of Independence, a primary objective of every Israeli government has been to ensure that its defence forces are qualitatively superior to any possible combination of enemies. Such superiority has extended beyond the weapons systems themselves, to include factors like motivation, training, initiative, tactical proficiency, and improvisational skill.[157] As the results of its conflicts over the last five decades demonstrate, the Israeli military has been very successful at achieving this superiority, with the

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153 Defence Science and Technology Organization, "The Takari program: An introduction." (http://www.dsto.defence.gov.au/esrl/ takari/takexint.html).

154 The Defence Science and Technology Organization, "Takari: Towards tomorrow." (http:///www.dsto.defence.gov.au/corporate/ publicity/brochures/takari.html)

155 The Defence Science and Technology Organization, "Takari R & D package 3 - Information acquisition." (http://www.dsto.defence. gov.au/esrl/takari/information/takexpl3.html).

156 Eliot A. Cohen, "Israel after heroism," *Foreign Affairs*, vol.77, no.6, (November/December 1998).

157 Eliot Cohen, Michael Eisenstadt, and Andrew Bacevich, "Israel's revolution in security affairs," *Survival*, vol.40, no.1, (Spring 1998), p.49.

consequence that its military is, according to many, among the best prepared and trained such forces in the world. And yet, the current RMA presents a major challenge to the IDF, as it threatens to re-draw the Middle East military and strategic environment.

While there are no publicly available documents that indicate the importance of the RMA to the IDF, the circumstantial evidence is nonetheless quite compelling. To begin with, there is the US-Israeli strategic alliance,[158] one which assures that Israel receives access to advanced American military equipment and technologies (not to mention some $3 billion in US aid annually). While the alliance has been challenged in recent years as a result of perceived Israeli intransigence on the peace process, Israel continues to be the closest American ally in the region. As for military hardware, for decades Israel has received the most advanced American arms exports, systems that are generally denied to most countries. In recent years, US exports have included F-15I long-range strike fighters, M1A2 tanks, Apache helicopters, and the Multiple Launch Rocket System. Much of this equipment has been modified by Israeli engineers to perform better under the extreme climatic conditions of the Middle East.

The combination of advanced American arms purchases and a very capable domestic defence sector (one which provides the IDF with a vast array of sophisticated weapons and platforms) has resulted in a technologically proficient military force. According to the authoritative *Jane's Intelligence Review*, "state of the art technology has had a revolutionary impact" on the IDF.[159] Nowhere is this more evident than in the Israeli Air Force (IAF). According to *Jane's*, the IAF's technological capabilities are matched by only one other country — the US. The IAF is computer-directed and networked, has effective real-time reconnaissance and bomb damage assessment, and an advanced C3I capability. Its overall capabilities are such that *Jane's* has concluded that "Israeli combat aircraft employ what may be the world's most capable and diverse mix of radars, electro-optical avionics, self-defence [electronic warfare] systems, and air-to-air missiles."[160] With regards to other elements of military power including armoured units, advanced munitions, and battle management skills, *Jane's* has concluded that Israeli capabilities are roughly comparable to those of the US, an indication that its military has clearly succeeded in incorporating advanced technology.

Other analysts/publications have reached similar conclusions. Anthony Cordesman, author of the recent study *Perilous Prospect*,[161] has concluded that Israeli defence forces enjoy many of the same capabilities that were employed by the US during the Gulf War. While Israel does not have access to all of the systems and high technology aids available to American forces, it has developed a comprehensive strategy that permits the rapid introduction of technology, and consequent changes in training to ensure that its forces take full advantage of doctrinal advances. Recently-added defence capabilities include day/night warfare, real-time integration of command, control, communication, intelligence, and battle management (C4I/BM), and the integration of PGMs into tactics and force structures. Israel has an integrated, real-time ground, air, and space-based surveillance system that enables its forces to accurately determine their enemies electronic order of battle.[162] Israeli forces also benefit by having beyond visual-range air combat and airborne C4I capabilities. Its mix of advanced tactical aircraft along with AWACS and E-2Cs give Israel virtually the same proficiency as American forces in many elements of air combat. Further, Israel essentially pioneered the use of unmanned aerial vehicles (UAVs), and has been at the forefront of research and deployment of

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158 In October 1998, the American and Israeli governments signed a new Memorandum of Understanding (MoU). This was the second such agreement reached by the two countries, replacing the initial one that was signed in 1988. The new MoU is primarily intended to strengthen the partnership in missile defences, a program of interest to both countries. The US is currently largely funding the Israeli Arrow defence program, which is intended to provide point defence against tactical missile attack. Unlike many of the systems associated with the American National Missile Defence (NMD) system, the Arrow has successfully completed several tests, and is expected to become operational in late 1999. For a review of the Israeli missile experience during the Gulf War, see Aharon Levran, *Israeli Strategy After Desert Storm: Lessons of the Second Gulf War*, (London: Frank Cass, 1997).

