

# **HUMAN FACTORS IMPLICATIONS AND ISSUES IN NETWORK ENABLED OPERATIONS**

A Report Prepared by

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## **Abstract**

Network Enabled Operations (NEOps) seems poised to become the driving concept behind CF transformation for a number of reasons, not the least of which is Canada's tendency to follow the American lead in new concepts related to war and other operations. This paper concludes that Canada and the CF should be cautious about using NCW as the foundation for NEOps, because the context and needs that are the basis for NCW may not be congruent with Canadian requirements.

The paper noted that NCW is not really a theory of war, as its proponents claim, but a series of largely untested hypotheses or assumptions that require validation before they should be accepted as a basis for transformation.

Recent Canadian Forces' (CF) operations have shown that a "one size fits all" approach to command and control, as proposed by many NCW advocates, may not be the best approach for networked operations, even in an increasingly integrated joint and combined operating environment.

Perhaps most importantly, from a Canadian point of view, using NEOps in the Joint, Interagency, Multinational, and Public (JIMP) or integrated context will require network architects not only to consider the use of information technology as an enabler, but also for them to address the much more complex issue of the creation of effective social networks.

In summary, NEOps as a concept has a promising future if it is predicated on Canadian needs and culture. However, there is significant risk in placing too much reliance on concepts like NCW which put the technology before the human requirements. Therefore, future development of the NEOps concept should be firmly rooted in the Canadian context and based on Canadian experience. NEOps concept development should be complemented by the relevant experience of others, but it should avoid slavishly copying other frameworks as DND has sometimes done in the past.

## Résumé

Les opérations facilitées par réseaux (OFR) semblent actuellement devenir le concept moteur de la transformation de Forces canadiennes (FC). Plusieurs raisons expliquent ce fait, la plus importante étant sans doute la tendance du Canada à suivre la voie tracée par les États-Unis dans les nouveaux concepts liés à la guerre et à d'autres opérations. Les conclusions du présent article indiquent que le Canada et les FC devraient faire preuve de discernement dans l'emploi de la guerre réseautique (GR) comme fondement des OFR, car le contexte et les besoins qui motivent le recours à la GR ne correspondent peut-être pas aux conditions canadiennes.

L'article fait valoir que la GR ne constitue pas vraiment une théorie de la guerre, comme l'affirment ses adeptes, mais plutôt une série d'hypothèses et de suppositions généralement non vérifiées qui ont besoin d'être validées avant d'être acceptées comme base d'une transformation.

De récentes opérations des FC ont démontré que l'approche uniformisée en matière de commandement et de contrôle que préconisent plusieurs partisans de la GR n'est peut-être pas la plus adéquate pour les opérations en réseau, même dans un contexte d'opérations interarmées et interalliées de plus en plus intégrées.

Sans doute plus important encore, du point de vue canadien, est le fait que l'utilisation des OFR dans un cadre interarmées, interinstitutions, multinational et public ou intégré exigera des architectes de réseaux qu'ils considèrent la technologie de l'information non seulement comme un outil habilitant, mais aussi comme un moyen de relever le défi beaucoup plus complexe de créer des réseaux sociaux efficaces.

En résumé, le concept des OFR a un avenir prometteur s'il se fonde sur la culture et les besoins canadiens. Par contre, le fait de trop se fier à des concepts comme la GR, qui accorde plus d'importance aux besoins technologiques qu'aux besoins humains, comporte un risque considérable. Il est donc essentiel que le développement futur du concept des OFR soit fondamentalement lié au contexte de notre pays et qu'il se fonde sur l'expérience canadienne. S'il est vrai que l'expérience pertinente d'autres nations peut alimenter ce développement, il faudrait toutefois éviter de copier aveuglément d'autres structures, comme l'a déjà fait le MDN.

## Executive Summary

This report is based on a requirement by the Command Effectiveness and Behaviour Section of Defence Research and Development Canada (DRDC) – Toronto to examine the theoretical and historical origins of the concept of Networked Enabled Operations, addressing, in particular, the assumptions that are embedded in the current concept and the implications of those assumptions for military command and control and military organizations.

Network Enabled Operations (NEOps) seems poised to become the driving concept behind CF transformation for a number of reasons, not the least of which is Canada's tendency to follow the American lead in new concepts related to war and other operations. Even though NEOps has not yet been clearly defined, recent NEOps conceptual statements indicate a similarity to the American concept of Network-Centric Warfare (NCW) as NEOps is expected “to generate increased combat power by networking sensors, decision makers and combatants to achieve shared battlespace awareness, increased speed of command, higher operational tempo, greater lethality, increased survivability, and greater adaptability through rapid feedback loops.”<sup>1</sup>

This paper examines NEOps and its progenitor, NCW, and concludes that Canada and the CF should be cautious about using NCW as the basis for NEOps, because the context and needs that are the basis for NCW may not be congruent with Canadian requirements. It also found that NCW is not really a theory of war, as its proponents claim, but really a series of largely untested hypotheses or assumptions that require validation before they should be accepted as a basis for NEOps.

Many believe that in order to adapt to change through innovation, military professionals and those in the defence community need to understand the intellectual as well as the technical tools that they use in their work. To gain an understanding of NEOps as a professional tool, they must, therefore, be conscious of the historical and theoretical context in which it originated and is evolving. As part of this context, it was noted that each nation and each service in a nation's armed forces have their own unique paradigm of how military operations should be conducted based on the physical environment in which they operate, their historical experience, and their culture.

These physical and cultural settings in which armed forces operate form the basis for a number of critiques of NCW, whose advocates propose a specific type of command-by-influence, or mission command, as a key to future networked operations based on NCW. As noted in this report, this “one size fits all” approach to command may not work in today's varied operating environments. For example, air forces operate in the least cluttered battlespace. In these circumstances both command-by-direction and command-by-plan are possible, and they are effective command styles given the nature of modern air warfare. Armies, on the other hand, usually operate in the most complex and chaotic operating environment, and, therefore Western armies have, for the most part adopted the doctrine of mission command or command-by-influence so that decisions can, in theory, be taken by those closest to the situation, often down to the level of the individual soldier.

Navies, however, operate in an environment of medium complexity, compared to air forces and armies, and, therefore most Western navies in the Anglo-American command tradition have identified the need for a command and control system to effectively coordinate maritime operations in a relatively complex, multi-threat environment, over a wide area. Within the naval framework, although individuals would be connected via their consoles, they would be operating as elements of larger systems, such as the various ships' operations rooms (at the lowest level) within the fleet framework. While the Canadian Navy and some other navies in the Anglo-American command tradition are creating and increasingly implementing a unique naval command-by-influence style, navies still have occasion to use the command-by-direction style that they have practised for centuries.

Despite working in different physical environments with different command and technical systems, the Canadian naval and land force experience, particularly the Army's stabilization efforts in post-conflict Afghanistan and the Navy's command of coalition operations in the Arabian Sea, reinforces the belief that the human network, not the technical network, should be the basis for future approaches to CF transformation. However, the differences in the physical environments among land, sea and air forces often dictate different approaches to conducting operations that in turn demand different command arrangements and technical systems. Therefore, a "one size fits all" approach to command and control may not be the best solution for networked operations, even in an increasingly integrated joint and combined operating environment.

More general critiques of NCW come from a number of Canadian commentators who note that NCW is too technically focussed. They observe that NEOps appears to be more focussed on human factors than NCW, but caution that any definition of NEOps should be consistent with Canadian culture and ethos. These analysts argue, therefore, that DND and the CF should be careful about borrowing a concept that may not be compatible with their needs and they should also be cognizant of the fact that implementing NEOps will require more than simply overlaying a networking capability onto an existing organizational or command and control structure. Perhaps most importantly, from a Canadian point of view and based on recent Canadian experience, using NEOps in the Joint, Interagency, Multinational, and Public (JIMP) or integrated context will require network architects not only to consider the use of information technology as an enabler, but also for them to address the much more complex issue of the creation of effective social networks.

In summary, NEOps as a concept has a promising future if it is predicated on Canadian needs and culture. However, there is significant risk in placing too much reliance on concepts like NCW which put the technological cart before the human requirements that should drive any transformation initiative. Therefore, future development of the NEOps concept should be firmly rooted in the Canadian context and based on Canadian experience. NEOps concept development should be complemented by the relevant experience of others, but it should avoid slavishly copying other frameworks as DND has sometimes done in the past. In the Canadian context of human-centred networks, research to support the development of the NEOps concept should be conducted in the areas

related to the human dimension of networks based on theory and on Canadian practical experience. In this way, NEOps could become a suitable model to support the transformation of the CF and DND.

## Sommaire

Le présent rapport vise à permettre à la Section de l'efficacité du commandement et du comportement de Recherche et développement de la défense Canada (RDDC) à Toronto d'examiner les origines théoriques et historiques du concept des opérations facilitées par réseaux, en particulier les suppositions qui sont intrinsèques au concept actuel et l'incidence de ces suppositions sur le commandement et le contrôle militaires et les organisations militaires.