159 Jane's Intelligence Review, *A Propensity for Conflict: Potential Scenarios and Outcomes of War in the Middle East*, (Special Report #14, 1997), p.10.

160 *Ibid*., p.11.

161 Anthony Cordesman, *Perilous Prospect: The Peace Process and the Arab-Israeli Military Balance*, (Boulder, CO: Westview Press, 1996).

162 *A Propensity for Conflict*, p.16.

PGMs. Accordingly, in many areas of military competence, Cordesman has concluded that "Israel has capabilities similar to those of the US."[163]

This is not to suggest that Israel matches the US in every area of technological capability (it obviously cannot), but indicates that, to a considerable degree, Israel has succeeded in introducing advanced technology into its military. This effort has, in fact, been so successful that the Arab-Israeli military balance has, for all intents and purposes, essentially disappeared over the past decade. While Arab military forces have partially modernized, they have generally failed to introduce the technologies upon which advanced militaries are based.[164] As a result, most analysts now believe that Israel's margin of military superiority over the Arab states has grown dramatically in recent years, a development that may make the negotiation of a permanent peace in the region more difficult.[165]

Lastly, it should be noted that, like Britain and Australia, Israel has a diverse and rapidly growing civilian technology sector, one which has benefited immensely from the immigration of 700,000 Jews from the former Soviet Union. Indeed, the success of Israel's high technology sector is reflected in a telling statistic: Israel has the second largest number of publicly-traded technology companies in US stock markets (behind the US).[166] This commercial success is creating a diverse array of products and services, many of which have defence applications. The conclusion reached from this analysis is that Israel is adapting well to the RMA, which demonstrates that the size of a country is not a critical factor in determining its overall RMA potential.

IV. Final Observations and Conclusions

Technology-driven changes in military affairs are often transient, sometimes eclipsed in less than a generation, and the competitive advantages that they offer can be fleeting. In a century that began with cavalry regiments and the static trenches of World War I and is ending with precision-guided munitions, stealth aircraft, and theories of information warfare, military change has been virtually continuous.[167] And yet, despite the enormity of recent developments, critics note that no "revolutionary" military changes are currently underway, and to the extent that any future dramatic transformation is foreshadowed, it is so far into the future as to render the current fascination with the RMA totally unwarranted.

In many important respects, the critics have it right. The conflict that RMA supporters highlight as conclusively demonstrating the revolutionary nature of modern war, the 1991 Gulf War, in fact only provided a sneak preview of information-age military power. The US fought with mechanized capabilities and tactics, concentrated massive ground forces in the theatre of operations, relied on the control and penetration of enemy air space, and had to move mountains of supplies — that relied on costly logistical systems — within reach of its combat forces. Further, while Iraq's military was numerically impressive, in reality it consisted of poorly-trained soldiers who lacked both motivation and the skills required to operate the country's advanced military hardware. In short, critics argue that if this is the conflict that supporters of the RMA are basing their argument on, then far more reflection and critical appraisal is needed.

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163 Cordesman, *Perilous Prospects*, p.98.

164 Cordesman has attempted to explain this failure. Among the principal explanations, he lists an authoritarian command system; the lack of a strategic assessment capability; major weaknesses in battle management, C4I and battle damage assessment; poor overall manpower quality; the lack of a cohesive force quality; problems in air-to-air combat; poor combined arms capabilities; and poor training. See *Perilous Prospects*, pp.88-92. On a more general level, this military failure can be linked to a much larger Arab inability to modernize their economies and introduce information technologies.

165 *A Propensity for Conflict*, pp.22-23.

166 This statistic was provided by Ms. Dina Wachtel, a former information officer with the Israeli embassy in Ottawa. Further evidence of the booming nature of Israel's technology sector was provided by *Newsweek*, which recently observed that "Silicon Valley's most serious global competitor is the mini-sprawl around Tel Aviv." See "The hot new tech cities," *Newsweek*, (November 11, 1998).

167 Henry and Peartree, "Military theory and information warfare," in *Parameters*, p.133.

Other critics question whether the current RMA is really a "revolution" at all, or whether it is primarily a series of technological advances that have simply resulted in the increased lethality of military force. As discussed earlier, for a military "revolution" to occur, it must combine new technologies with doctrinal or operational change. New technologies can thus make an RMA possible, but technological innovation alone cannot spark an RMA.[168] Several years ago, Martin Libicki and James Hazlett coined the term "Military-Technical Revolution" — or MTR — to highlight this distinction. In brief, an MTR is the impact of a new technology (or technologies) on warfare, while an RMA encompasses the subsequent transformation of operations and organizations.

This paper has not denied that the critics raise some important points. Without question, there *is* a degree of hyperbole attached to the RMA debate, and many supporters describe its advantages and characteristics without appearing to fully understand the nature of change in warfare or the various obstacles surrounding its successful implementation. In addition, as Colin Gray has noted, there is a kind of "wave train" in operation today, whereby the enormous size and influence of the extended US defence community all but ensures that a new idea "is likely to attain escape velocity for entry into scholarly orbit."[169] In the case of the RMA, this process is accentuated by a private sector hardware/software industry of enormous proportions, one both ready and willing to encourage the process to celebrate change with the commitment of tax dollars.

And yet, while there is much to be said for the critics' scepticism, it largely misses the point, and confuses the technology of the RMA with the changes it will ultimately bring about.[170] As noted earlier, the present RMA is still shrouded with uncertainty. With time, however, the picture will grow sharper, and the uncertainty will diminish. Indeed, it is hardly realistic to expect doctrinal changes given that some of the technologies upon which the RMA is based have only been in existence for a few years. It thus may take several more years — or even decades — before such changes are fully realized. But this does not lessen the importance of the process currently underway. It merely indicates that military establishments are approaching this period of change with caution, and wish to make sure that the structural changes adopted are the right ones. *That these last steps have not yet occurred is relatively unimportant; the fact that they are already largely taken for granted is.*

As for the significance of the Gulf War, it is now clear that the advances revealed in that conflict merely paved the way for far more important ones in the years that have followed. Since 1991, data communications programs uniting sensors, platforms, and command organizations into far more potent systems have been introduced. A new military formation — the network — permits forces to be both dispersed and integrated, making them more manoeuvrable, deadly, and invulnerable. The ability to integrate weapons, sensors, and other military systems in such networks depends on effective command, control, communications, and intelligence capabilities that are increasingly being improved and perfected. Further, significant advances in precision munitions and guidance technologies over the last few years have occurred, and each of the US services now feature an array of weapons that make use of these capabilities, something that was lacking just a few years ago[171] (indeed, this capability was demonstrated in the US/British bombing

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168 See Krepinevich, "Cavalry to computer."

169 Colin Gray, "Nuclear weapons and the revolution in military affairs," p.107.

170 It should also be noted, though, that some critics confuse elements of the RMA debate, and seem unsure of what the term means and implies. One example is an article written by Michael O'Hanlon, "Can high technology bring US troops home?," *Foreign Policy*, no.113 (Winter 1998-99). This author is sceptical of the ability of high technology to reduce the need for ground forces (particularly US bases overseas), and further believes that geography and physics create barriers that are not easily circumvented. While important points, O'Hanlon does not appreciate the totality of changes that information technologies are bringing about. Further, he argues that many of the technologies of the RMA "have been around for decades," a reference that, while partially true, understates the profound changes in many of these technologies in the last decade (sensors, satellites, computer systems and networks, etc.).

171 During the Gulf War, the AGM-86C air-launched cruise missile was the only weapon system that used the Global Positioning System (GPS) for terminal homing. Since then, five additional GPS-guided systems have been developed and introduced. See *Jane's Defence Weekly*, "The big question: Can Saddam be beaten by bombing alone?," vol.29, issue no.8 (February 25, 1998).

campaign against Iraq in December 1998[172]). What this means is that the side with C3I superiority will soon be in a position to achieve "information dominance," a term that, while admittedly a product of the age in which it was developed, *nevertheless accurately describes an environment in which a country can track its adversary's every move, manage the network of its own forces, and largely dictate the course and pace of the conflict*.[173]

Still, the American domination of the RMA thesis continues to draw attention, if only to highlight the gulf between the US and other countries. There are several explanations that account for this variance: (1) only the US has the wealth and military capital to take full advantage of the changes imagined by defence planners and others; (2) the American fascination with the ability to project precision force combines in the case of the RMA with an advanced civilian technology community; and (3) many of the countries that have similar — although not as extensive — expertise have been preoccupied with other tasks. Thus, for example, France, which has only recently begun the transition to a professional military force, has failed to make the kind of force structure reductions necessary to free up investment for the RMA.[174] Germany and Japan, still burdened with their wartime pasts, have hesitated about seeming to embrace ideas and technologies which would likely appear threatening to some of their neighbours.[175] Further, Germany is preoccupied with the task of absorbing the former GDR, while Japan has recently been plunged into a severe financial crisis.