Les opérations facilitées par réseaux (OFR) semblent actuellement devenir le concept moteur de la transformation des Forces canadiennes (FC). Plusieurs raisons expliquent ce fait, la plus importante étant sans doute la tendance du Canada à suivre la voie tracée par les États-Unis en matière de nouveaux concepts liés à la guerre et à d'autres opérations. Même si les OFR n'ont pas encore été clairement définies, de récents énoncés conceptuels à ce sujet indiquent une similarité au concept américain de guerre réseaucentrique (GR), puisqu'on s'attend à ce que les OFR « génèrent une puissance de combat accrue pour les détecteurs de réseaux, les décideurs et les combattants, afin qu'ils soient sensibilisés à l'espace de combat partagé et aient une plus grande vitesse de commandement, un rythme opérationnel plus élevé, une létalité accrue, une capacité de survie supérieure et une meilleure adaptabilité grâce à des boucles de rétroaction rapides. <sup>2</sup> »

L'auteur du présent article examine les OFR et leur instigateur, la GR, et en vient à la conclusion que le Canada et les FC devraient faire preuve de prudence dans l'emploi de la guerre réseaucentrique (GR) comme fondement des OFR, car le contexte et les besoins qui motivent le recours à la GR ne correspondent peut-être pas aux conditions canadiennes. L'article fait valoir que la GR ne constitue pas vraiment une théorie de la guerre, comme l'affirment ses adeptes, mais plutôt une série d'hypothèses et de suppositions généralement non vérifiées qui ont besoin d'être validées avant de servir de base à des OFR.

Beaucoup croient que pour s'adapter au changement par l'innovation, les professionnels militaires et les membres de la communauté de la défense doivent comprendre les outils intellectuels et techniques qu'ils utilisent dans leur travail. Afin de comprendre les OFR en tant qu'outil professionnel, ils doivent donc être conscients du contexte historique et théorique d'où elles proviennent et où elles évoluent. Dans ce contexte, il est à noter que chaque pays et chaque service des forces armées d'un pays a son propre paradigme unique quant à la façon dont les opérations militaires devraient s'effectuer, selon l'environnement physique dans lequel ils évoluent, leur expérience historique et leur culture.

Ces cadres physiques et culturels dans lesquels les forces armées évoluent sont à l'origine de plusieurs critiques formulées contre la GR, dont les adeptes proposent un type précis de commandement par influence ou de commandement de mission comme étant une clé pour les futures opérations par réseaux fondées sur la GR. Tel qu'il en est question dans ce rapport, cette approche uniformisée au commandement peut ne pas convenir dans les

environnements d'opération variés d'aujourd'hui. Par exemple, les forces aériennes évoluent dans l'espace de combat le moins encombré. Dans ces circonstances, le commandement par direction et le commandement par plan sont tous les deux possibles et constituent des styles de commandement efficaces, étant donné la nature de la guerre aérienne moderne. D'un autre côté, les armées de terre évoluent habituellement dans l'environnement le plus complexe et le plus chaotique qui soit; les armées occidentales ont donc pour la plupart adopté la doctrine de commandement de mission ou de commandement par influence de sorte que les décisions peuvent, en théorie, être prises par ceux qui sont le plus près de la situation, souvent même par des soldats individuels. L'armée de mer, quant à elle, évolue dans un environnement de complexité moyenne comparativement aux forces aériennes et terrestres. Par conséquent, la plupart des forces maritimes occidentales qui adhèrent à la tradition de commandement anglo-américaine ont déterminé qu'il leur fallait un système de commandement et de contrôle pour coordonner efficacement les opérations maritimes dans un environnement relativement complexe, à menaces multiples et sur une vaste région. Dans le contexte naval, bien que les gens seraient reliés entre eux au moyen de leurs consoles, ils agiraient comme éléments de systèmes plus vastes tels que les diverses salles d'opérations des navires (au plus bas niveau) dans le contexte de la flotte. Bien que la Marine canadienne et d'autres forces maritimes appartenant à la tradition de commandement anglo-américaine créent et adoptent de plus en plus un style unique de commandement naval par influence, les armées de mer ont encore l'occasion d'utiliser le style de commandement par direction qu'elles pratiquent depuis des siècles.

Même s'ils évoluent dans des environnements physiques différents et avec des systèmes techniques et de commandement différents, l'expérience canadienne sur le plan naval et terrestre, en particulier les efforts de stabilisation de l'Armée de terre dans l'Afghanistan de l'après-conflit et le commandement, par la Marine, des opérations de coalition dans la mer d'Oman, renforce la croyance selon laquelle le réseau humain – et non le réseau technique – devrait former la base des approches futures à la transformation des FC. Cependant, les différences dans les environnements physiques où évoluent les forces terrestres, aériennes et navales dictent souvent les différentes approches utilisées dans les opérations qui, à leur tour, exigent des styles de commandement et des systèmes techniques différents. Par conséquent, une approche uniformisée en matière de commandement et de contrôle n'est peut-être pas la plus adéquate pour les opérations en réseau, même dans un contexte d'opérations interarmées et interalliées de plus en plus intégrées.

Un certain nombre de commentateurs canadiens formulent des critiques plus générales à l'effet que la GR met trop l'accent sur le côté technique. Ils observent que les OFR semblent se concentrer davantage sur les facteurs humains que la GR, mais mettent en garde que toute définition des OFR devrait être conforme à la culture et à l'éthos canadiens. Ces analystes soutiennent donc que le MDN et les FC devraient faire preuve de prudence lorsqu'ils empruntent un concept qui peut ne pas être compatible avec leurs besoins et se rendre compte que la mise en œuvre des OFR nécessitera plus qu'une simple superposition d'une capacité de réseau sur une structure organisationnelle de commandement et de contrôle existante. Sans doute plus important encore, du point de

vue canadien, est le fait que l'utilisation des OFR dans un cadre interarmées, interinstitutions, multinational et public ou intégré exigera des architectes de réseaux qu'ils considèrent la technologie de l'information non seulement comme un outil habilitant, mais aussi comme un moyen de relever le défi beaucoup plus complexe de créer des réseaux sociaux efficaces.

En résumé, le concept des OFR a un avenir prometteur s'il se fonde sur la culture et les besoins canadiens. Par contre, le fait de trop se fier à des concepts comme la GR, qui accorde plus d'importance aux besoins technologiques qu'aux besoins humains, comporte un risque considérable. Il est donc essentiel que le développement futur du concept des OFR soit fondamentalement lié au contexte de notre pays et qu'il se base sur l'expérience canadienne. S'il est vrai que l'expérience pertinente d'autres nations peut alimenter ce développement, il faudrait toutefois éviter de copier aveuglément d'autres structures, comme l'a déjà fait le MDN. Dans le contexte canadien de réseaux axés sur les humains, la recherche visant à appuyer le développement du concept d'OFR devrait s'effectuer dans les domaines reliés à la dimension humaine de réseaux fondés sur la théorie et sur l'expérience canadienne pratique. Ainsi, les OFR pourraient devenir un modèle capable d'appuyer la transformation des FC et du MDN.

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## Introduction

At the beginning of the 21<sup>st</sup> century the concept of networked operations has come to the fore of ways of thinking about warfare and other operations involving military and security forces. The leading approach to networked operations is called Network-Centric Warfare (NCW). This concept was originally developed by the US Navy, but it now dominates US military transformation initiatives and is being used as a template for future American command and control (C2) frameworks. Networked operations are currently touted as the way to fundamentally change the way the US, and, by extension, coalition forces will conduct operations.

This report is based on a requirement by the Command Effectiveness and Behaviour Section of Defence Research and Development Canada (DRDC) – Toronto to examine the theoretical and historical origins of the concept of Networked Enabled Operations, addressing, in particular, the assumptions that are embedded in the current concept and the implications of those assumptions for military command and control and military organizations.