And yet, as Section III demonstrated, several countries are beginning to appreciate current military changes and are acting accordingly. As discussed, Britain has made extensive preparations, and its advanced civilian technological base gives it an added advantage. Australia and Israel, both with highly skilled and educated militaries, have also made considerable preparations. Numerous other European countries — including Sweden, Italy, and Switzerland — are also examining what recent technological changes might mean and how they might affect future force structures. Awareness is not limited to Western countries, though. Chinese military planners were particularly shocked at the easy triumph of American forces in the Gulf, and have begun paying considerable attention to the potential of modern technologies.[176] In addition, as noted earlier, Russian military planners have long recognized the revolutionary properties of information technologies, even if their country's financial crisis and economic backwardness prevents them from participating in the RMA in any meaningful way.[177] What appears most likely to emerge from this broader international debate is not a single conception of the revolution in military affairs, but several, all tailored to each country's particular international circumstance.[178]

In spite of this attention, questions are being raised about the ability of many countries to reformulate their militaries to take advantage of advanced technologies. Thus, for example, the RMA debate is largely irrelevant in much of Africa, Central and South America, parts of Asia, the Arab Middle East, and the former

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172 An estimated 98% of the ordinance used in Operation Desert Fox was precision-guided, an enormous increase over the 10% figure from the Gulf War. Ironically, the only (non-guided) bombs used in the campaign were deployed from B-1 bombers, an aircraft introduced into service in the late-1980s that were intended to modernize US bomber forces. In contrast, 40 year old B-52 bombers fired an array of laser-guided bombs and GPS-capable missiles. See Steven Lee Myers, "2 B-1s join Iraq combat and gain vindication," *New York Times*, (December 21, 1998).

173 McNair Paper #59, "Right makes might," Section 3, p.2.

174 In addition, France seems committed to maintaining a domestic military production capability in all major weapons systems, an insistence that requires enormous amounts of government funding. Until France comes to the realization - one that Britain and Germany reached long ago - that this capability is unnecessary (and unaffordable), its ability to invest in RMA technologies will remain limited.

175 Eliot A. Cohen, "American views of the Revolution in Military Affairs," (Tel Aviv: The Begin-Sadat Center for Strategic Studies, Mideast Security and Policy Study #28, 1996), p.10.

176 Ahmed Hashim has recently noted that Chinese literature on the RMA is so extensive "that the proverbial unsuspecting visitor form Mars would be forgiven for thinking that the People's Liberation Army is in the forefront of the dramatic changes taking place in how we think about and wage conventional war." Ahmed S. Hashim, "The revolution in military affairs outside the West," *Journal of International Affairs*, vol.51, no.2 (Spring 1998), p.440. For a recent review of Chinese thinking on the RMA, see John Arquilla and Solomon Karmel, "Welcome to the revolution... in Chinese military affairs," *Defense Analysis*, vol.13, no.3 (1997).

177 For a review of Russia's RMA prospects, see Jacob Kipp, "Confronting the RMA in Russia," *Military Review* (May/June 1997).

178 Cohen, "American views of the Revolution in Military Affairs," p.10.

Communist countries of Eastern Europe, all of which lack the advanced technology infrastructure upon which it is based. Indeed, questions have even been raised about the ability of Western European countries to participate, as some may be unwilling to either make or pay for the enormous preparations required. One solution that has recently been suggested is the establishment of a "EuroDARPA," a defence R&D organization that would combine the military research capabilities of the major European countries.[179] The rationale for such an agency is the awareness that the enormous size and vitality of the American economy gives the US advantages that cannot be duplicated by smaller — or even middle-sized — actors. While there are numerous obstacles to the creation of any pan-European military R&D effort, the fact that such talk is even occurring indicates a realization of the importance of the issue and the stakes involved.[180]

In the US itself, there is growing concern that the capabilities of American military forces may soon outpace those of its allies.[181] Such concern recently led the American Defense Science Board, a senior advisory panel, to undertake a year-long study examining how US allies are coping with rapid technological change. According to the terms of reference for the study, "DoD must not only ensure a wide gap between US capabilities and those of potential adversaries, but also that emerging US military capabilities are compatible with potential future coalition partners."[182] While it is unclear how the US may alleviate the problem, the recognition of it indicates that the US sees possible dangers in the unilateral adoption of new defence technologies.[183]

Given this context, what are Canada's prospects for the RMA? As this paper has shown, DND has approached the issue with considerable caution and uncertainty. It now seems apparent that the department failed to study the issue in sufficient detail when it first began to attract attention in the early-to-mid 1990s, and its efforts since then have been attempts at overcoming this initial deficiency. These latter efforts have generally been unsuccessful, however, as the department has yet to offer a comprehensive account of what the RMA is, why it is important, and how the Canadian Forces will be affected. Indeed, even the department's (notably few) specific efforts at examining the Canadian implications of the RMA rely on generalizations and lack specificity on critical issues including force structure, procurement, and implications.