There is still some confusion as to what the concept of NCW actually entails both because definitions of NCW have changed since it was first formally introduced as a concept over seven years ago<sup>3</sup> and because of what some critics have referred to as its “jargon-laden language.”<sup>4</sup> In the late 1990s NCW was seen to consist largely of a fully integrated information network with all platforms being nodes in the network. The primary aim was to produce a “common operating picture” so that all players would be working from the same computer-mediated visual presentation.<sup>5</sup> Today, its principal architects describe NCW as two things: 1) “an emerging theory of war in the Information Age”; and 2) “a concept that, at the highest level, constitutes the military’s response to the Information Age.” We are told in the latest official US policy statement, *The Implementation of Network-Centric Warfare*, that NCW is now about “the combination of strategies, emerging tactics, techniques, and procedures, and organizations” that networked forces can use to “create a decisive warfighting advantage.”<sup>6</sup> Despite these declarations, Canadian researchers have noted the lack of a succinct definition of NCW in official publications.<sup>7</sup>

A concrete example of one of the latest iterations of NCW is the US Navy (USN) and US Marine Corps (USMC), “functional concept” for future operations - FORCENet. As one of the latest derivations of NCW and one closest to its US Navy roots, it gives us some insights into the most recent concepts underlying networked operations. A paper issued by the US Department of the Navy “to establish a common direction for the diverse efforts that contribute to building naval command and control capabilities in the future and to provide a common framework for thinking about future command and control”<sup>8</sup> says that: “The foundation of FORCENet is a *fully integrated, self-healing, self-organizing* communications system or infrastructure... To optimize network effects, the infrastructure will be based on a *modular, open-systems architecture* which allow all nodes to interact regardless of location or network address [italics in original].”<sup>9</sup>

Although the FORCEnet concept acknowledges the human dimension of networked operations, this reference to the human dimension belies the technology-centric approach found in most of the derivatives of NCW because the FORCEnet paper states that in the design of this new approach to warfare and other operations, “technology solutions are often the most obvious” and that technology should “co-evolve with the other elements of force development.” In line with this technology focus, three of the six dimensions of FORCEnet are physical and only one explicitly human-centred.<sup>10</sup> This technology focus may be putting the cart before the horse in ways that militaries have done in the past – buying the newest and the best equipment without any clear idea how it might affect, negatively as well as positively, the way in which operations are conducted. From a Canadian perspective, two main deficiencies stand out in current NCW concepts: 1) their emphasis on warfighting versus other types of operations; and 2) their focus on technology over the human dimension in conducting operations.

Like other concepts that have had a major impact on how Western militaries think about warfare and other operations in the past 20 years, (e.g., the RMA, operational art, manoeuvre warfare, rapid and decisive operations, and effects based operations) networked operations have their origins in the US, and, therefore have had a major impact on how other Western nations think about military and security operations. But it would be prudent not to fully embrace NCW-based concepts because, whatever their strengths and weaknesses, there is also no guarantee that they will endure. This is due in part to the fact that NCW exaggerates certain fashionable technological features of ideas about warfighting and pays little attention to other critical issues, such as the strategic, political, social, and human dimensions of war, as we shall see.<sup>11</sup> And like other concepts that have also catered to the latest fads, the concept of networked operations now has its turn to have a place in the sun. Yet, because of its genesis in late 20<sup>th</sup> century naval warfare operations and business practices, reinforced by experience in certain post-Cold War military campaigns (like Desert Storm), the sun may already be setting on networked operations as “post-hostilities” campaigns in Afghanistan and Iraq challenge some of its basic tenets.

We know that some theories stand the test of time, while others do not apply very well across temporal and cultural boundaries. Whether NCW will shortly become passé or not, will depend on a number of factors. Some of these factors include the theoretical foundations of NCW and the cultural implications of adopting it as an overarching principle of transformation. Yet in all the discussions of networked operations, there is very little discussion about its origins and perhaps more importantly how various theoretical concepts have been lumped together, under different names, to describe varied visions of networked operations. For example, a recent paper from the Canadian Forces’ (CF) office of the Director General Joint Force Development refers to “the theory of Transformation and the associated concepts of Effects Based and Network Centric Operations,” when in fact there are a number of “theories” of transformation, and Effects Based Operations and Network Centric Operations are not closely “associated” either with each other or with transformation, as we shall see.<sup>12</sup> There is a danger in this approach of combining distinct related theoretical constructs into one amalgam: as one commentator on operational art noted in the formative years of that concept, attempting

to combine too many diverse, and potentially incompatible, ideas under one umbrella term “may invite only muddle.”<sup>13</sup>

This muddle is apparent in the very nomenclature associated with networked operations today. The origins of the dominant strand in networked operations discourse today comes from the American concept of Network-Centric Warfare, but other countries have taken NCW and adapted and modified the concept to suit their own needs and military cultures. For example, the Australian military has put more emphasis on the human dimension of NCW than found in the original US model. Other countries have gone further in their adaptations and created new names for their brand of NCW. For example, the UK now uses the term Network Enabled Capabilities (NEC) which is described as more “commander-centric” than “network centric.” Canada has adopted the term Network Enabled Operations (NEOps), an evolving concept, which is to be linked to other Canadian initiatives like the “3-D” (Defence, Diplomacy, and Development) approach to security.<sup>14</sup> However, like NCW, there is no officially approved, concise definition of NEOps.<sup>15</sup> Arguably, the best succinct definition of NEOps to date is: “the conduct of military operations characterized by common intent, decentralized empowerment and shared information, enabled by appropriate culture, technology and practices.”<sup>16</sup> The problem with some of the efforts to develop the NEOps concept in Canada is a lack of awareness of the assumptions and cultural outlooks that are imported with NCW and other approaches to networked operations. In developing new concepts it is useful to borrow and synthesize good ideas from others; however, it is essential to have a solid grasp of the underlying values and beliefs that come with these concepts.

## **Theoretical Foundations**

Advocates of NCW assert that it is an emerging theory of war, based on the Tofflers’ waves theory of warfare and the notion that we now live in the Information Age where “third wave” high-technology information warfare will become the new standard for success in war fighting and other operations.<sup>17</sup> However, critics have challenged these and other assumptions underpinning NCW. Therefore, it is necessary to briefly examine the nature of theories of war to understand NCW as a theory of war.

Related to this question is the debate in parts of the literature on whether networked operations is a topic that primarily belongs in the domain of military art or military science. This paper takes the position that networked operations is a multidisciplinary topic that requires insights from many academic disciplines as well as from practitioners; therefore, debate over the proportion of art and science in this concept is largely sterile. To illustrate this point, we know that successful creative artists like painters must have, besides artistic talent, an understanding of sciences like geometry (to understand concepts like perspective) and chemistry (to work with various media like paints). Likewise, the most successful scientists acknowledge that there is a creative or artistic side to their work. For example, Canada's second Nobel Laureate in physics, Bertram Brockhouse, was described by a colleague as having “this gift of just knowing what the answer is, then doing the experiment to prove it.”<sup>18</sup> This statement bears an uncanny resemblance to an observation by a critic of NCW on the methodology used by those charged with

developing this concept, “This is a relatively new idea and the theory calls for extensive experimentation. But the way it is being done implies they already know the outcome of the experiments.”<sup>19</sup> Therefore, for those who believe that the outcome of experiments should not be pre-determined, the methodology being used to develop NCW is flawed.

The debate over art versus science notwithstanding, there are some concepts that should be clearly understood because they are important in comprehending the context in which tools like NCW and NEOps originated and are evolving. Therefore, before examining the specifics of these tools, two concepts - theories and paradigms - will be discussed.

### **NCW as a Theory**

The authors of the most recent articulation of the NWC concept, *The Implementation of Network-Centric Warfare*, have selected definitions of the word “theory” that emphasize its speculative nature in some common usage.<sup>20</sup> This usage of theory, defined in one dictionary as “a speculative or conjectural view of something,” accords closely to the understanding of Prussian strategist Carl von Clausewitz (1780-1831) as to how theories should be used. Clausewitz’s approach was strongly influenced by Kantian philosophy, and he used the dialectic approach of thesis, antithesis, and synthesis to study the subject of war. In his book *On War* he constantly revised his hypotheses and he moved back and forth between the ideal and the real states of war.<sup>21</sup> Many of the writings found in the American professional military literature, however, quote Clausewitz out of context as if he had written a book of instruction on the conduct of war. But he did not; he wrote a treatise to help us better understand the phenomenon of war through debate and the synthesis of competing concepts.<sup>22</sup>

The implications of the speculative approach to theories have important implications for NCW theory. It could be argued that NCW “theory” is no more than a series of largely untested hypotheses or assumptions that should be subjected to research and a Clausewitzian dialectic to determine their usefulness. While this approach is nothing new in the history of military theories, there are profound implications when one observes how completely NCW has been embraced as the benchmark for US Department of Defense (DoD) transformation, and by extension some other Western nations’ military transformation. In many policy documents NCW is often portrayed, not as a speculative theory, but as an authoritative doctrine on future warfare. Accepting it as such and embracing it completely may be a high risk activity as the transformation of militaries and their future may be based on untested speculation. This problem is exacerbated for nations like Canada that are creating their own “theories” of networked operations on, arguably, the proverbial foundations of sand that may be washed away by the next “wave” in military theory.

A number of organizations have adopted NCW as though it were an integrated view of the fundamental principles underlying a science or its practical applications.<sup>23</sup> In this view of a theory, if its principles are correctly applied, the

theory is generally accepted to have explanatory power. This description might be used to characterize the approach of the Swiss-French strategist Baron Antoine-Henri Jomini (1779-1869) to the study of war. Jomini emphasized decision-making rules, operational results and conceptualizing warfare as a huge game of chess. His conception of war has been surprisingly durable in the present age of computer-mediated warfare where the Jominian paradigm underpins much of the Western approach to modern warfare.<sup>24</sup> In today's world, where our lives are strongly influenced by scientific notions, we usually expect a theory to be able to explain causality or why things happen.<sup>25</sup> Therefore, when many military professionals see the word "theory" attached to a concept, they expect it to have considerable explanatory power.

The latest policy statement on NCW, *The Implementation of Network-Centric Warfare*, offers an interesting paradox in its analysis as it attempts to combine aspects of both Clausewitz's and Jomini's approaches to its own theoretical approach. On the one hand it concludes that "classic strategic theories of war may require adaptation to a changing environment... [but that] they remain fundamentally intact. The logic of waging war and of strategic thinking is as universal and timeless as human nature itself." Furthermore, *The Implementation of Network-Centric Warfare* acknowledges that a large number of theorists at the end of the 20<sup>th</sup> century proposed a number of alternative frameworks for war in the future. On the other hand, by adopting the concept of the "information age" as its foundation, *The Implementation of Network-Centric Warfare* has not attempted a synthesis of previous theories of war, but has pinned its hopes on one specific interpretation of war. And the Toffler's interpretation of war occurring in waves, with the current wave being based on information, has been challenged by a number of commentators including Steven Metz, currently teaching at the US Army War College's Strategic Studies Institute. He argues that "Quintessentially American, the Tofflers concentrate on technology feasibility with little concern for the strategic, political, social, psychological or even ethical implications of changing military technology." He states that their theories are particularly attractive to the US military because of their relatively simple, if flawed, interpretation of war.<sup>26</sup> Therefore, despite its recognition of the importance of the human in the latest NCW policy documents, it is important to remember that NCW theory is founded on an essentially technological approach to war.

Another problem with applying NCW theory is based on US military culture. *The Implementation of Network-Centric Warfare* recognizes that the theoretical constructs of the classic theorists of war "remain fundamentally intact," and among the classical theorists Clausewitz is cited most frequently as the basis for the doctrinal writings of the US services. However, his theories are in some respects at odds with the assumptions underlying NCW, and this situation may cause difficulty in adapting NCW to current or future doctrine.<sup>27</sup> Furthermore, as Paul Johnston has demonstrated, the characteristics, historical experience and culture of an armed force may have an important impact on both how armed forces plan to fight and how they actually perform on the battlefield.<sup>28</sup> If

implementing NCW requires major cultural changes in armed forces, its advocates should take into account that successful cultural change often takes a considerable amount of time and that such change is usually measured in years, and even decades, as major culture change may require paradigm shifts in the organization.

### **Paradigm Shifts**

The process of paradigm shift often has significant effects on how a particular theory affects an organization's predominant paradigm. In some cases the new theory effects a paradigm shift; in other cases the theory is modified or rejected to fit into the prevailing paradigm.<sup>29</sup> Azar Gat, a leading writer on military thought, notes that "[n]ew and significant intellectual constructions usually emerge at times of fundamental change or paradigmatic shifts, when prevailing ways of interpreting and coping with reality no longer seem adequate."<sup>30</sup> But during paradigm shifts, new notions and concepts are often hazy and ill defined. Part of the reason that NCW concepts are unclear is that NCW was developed at the end of the Cold War when a paradigm shift about the nature of war and conflict was under way. And yet NCW drew on theories whose antecedents came from the Cold War period, particularly naval operations and certain aspects of business theory.

Therefore, in examining the history of NCW this paper will focus on the origins of NCW, because it roots in naval operations and business theory, have nurtured certain assumptions that are found in the fruit of the NCW theoretical tree. These assumptions, while compatible with some military cultures, are not compatible with, and may be actually antithetical to, other military cultures. This situation arises because each country's military and each service within that military has its own war fighting paradigm based on the physical environment in which it fights, its technology, its history and its culture. Some of these paradigms can accept the notions embedded in NCW easily, other paradigms can accept these notions but must modify them to work in a different framework, and still other paradigms are not compatible with the key assumptions of NCW.

Throughout this discussion, it would be wise to keep Williamson Murray's thoughts on theories and models in mind. He argues that while they can aid analysis, they can offer no formulas for the successful conduct of war, because its reality is far too subtle and complex to be encompassed by theory. At best, he claims that theories can provide a way of organizing the complexities of the real world for studying war because, as Clausewitz suggests, "principles, rules, even systems" of strategy must fall short in a domain where chance, uncertainty, and ambiguity dominate. And yet, while many variables that cause ambiguity have different effects from one situation to another, others cause effects whose features recur with impressive regularity.<sup>31</sup>

# Critiques Of NCW

## US and other Critiques

One of the major critiques of NCW is that it is a technology-centred approach to war fighting and other operations. Clearly, technology has had an important impact on how recent campaigns have been conducted. For example, in the post-September 11 epilogue to her book, Sloan argues that the Afghanistan campaign left almost no area of the RMA untouched, especially the use of precision munitions and disengaged combat. She notes that 60 percent of the munitions dropped on Afghanistan were precision-guided compared to 35 percent for the Kosovo campaign and 6 percent for the Gulf War. Furthermore, the first use of unmanned combat vehicles on a large scale has led to the prediction that by 2025, 90 percent of combat aircraft will be unmanned.<sup>32</sup> Yet despite all these technological advances, some parts of the campaign were not much different than those waged 85 years ago on the Western Front. A recent lessons learned brief from Afghanistan pointed out that, like their First World War ancestors, US (and Canadian) ground troops were still lugging into combat 80 pounds of equipment on their backs.<sup>33</sup> This is only one example of how technology has not changed every aspect of warfare and why it should not be the focal point for future approaches to war and other operations. Some of the most trenchant criticisms of a technocentric approach to war and other operations follow.

### Technology and Human Factors

A fundamental policy and budget issue for many armed forces today is what balance to strike between technology and human resources in force structures of the future. Often the question is framed as: what proportion of expenditures should be allocated to new equipment versus training? Stephen Biddle's iconoclastic interpretation of Coalition success in the Gulf War offers a model that incorporates both factors. He uses it to support his premise that "future warfare is an incremental extension of a century-long pattern of growth in the importance of skill differentials between combatants," and that outcomes between highly skilled opponents have changed relatively little in spite of major changes in technology. His explanation of Coalition victory in the 1991 Gulf War posits a powerful synergistic interaction between a major skill imbalance and new technology to account for its outcome. He theorizes that it was only the extremely low skill level of Iraqi forces compared to Western forces in the Coalition plus the technical preponderance of the Coalition that allowed it to win a near bloodless victory. Biddle claims that higher Iraqi skill levels, even with their technological inferiority, would have resulted in significant Coalition casualties; likewise, lower Coalition skill levels, even with technological superiority would also have resulted in significant Coalition casualties.

Biddle maintains that his interpretation has important policy implications, because most current net assessment and force planning methodologies focus on numbers and the technical characteristics of adversaries' weapons. These methodologies

run the risk of producing a serious misjudgement of the real military power of opponents and could result in major errors in estimates in the forces needed to meet future threats. Biddle claims that those who argue that modernization should be protected at the expense of training and readiness overestimate the value of technology and underestimate the effects the role of skill in using technology has on the outcome of a conflict. He concludes that a more systematic study of opponents' skills is needed because little research has been done on the relationship between weapons effects and the skills of the operators.<sup>34</sup> Biddle's ideas have important implications for Canada and other medium powers, as potential US coalition partners must consider the trade off between numbers and quality of troops and quantities of sophisticated equipment.

Owens cautions us against putting technology ahead of other considerations and he labels that phenomenon as "technophilia." He argues that: "Technophiles contend that a 'revolution in military affairs' based on emerging technologies has so completely changed the nature of warfare that many of the old verities no longer hold true. The technophiles argue that the US must do what is necessary to ensure its dominance in military technology even if it means accepting a substantially reduced force structure." But Owens cautions us against technophilia because he says the future is unknowable and that the US has confronted at least one strategic surprise per decade since Pearl Harbor. He recommends not relying too heavily on technology and maintaining balanced forces that work together like the blades on scissors.<sup>35</sup>

Others suggest that the very nature of technology has changed at the beginning of the 21<sup>st</sup> century. Leonhard asserts that future war will be characterized by prototypes rather than mass production. Because of the rapid evolution of technology, he argues that there will be no "technological end state," but that in an era of technological flux it will be the side that can adapt and field workable prototypes based on changing permutations and combinations of technology that will succeed. This will be a major challenge to the American warfighting culture, long based on quantity as much as quality, because the new "prototype warfare" will require "unprecedented levels of innovation and flexibility among warfighters."<sup>36</sup>

## **C2 Critiques**

Another major theme in critiques of NCW is that its implementation will have adverse unintended consequences on command and control. The potential of NCW is huge if commanders were to actually have access to all the information that could affect their missions. With the holy grail of "full situational awareness" potentially so close to hand, many advocates see the developing technology as a panacea, without recognizing the extent to which it challenges traditional notions of command and control. Although primarily an issue that will be settled by the US armed services, the implications for America's coalition partners are huge. The Australian Defence Forces (ADF) are in many ways comparable to the Canadian Forces. The following discussion from the RAN's

Sea Power Centre, although made in the narrower context of undersea warfare (USW), neatly summarizes the scope of the issue:

[A] variety of [network-enabled] technologies promise to advance the sophistication of USW, offering the hope that increased mission effectiveness will derive from a combination of improved sensors, multiple platforms, and efficient, rapid data exchange and fusion. But there are profound difficulties in the practical application of both the technology and the doctrine. The larger debate about the nature and value of NCW is far from settled, and the debate about how to apply and manage it in the underwater battlespace is even less mature. ADF doctrine acknowledges the as yet unformed nature of NCW and the risks inherent in trying to incorporate it into Australia's future warfighting concepts. What is clear is that we have not yet witnessed the genesis of either a concept or a technology that will make the oceans transparent. It also seems likely that rather than a revolution, NCW operations will ultimately be seen as another step in the leap-frogging process USW has followed since World War I. Certainly, there is nothing to suggest that the next two decades will witness other than a continuation of this process.<sup>37</sup>

Others are learning the lesson that allied navies have come to appreciate: the problem with NCW seems to be one of learning to filter the flow of all that information so that it reaches commanders at a manageable rate. It is easy to perceive many of these problems as limitations of current technology, but it is important also to acknowledge that there is a limit to what the human mind can process. There is a large and growing literature on some of the problems related to the human dimensions of command and NCW, and some important ones are summarized here.