Section II also revealed that: (1) Canada's ability to participate in the RMA may be hampered by this country's limited civilian high technology base; and (2) Canada's strategic reality may largely negate the importance of the RMA for the CF in any event. Regarding the first point, the discussion revealed that, in spite of widespread government and industry claims to the contrary, the Canadian technology sector is niche-oriented and heavily dependent on American investment. Further, the Canadian reluctance to invest in science and technology R&D does not bode well for the future, especially considering that DND is increasingly looking to the private sector for new technology and specialized applications. As for the latter point, if peacekeeping/peacebuilding becomes the principal operational mission of the CF (as DFAIT would clearly prefer), then the utility of the RMA to Canada will be reduced, as high technology military equipment and systems are generally of little benefit for such operations. If, on the other hand, the department wishes to

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179 See *Jane's Defense Weekly*, "EuroDARPA needed to bridge technology gap," (May 29, 1998, http://www.janes.com/defence/ onlineproducts/jdw2/testeurop/Jdw0562.html).

180 One current indication of the European recognition of the enormous stakes involved in military R & D is the imminent introduction of the Eurofighter Typhoon, a joint fighter aircraft program between the governments of the UK, Germany, Spain, and Italy. Despite numerous delays and difficulties, production of the aircraft is expected to begin next year.

181 As one example of the degree to which the US is embracing technology, the US Army is set to introduce a fully digitized division in the year 2000. See Dan Coats, "Division 21: Landpower transformation or evolution?" *National Security Studies Quarterly*, vol.4, no.3 (Summer 1998) and *Jane's Defence Weekly*, "4th infantry division sets trend in motion," vol.28, issue no.13 (October 1, 1997). At present, Britain is the *only* other country actively testing a digitized division, with a planned deployment date of 2003 at the earliest.

182 *Jane's Defence Weekly*, "US worried by coalition 'technology-gap'," vol.30, issue no.4 (July 28, 1998).

183 US Army Brig. General William Bond, the Director of the Army Digitization Office, noted in a recent interview that "there's been a lot of concern that [the US] is getting well ahead of our allies and that the [information technologies] that we have would preclude them from working with us in a multinational operation." See *Jane's Defence Weekly*, "Interview," vol.30, issue no.8 (August 26, 1998). The statement mirrored those made in 1997 by the US Ambassador to NATO. See *Jane's Defence Weekly*, "USA warns of three-tier NATO technology rift," vol.28, issue no.13 (October 1, 1997).

maintain a capability to conduct high intensity conflict operations and participate in multilateral coalitions (as the 1994 Defence White Paper affirmed), then immediate action is required, with the first step being a comprehensive RMA strategy for Canada. Perhaps what is most required is a bureaucratic truce between DND and DFAIT, and the elaboration of a set of revised security objectives that meet the satisfaction of both departments. Until such agreement is reached, the two will continue to work at cross purposes, with the result that the strategic status quo will continue indefinitely (an outcome that DFAIT may actually favour).

In sum, a military revolution is underway. It will necessitate changes that are still difficult to imagine and comprehend. At present and into the foreseeable future, only the US has the combination of technological, military, and human skills to fully participate in this revolution. While many scholars believe that long-term US military superiority is unlikely,[184] this observer is not convinced. American military dominance in the late 20th century is surpassed only by American economic dominance, and it is the latter that will increasingly propel the former in the coming years. Countries that could conceivably challenge the US in the next century — China, India, perhaps a revitalized Russia — appear woefully unprepared to effectively test America's technological and information edge, one that is actually *increasing*. Indeed, the ability to participate in the information-based revolution may ultimately result in a new global hierarchy, one that will place Western countries (aided by a small group of others) in a decidedly privileged position.[185] The challenge facing Canada — and many other smaller countries — is to determine whether and how it can participate in the emerging RMA, and to define the military roles it wishes to play in a strategic environment that, while essentially stable, will likely feature periods of instability and conflict, punctuated by periodic uses of force.

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184 See, for example, Krepinevich, "Cavalry to computer."

185 Andrew Richter, "The technological divide: The information revolution and the emerging global hierarchy," (paper presented at the International Studies Association conference, Toronto, March 1997).