Thomas Barnett, formerly a Professor and Senior Decision Researcher at the US Naval War College, offers a number of criticisms of NCW, but he is particularly critical of the strain the common operating picture could put on commanders at all levels. It may push too many commanders, fed by an almost unlimited data flow, into being control freaks making the common operating picture into a sort of non-stop internal spin control by commanders trying to influence what others see. It also risks becoming a command-manipulated virtual reality, at worst degenerating into the senior command staff engaging in a heavy-handed enforcement of the commander's view of the situation all in the name of shaping and protecting the common operating picture. In any event, the developers of NCW may have fallen into the technology trap of providing information for information's sake, without considering the real needs of commanders.<sup>38</sup>

William Lescher, who reminds us that in large organizations the pace of innovation is constrained more by organizational culture than by technology, offers another caution. He argues that unless the US military gets past its

fascination with technology to address critical issues such as a zero-defects mentality, risk aversion, poorly designed war fighting experiments, and widespread contentment with current performance, expectations for NCW will not be realized.<sup>39</sup>

More recent criticism of NCW has addressed its conceptual origins. Kagan argues that the underlying flaw in NCW is that it reflects an effort to translate a business concept of the 1990s into military practice. The basis of NCW is drawn explicitly from the examples of companies like Cisco Systems, Charles Schwab, Amazon.com, American Airlines and Dell Computers among others. It has been claimed that all of these companies attained dramatic competitive advantages in their fields by creating vast and complex information networks, and using these networks to predict inventory needed to meet customer orders has permitted them to become “maximally adaptable,” building products to the exact specifications of each customer only when the customer wanted them. This information technology allowed these companies to make enormous efficiencies because they could make accurate predictions, minimize risk and adapt to rapidly changing circumstances. The key to NCW, according to its advocates, is to achieve information dominance over the enemy in much the same way that successful corporations use information to dominate their markets.<sup>40</sup> However, recent experience and reading history should remind us that war is not business; enemies are not customers to be serviced; and the type of information dominance this approach to war demands is unlikely to be achieved with enemies who are adaptable and able to foil attempts to gather intelligence, especially using the technical means that predominate in NCW.

Another problem with NCW, according to Kolenda, is the assumption that fusing information into a common operating picture will result in uniform interpretation of the information by its various users. He argues that shared situational awareness does not inevitably lead to “shared appreciation on how to act on the information” as different people, based on their experience, education, culture, and personalities will assess risk and how to best “maximize the effectiveness of themselves and their organizations” differently. Kolenda concludes that technology-based common operating pictures can be used to keep the creative abilities of subordinates within the framework of a commander’s intent; however, these subordinates must be given the authority and autonomy they need to create, within the commander’s intent, original solutions to the problems at hand. Therefore, to ensure success, information technology should “result in empowerment and initiative rather than rigidity and overmanagement.”<sup>41</sup> One tool to ensure the effectiveness of subordinates in networked operations is Pigeau and McCann’s Balanced Command Envelope, as described in a NCW environment by Forgues in the section below.

The most recent NCW policy statement, *The Implementation of Network-Centric Warfare*, publication offers evidence from operations in Afghanistan and Iraq of the success of NCW in these campaigns. But a number of commentators have observed that there has not been enough open debate on these lessons and that

some of the lessons have reached conclusions that are personalized or politicized. As one commentator put it, NCW “has a ‘certain naive quality’ when it focuses on concepts like ‘information dominance’ to the exclusion of other ideas, including those that might undercut its value.”<sup>42</sup> For example, immediately after what has been described as “the combat phase” of Operation Iraqi Freedom, many proponents of NCW declared that NCW had been responsible for achieving victory in Iraq. It soon became clear that there was much to be done before victory could really be declared. One American commentator reflected the views of a number of critics of NCW with this statement:

The Pentagon's version of ‘transformation’ is all about using technology to enhance the military's standoff power – the precision-guided bombs and unmanned robots that allow America to dominate a battlefield without risking high US casualties. But political transformation requires the opposite – an intimate "stand-in" connection with the culture and people you propose to transform.<sup>43</sup>

Despite the optimistic quotes found in *The Implementation of Network-Centric Warfare* about the success of NCW in recent operations in Iraq and Afghanistan, there are reports from the field that call them into question and highlight the Canadian perception that the human dimension of networked operations, like HUMINT (human intelligence), are more important in some circumstances than information gathered by technical means:

HUMINT drives successful operations and allows us to focus combat power, but we are happy if we hit pay dirt 25 percent of the time. There is little useful information that comes down from higher, and the higher it comes from the less useful it is for a maneuver battalion. There are too many variables for it to be precise.<sup>44</sup>

Finally, others have criticized lessons from operations in Afghanistan and Iraq cited by advocates of NCW to support its relevance because the lessons were gleaned from “fighting incompetent adversaries” and that the lessons were not “necessarily a good basis for making long-term force posture decisions” because future enemies may be more capable.

One of the most controversial topics in the command and control and the networked operations debate today is the relationship between technology and the exercise of command. As Moltke observed over 100 years ago, it is important to recognize the limitations of technology and take them into account when exercising command. Van Creveld has expanded on this idea and, while noting that there is no such thing as a “one size fits all” C2 system, has reminded us that there will always be unpredictability caused by the fog of war.<sup>45</sup> But as Robert Polk noted, this point is often lost on the “C4ISR” crowd who believe that

technology can tame uncertainty and that the future of war lies more in the art of mastering the science of well-laid plans than in fighting an opponent.<sup>46</sup>

This excerpt from a recent analysis of C2 in an NDHQ staff paper summarizes the issues nicely: “We want our leaders and their subordinates to be enabled by appropriate information technologies and architecture in order to develop the situational awareness essential for mission success. However, confident battlespace awareness will only result from the appropriate fusion of technology, organization, doctrine and personnel. There is no point in generating more information about the battlespace if: a) the doctrine is not well enough developed to assist in managing the information; b) the technology cannot rapidly and securely transfer vast amounts of data over long distances; c) the organization is so layered and compartmentalized that the right information never reaches the right people in time; and d) operators are unable to derive action-relevant knowledge from the information displayed to them.”<sup>47</sup>

Another factor that should be taken into account in the command and control and the networked operations debate is the different physical, not to mention cultural, environments in which armies, navies, and air forces operate. Air forces operate in a relatively simple environment and in this comparatively uncluttered battlespace command-by-direction and command-by-plan are not only possible, but as we have seen, perhaps necessary. Armies have, arguably, the most complex operating environment and the stated command doctrine of most Western armies, mission command or command-by-influence, is designed to take this complex operating environment into account. Navies are, perhaps, in between the other two services, and, therefore susceptible to a greater range of command styles. While command-by-direction has been practised by navies for centuries, the last two decades have witnessed revolutionary progress towards command-by-influence in naval operations.

Given these factors, a useful starting point in the design of any new C2 framework, but one rarely considered by technophiles who design systems to maximize technical possibilities (like bandwidth and resolution), would be to begin the design of any new C2 system with an explicit statement of what the commander requires from the system. These requirements will, of course, vary according to the commander’s role and it would seem will vary according to a commander’s personal qualities and preferences. This puts new meaning into van Creveld’s observation that there is no such thing as a “one size fits all” C2 system.<sup>48</sup>

## **Canadian Concerns**

Many Canadian concerns about NCW as a basis for NEOps are similar to those summarized above; therefore, they will not be repeated in detail here. However, a number of concerns raised by Canadian commentators that provide a different dimension to the criticisms of NCW are worth discussing.

## A C2 Critique

One of the earliest Canadian critiques of NCW was made by a student on the Advanced Military Studies course at the Canadian Forces College in 2000 and published in 2001 using the Pigeau-McCann framework as an analytical tool. At the time, many of the human-centred issues now appearing in NCW documentation were not found in the NCW literature.

Forgues notes that recent advances in information technology have affected the organizing principles for the conduct of operations and that NCW is one approach to “further exploit information technology and significantly enhance the functions of command and control on the battlefield.” He argues that “command is a mission-oriented human endeavour performed within the limits of a commander’s personal attributes,” and that this requires “creativity and intuition to make sound decisions in a NCW environment.”<sup>49</sup> One could also add that given the highly stressful nature of modern warfare emotional and interpersonal competencies will be equally important for future leaders.

In the NCW environment Forgues argues that the factor of personal authority “will create a double-edged sword that commanders will need to wield carefully.” If things are going well during an operation a networked environment, word will quickly spread of success and this should increase a commander’s personal authority within his force. But if the force encounters setbacks or failures, the commander’s personal authority could decrease. Along these lines, another phenomenon, not discussed by Forgues, but that could be magnified by NCW is that commanders’ decision processes may be more visible to subordinates at all levels with the resultant positive or negative outcomes.

Another double edged sword in an NCW environment may be the factor of intrinsic responsibility. The high degree of shared awareness that NCW should bring among members of a force could act to increase intrinsic responsibility in certain circumstances. For example, a setback might cause some elements of a force to have an increased sense of their responsibility to carry out a mission, but a shared awareness of imminent defeat might adversely affect intrinsic responsibility and paralyze the force. As we have seen, NCW may complicate or obfuscate lines of extrinsic responsibility.<sup>50</sup>

A networked environment might have a variety of effects on what Pigeau and McCann called shared intent among commanders and their subordinates. There is every reason to expect that explicit shared intent will be dramatically increased with NCW; however, Pigeau and McCann tell us that it is only the tip of the iceberg. The effect of NCW on implicit intent is not known at the moment, and yet it is arguably the most important of the two parts of shared intent. In any event, as Forgues observes, “the fundamental need of shared intent and the element of trust it engenders will remain a cornerstone of command in network-centric warfare.”

In summary, based on the Pigeau-McCann framework, Forgues tells us that a commander should be within the Balanced Command Envelope, that is “a given commander’s abilities must match the levels of competency, authority, and responsibility associated with his position.” Furthermore, he asserts that “information technology alone is not sufficient to enable self-synchronization in a NCW environment,” but that organizations will “need to ensure that commanders at all levels have the attributes necessary to accomplish the task.” Forgues concludes that:

The NCW environment will not determine the essence of command in war. The technology will indeed bring a new set of variables to the command equation that must be solved by commanders. In the words of Martin van Creveld, ‘Far from determining the essence of command, then, communication and information processing technology merely constitutes one part of the general environment in which command operates.’ The technological component of war can never fully account for the dynamic interaction of human beings and ‘war will remain predominantly an art, infused with human will, creativity, and judgement.’<sup>51</sup>

In response to critics like Forgues, the most recent statements on NCW by Cebrowski have attempted to make the human dimension of NCW more prominent.<sup>52</sup> However, because of its theoretical and experiential roots, many see NCW as still excessively focussed on technology. This is consistent with the view of those at the forefront of developing the NEOps concept in Canada who noted that, NCW tends “to focus attention excessively on the network and its related technology, and seemed to exclude military operations other than war.”<sup>53</sup>

### **Recent Criticisms**

In March 2005 two workshops were convened under the auspices of DRDC – Toronto to gather the views of Canadian subject matter experts (SMEs) on networked operations. The following excerpts from that report highlight the main concerns of Canadian SMEs expressed at those workshops:

Speed of command allows participants to adjust and modify their position more quickly, thereby leading to more robust Commander’s Intent. A hidden assumption to speed of command, therefore, is that the locus of command can rapidly shift, i.e., “command is allowed to fluctuate” based on who has the most relevant knowledge for the given situation. And this knowledge can be more than mere core knowledge. . In response to this interpretation, however, one SME noted that this notion is possible in the Army, whereas it is difficult in the Air Force and Navy. For example, following 9/11, within the Air Force, the decision to shoot down a passenger airline emerged. As one SME explained,

in an NEOps paradigm, a decision such as this would necessarily remain in the hands of the commander, because he is ultimately responsible for all activities and some decisions are simply “too important”. In particular, there was a concern among SMEs that speed of command would lead to a faster means to make old mistakes.<sup>54</sup>

The ultimate outcome of NEOps is increased mission effectiveness, [emphasis in original] which can be understood as quicker submission of the enemy with decreased lethality and destruction. Of course, within a peacekeeping operation, this would need to be defined differently. For example, one SME noted that mission effectiveness might be understood as “improving quality of life”. Thus, the political and social outcomes are as important as military outcomes.<sup>55</sup>

Another key challenge in NEOps is the often implicit assumption that simply providing people with access to the same information will enable common understanding. Again, the issue of how “common intent” can actually be promoted among network players, often from diverse backgrounds and cultures (both national and organizational) represents a major challenge for the future. As such, there will need to be consideration around control mechanisms. For example, what is the role of doctrine and mission command?<sup>56</sup>

SMEs also noted that another potential challenge to NEOps will be attempting to implement it universally within the CF. In other words, SMEs argued that a “one size fits all” approach would undermine the particular nuances across environments in the CF. One SME believed that the impact will be more dramatic on the Army than the Navy or Air Force, explaining that the interaction of the soldier on the ground with another member of the land force is very different from the interactions in a maritime or air context. Some of the literature tends to support this perspective. For example, the notion of joint interoperability has been questioned because of the belief that air, sea, and land combine to achieve a “‘unified’ battlespace” (McMaster, 2003). But as McMaster states, “the factors that preserve uncertainty in war despite technological superiority are mainly land-based”.

Finally, NEOps will be a challenge to the organizational culture and structure. According to MacNulty (cited in Warne et al., 2004), some changes to organizational culture will be reflected in command plans, the planning process, competition, attitude to change and risk, decision making planning cycle, and resourcing

systems. Currently, there appears a lack of scientific investigation regarding NEOps and its impact on and interaction with CF culture.<sup>57</sup>

It appears, then, that the kind of transformation required for NEOps – or more specifically something like self-synchronization – will be a product of culture and doctrinal change within the CF as opposed to technological implementation.<sup>58</sup>

SMEs also noted that within the NEOps paradigm, the hierarchical structure of the military will be changed into a flatter organization, which resembles a “web of command” instead of a chain of command. If one of the desired outcomes of NEOps is distributed decision making, then the CF needs to consider the changes to the organizational structure that are required. For example, current C2 is based on a central, hierarchical model. While thinking around greater horizontal command approaches has been emphasized (McCann & Pigeau, 2000), how does NEOps make this process more of a reality and hence more immediate? How does CF culture begin to embrace a “web of command” in place of a chain of command? This may require another form of leadership to reflect decentralized decision making, while still maintaining the essential level of authority. This leads to the question of how authority changes in a NEOps environment.<sup>59</sup>

SMEs also noted other challenges likely in implementing NEOps in Canada. Working within a JIMP context, for example, was seen as likely to present unique challenges to working in networked operations. For example, SMEs pointed out that although NEOps needs to be understood within a broader operational context, evolving partnerships (e.g. with differing JIMP stakeholders) will require different sharing requirements.<sup>60</sup>

Interestingly, the *CF Strategic Operating Concept* (2004) identifies the implausibility of removing all of the fog and friction of war through networks. It is documented that “human intelligence, obtained in part through human networking, will be key to achieving [an] information advantage” in the future battlespace. Though networks and sensor capabilities have improved the operational picture and decreased the uncertainty of war, certainty will never be realized because “[d]ifferences in individual cognitive processes, technological failures, and the actions of adaptive adversaries will all continue to frustrate achievement of a completely certain operating picture” (*CF Strategic Operating Concept*, 2004, p. 18). So despite the information advantage that arises from robust networking, commanders will still have to make

decisions in the face of uncertainty. Networks themselves will not eliminate the uncertainty of war. These points highlight the caution in the Canadian perspective of NEOps when compared to the U.S. conception of NCW.<sup>61</sup>

However, there was a general concern among SMEs that, as the CF moves forward, it should not get “blind-sided” by the mere technological potential for combat operations. Rather, the CF also needs to embrace the full extent of transformation and the paradigm shift in military affairs and take into account the unique roles that Canada plays in international affairs. It also needs to consider the unique impacts that NEOps will have on the human actors and the CF organizational structure and culture. As such, SMEs identified a number of cognitive and social factors that require investigation as Canada moves forward. They feared that there might be many rapid organizational changes without the benefit of the robust research that they thought necessary. SMEs also thought that it was critical to integrate Canadian strategic operating concepts, such as the JIMP framework and the 3D approach, to international affairs through a fully articulated definition of NEOps. In fact, it was pointed out that NEOps is a governmental concept rather than a military concept. The question remains whether a military model will dominate in the governmental model. SMEs also thought it was important to differentiate the Canadian concept of NEOps from the US concept of NCW in order to ensure that all of the missions in which the CF participates are given adequate attention.<sup>62</sup>

Writing at the turn of the last century Sloan concluded that an RMA was underway and that it has the potential to dramatically change warfare in the next two to three decades. Her conclusions about how Canada and other similar countries could deal with rapid technological change as represented by the RMA are equally applicable to NCW. She argued that despite the challenges of expensive equipment and small budgets, these countries can, by making selective investments in new technology, maintain some capabilities that will allow them to be interoperable with or to provide niche capabilities to American and other coalition forces. She suggests that Canada invest in capabilities that can respond to both high- and low-intensity tasks, e.g., advanced C4I, intelligence, surveillance, and reconnaissance systems, UAVs, strategic lift, PGMs, and highly lethal yet rapidly deployable and mobile ground forces. Sloan echoes Biddle’s concerns when she advises that Canada must consider the trade off between personnel and technology. She concludes that to ensure that this trade-off is set above the line of operational and political marginalization increased defence spending is required.<sup>63</sup> It remains to be seen if recently promised increases in Canada’s defence budget will be enough to address her concerns.

## Conclusions

NEOps seems poised to become the driving concept behind CF transformation for a number of reasons, not the least of which is Canada's tendency to follow the American lead in new concepts related to war and other operations. This paper examined NEOps and its progenitor, NCW, and concluded that Canada and the CF should be cautious about using NCW, a concept that was developed in a certain context to meet certain needs, as the basis for NEOps, because that context and those needs may not be congruent with Canadian requirements.

While the notion of networked operations has been embedded in the conceptual approaches to operations of a number of militaries, recently a specific variant, NCW, has come to dominate the debate on change and transformation and it is being used as a template for future American command and control frameworks. This domination came about not because of any overwhelming empirical evidence or because of its wide-ranging practical virtues, but because it was imposed on the US Office of Transformation by one of its leading advocates Arthur Cebrowski. There is still considerable confusion as to what the concept of NCW actually entails because the concept itself has been evolving over the past seven years and because of its arcane language. Furthermore, as the concept has evolved, it has moved well beyond its naval roots and incorporated a number of models from other domains, for example, EBO, information age warfare, mission command (or command-by-influence), manoeuvre, and elements of the OODA loop, which are not necessarily compatible with the original NCW construct and which are not always well articulated or described themselves. This has caused a great deal of confusion in the debates on NCW-driven transformation and, unfortunately, this confusion has been glossed over in a number of official publications. This conceptual confusion is exacerbated by the fact that even "transformation" is not clearly defined by those in charge of these efforts in the US today.

The paper asserted that in order to adapt to change through innovation, military professionals and those in the defence community need to understand the intellectual as well as the technical tools that they use in their work. To gain an understanding of NEOps as a professional tool, they must be conscious of the historical and theoretical context in which it originated and is evolving. This paper noted that NEOps is seen by many as a branch on the NCW theoretical tree; however, NCW is not a theory of war in the sense of an idea or principle that has explanatory or predictive value, rather it has been described as a series of largely untested hypotheses or assumptions strung together in various official documents. Moreover, proponents of NCW, while recognizing the value of a wide range of theories of war, have used the Tofflers' "third wave" Information Age model as the theoretical foundation for NCW. This model has been widely criticized for its over reliance on technological explanations for changes in war, and this is one of the reasons why NCW has been characterized as a technophile's approach to war. It would seem prudent, therefore, to base any new approach to future war on a synthesis of various theories of war, comprising their best features, rather than on one controversial model.

NEOps has not yet been formally accepted as a principle supporting the transformation of DND nor has it been clearly defined, but recent NEOps conceptual statements indicate a similarity to the NCW idea in that NEOps is expected “to generate increased combat power by networking sensors, decision makers and combatants to achieve shared battlespace awareness, increased speed of command, higher operational tempo, greater lethality, increased survivability, and greater adaptability through rapid feedback loops.”<sup>64</sup> However, a number of Canadian commentators note that NEOps is more focussed on human factors than NCW. There is also an awareness among many Canadian commentators that any definition of NEOps should be consistent with Canadian culture and ethos. DND and the CF should, therefore, be careful about borrowing a concept that may not be compatible with their needs and be cognizant of the fact that implementing NEOps will require more than simply overlaying a networking capability onto an existing organizational or command and control structure. Perhaps most importantly, from a Canadian point of view and based on recent Canadian experience, using NEOps in the JIMP context will require network architects not only to consider the mere use of information technology as an enabler, but also for them to address the much more complex issue of the creation of effective social networks.

The main criticisms of NCW are based on the fact that it is a technology-centred approach to war fighting and other operations. Biddle notes that new technical systems, like those proposed by NCW, can require very costly investments, but he reminds us that training and readiness require sizeable investments as well. And without adequate investments in training and readiness new technology will not necessarily be the force multiplier or decisive element that some believe it will be. Biddle’s arguments have important implications for Canada and other similar countries, as potential US coalition partners must consider how to balance their investments among numbers and quality of personnel and quantities of sophisticated equipment.

A more fundamental criticism of NCW was put forward by Kagan who asserted that its origins in 1990s business and technical processes were not necessarily conducive to a 21<sup>st</sup> century theory of war. The idea that in using NCW a military can achieve information dominance over an enemy in much the same way that some successful corporations have used information to dominate their markets is a dubious proposition at best, according to some critics, as unlike customers, enemies will usually try to frustrate attempts to gather intelligence, especially using the technical means favoured by NCW.

Even if NCW is able to fuse information into a common operating picture, Kolenda argues that the education, culture, and personalities of those viewing the picture will result in diverse interpretations of what is presented. Furthermore, a number of commentators have noted that the more efforts that are taken to standardize both the information and the interpretation of that information, the more likely it is that creativity and originality will be stifled. This suppression of creativity and originality will work against the development of command-by-influence in a NCW environment. To ensure that commanders are able to make optimal use of networked C2 systems, it has been suggested that they should be within what Pigeau-McCann postulate as the “Balanced

Command Envelope” to ensure the required symmetry amongst the competency, authority, and responsibility necessary for effective command. Furthermore, it has been argued that information technology will not guarantee self-synchronization in a NCW environment if commanders at all levels do not have the attributes required to do their jobs.

Another critique of the technical focus of NCW is its use of state-of-the-art, remote sensing to gather information. Recent reports from Iraq contradict official NCW policy documents about the usefulness of this information, as users in the field support those critics who contend that, to effect political transformation, an intimate "stand-in" connection with the culture and people you propose to transform is required.

The physical and cultural settings in which armed forces operate are the base for other critiques of NCW. As noted in this report, air forces operate in the least cluttered battlespace and in these circumstances command-by-direction and command-by-plan are not only possible, but perhaps necessary. Armies on the other hand usually operate in the most complex and chaotic operating environment, and, therefore Western armies have, for the most part adopted the doctrine of mission command or command-by-influence so that decisions can, in theory, be taken by those closest to the situation, often down to the level of the individual soldier. Navies operate in an environment of medium complexity, compared to air forces and armies, and, therefore most Western navies in the Anglo-American command tradition have identified the need for a C2 system to effectively coordinate maritime operations in a relatively complex, multi-threat environment, over a wide area (normally a theatre of operations but which could encompass global operations). Within the naval framework, although individuals would be connected via their consoles, they would be operating as elements of larger systems, such as the various ships’ operations rooms (at the lowest level) within the fleet framework. These new C2 systems, based on the original NCW concept, are enabling navies to replace the command-by-direction style that has been practised by navies for centuries, with a uniquely naval command-by-influence style that has increasingly been observed in naval operations of the Canadian Navy and some other navies in the Anglo-American command tradition in the last two decades.

Some recent Canadian concerns with networked operations as articulated in the NCW documentation that appears to be informing the emerging NEOps concept in Canada are as follows: increased speed of command could lead to a faster means to make old mistakes; increased mission effectiveness, usually defined in NCW documents in terms of defeating an enemy more efficiently, in the context of a peacekeeping operation should be understood described with phrases like “improving quality of life”; the implicit assumption in NCW and NEOps is that simply providing people with access to the same information will enable common understanding, but how “common intent” can actually be promoted among network players, often from diverse backgrounds and cultures (both national and organizational) represents a major challenge for the future; a major challenge in implementing NEOps will be its effect on organizational culture and structure, but there appears to be a lack of scientific investigation regarding NEOps and its impact on and interaction with CF culture; there appears to be a focus on the technical

aspects of NEOPs to the detriment of how transformation based on NEOPs might affect the roles that Canada plays in international affairs and the impact that NEOPs will have on the human dimension of CF operations.

A number of critics have noted that NCW's origins were in concepts designed to prevail in "big" wars, but that today's environment is one of "small" wars. The most recent variant of "small war" theory, Fourth Generation Warfare (4GW) or Idea-Driven Warfare offers a number of challenges to the NCW concept. As we have seen, many of the technical aspects of NCW (especially its C2 architecture) were designed to operate in a naval environment of medium complexity to deal with relatively well known and quantifiable threats. The 4GW environment is highly complex and many of the threats are unpredictable, difficult to quantify, and changing, as opponents use "4GW judo" to keep large Western security, military, and legal bureaucracies off balance. If one accepts Lind's assertion that the real centre of gravity of 4GW opponents is a shared religious/ideological goal where common purpose and zealotry replace recognizable military command structures and military pattern equipment, then NCW technology-based systems may not have the flexibility to deal with this threat.

The Canadian military experience in the post-Cold War environment, particularly the Army's stabilization efforts in post-conflict Afghanistan and the Navy's command of coalition operations in the Arabian Sea, reinforces the belief that the human network, not the technical network, should be the basis for future approaches to CF transformation. The CF experience with the Canadian deployment with ISAF Rotation IV in 2003 provided lessons similar to those gleaned from Canada's mission to Bosnia during Operation Palladium, and certain recent domestic operations. Typically, in this new environment the CF are sent into complex security environments without clear strategic objectives save for the imperative to establish a "secure environment."

In operating in these complex security environments, the primary difference between the NCW concept and the Canadian Army's practice in peace support operations since 1992 is that instead of having the technical network as the centre of focus, the Canadian Army has focussed on creating human-centric networks with technology of various kinds being adapted to meet the needs of the human network. This adaptation has often resulted in technical networks that are *ad hoc* and hybrid in nature, but this has been necessary because the Canadian Army has not had access to the full range of information management tools employed by US armed forces.

The Canadian Army's post-Cold War experience has demonstrated that the challenges posed by peace support operations in post-conflict situations are best met with holistic solutions that identify issues that must be addressed simultaneously, in a distributed fashion, across elements of national power in order to achieve the desired result. This methodology is achieved best with the human-centric not the network-centric approach.

The lack of clear strategic objectives and a unifying concept of operations in many cases has forced the Canadian Army to exert great efforts to construct these hybrid networks in order to allow for interaction and to create cooperation among the numerous diverse

groups involved in a particular mission. The creation of a cohesive and focused plan that fosters unity of effort in these circumstances demands an understanding of the nature of societal reconstruction and renewal required for a particular region, but also must be linked to structures that provide focus to all entities within a given country, like Afghanistan. The Canadian experience has been that it is often the military that must provide the assistance and the impetus necessary for the formulation of an overarching system, or networked community, to achieve the ultimate objective of removing the causes of war in a region. The plan “Creating a National Economy: The Path to Security and Stability in Afghanistan” was described as an example of the product of the Canadian Army’s human-centric network in Afghanistan – a coherent plan to achieve a strategic vision of a rejuvenated and independent Afghanistan as an integrated member of the global community.

The Canadian Navy’s experience was somewhat different, given its very good access to developing USN network-enabled systems and procedures. Interestingly, however, that naval experience points to the same conclusion as the army experience, reinforcing the validity of an approach that balances the human and technological factors. This further demonstrates that a “one size fits all” concept may not be best suited to the unique capabilities required by each service, even in an increasingly integrated joint and combined operating environment.

In summary, NEOps as a concept has a promising future if it is predicated on Canadian needs and culture. However, there is significant risk in placing too much reliance on concepts like NCW which put the technological cart before the human requirements that should drive any transformation initiative. Therefore, future development of the NEOps concept should be firmly rooted in the Canadian context and based on Canadian experience. NEOps concept development should be complemented by the relevant experience of others, but it should avoid slavishly copying other frameworks as DND has sometimes done in the past. In the Canadian context of human-centred networks, research to support the development of the NEOps concept should be conducted in the areas related to the human dimension of networks based on theory and on Canadian practical experience. In this way, NEOps could become a suitable model to support the transformation of the CF and DND.

## Reference List

Alberts, David S., John J. Garstka and Frederick P. Stein. *Network Centric Warfare: Developing and Leveraging Information Superiority*. US Dept of Defense [DoD], C4ISR Cooperative Research Program, 1998.

Arkin, William A. "Spiraling Ahead: With the Loss of its Greatest Champion, What's to become of Transformation?" *Armed Forces Journal International* 143 (Feb 2006), 39-42.

Aubin, Stephen. "Stumbling Towards Transformation." *Strategic Review* 28, no. 2 (Spring 2000), 39-47.

Babcock, Sandy. "Canadian Network Enabled Operations Initiatives." Ottawa: National Defence Headquarters [NDHQ], Directorate of Defence Analysis [nd, 2004?]).

Barnett, Thomas P. *The Pentagon's New Map: War and Peace in the Twenty-First Century*. New York: G.P. Putnam's Sons, 2004.

------. "The Seven Deadly Sins of Network-Centric Warfare." *US Naval Institute Proceedings* 125, no. 1 (January 1999), 36-9.

Barzelay, Michael and Colin Campbell. *Preparing for the Future: Strategic Planning in the US Air Force*. Washington, DC: Brookings Institution Press, 2003.

Baumann, Robert F. "Historical Perspectives on Future War." *Military Review* 76, no. 2 (March-April 1997), 40-8.

Bercuson, D.J. "Defence Education for 2000...and Beyond." In *Educating Canada's Military*, report of a workshop held at the Royal Military College of Canada 7-8 December 1998.

Biddle, Stephen. "Victory Misunderstood: What the Gulf War tells us about the Future of Conflict." *International Security* 21, no. 2 (Fall 1996), 139-79.

Bond, Brian and Martin Alexander. "Liddell Hart and DeGaulle." In Paret, ed., *Makers of Modern Strategy*, 598-623.

Broad, William and Nicholas Wade. *Betrayers of the Truth*. New York: Simon and Schuster, 1982.

Builder, Carl H. *The Icarus Syndrome: The Role of Air Power Theory in the Evolution and Fate of the US Air Force*. London: Transaction Publishers, 1994.

Canada, Department of National Defence. *1994 White Paper on Defence*. Ottawa: Canada Communications Group, 1994.

- . *Canada's Army: We Stand on Guard for Thee*. B-GL-300-000/FP-00 (1 April 1998).
- . *Command, Sense, Act, Shield and Sustain: DLSC Report 01/01 Future Army Capabilities*. Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, January 2001.
- . *Conduct of Land Operations – Operational Level Doctrine for the Canadian Army*. B-GL-300-001/FP-000 (1 July 1998).
- . *Defence Research and Development Canada – Concept of Operations for Collaborative Working (Version 2.2)* (25 May 2004).
- . *The Debrief the Leaders Project (Officers)*. Ottawa: Office of the Special Advisor to the Chief of the Defence Staff for Professional Development, May 2001. Available at [http://www.cda.forces.gc.ca/2020/engraph/research/debrief/doc/DebriefLeaders\\_e.PDF](http://www.cda.forces.gc.ca/2020/engraph/research/debrief/doc/DebriefLeaders_e.PDF).
- . “DND/CF Networked Enabled Operations: Keystone Document (Final Draft) - A DND/CF Concept and Roadmap Paper.” Ottawa: NDHQ, 30 May 2005.
- . “Employment of Collaboration at Sea Systems in Task Group Operations.” CFCF 106D, TACNOTE 6520 (Unclassified), March 2003.
- . *Evaluation of the Impact of LFC2IS on Warfighting Operations at the Brigade Group Level: Operational Research – Army Experiment 6B – EXERCISE ATHENE WARRIOR*. Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, November 2002.
- . *Future Army Development Plan*. Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, 8 March 1999.
- . *Future Force Concepts for Future Army Capabilities* (Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, 2003).
- . *The Future Security Environment: DLSC Report 99-2*. Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, August 1999.
- . *Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR): DLSC Army Experimentation Centre Report 9906 Army Experiment 1*. Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, December 1999.
- . *Land Force Command*. B-GL-300-003/FP-000 (21 July 1996).
- . *Land Force Information Operations*. B-GL-300-005/FP-001 (18 January 1999).

- . *Land Force Tactical Doctrine, Vol. 2.* B-GL-300-002/FP-000 (16 May 1997).
- . *Leadership in the Canadian Forces: Conceptual Foundations.* Kingston: Canadian Defence Academy, 2005.
- . *Leadmark: The Navy's Strategy for 2020.* Ottawa: Chief of Maritime Staff, 2001. Also at: [http://www.navy.dnd.ca/mspa\\_news/news\\_e.asp?id=11](http://www.navy.dnd.ca/mspa_news/news_e.asp?id=11).
- . "National Defence Strategic Capability Investment Plan, Issue 1." (November 2003). Available at [http://www.vcds.forces.gc.ca/dgsp/pubs/rep-pub/ddm/scip/intro\\_e.asp](http://www.vcds.forces.gc.ca/dgsp/pubs/rep-pub/ddm/scip/intro_e.asp).
- . *Operations in the Expanded Battlespace: DLSC Future Army Experiment.* Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, June 2001.
- . *Peace Support Operations.* B-GJ-005-307-FP-030 (6 November 2002).
- . *A Role of Pride and Influence in the World: Defence Policy Statement.* Ottawa: NDHQ, Minister of National Defence, April 2005. Available at: [http://www.forces.gc.ca/site/Reports/dps/main/toc\\_e.asp](http://www.forces.gc.ca/site/Reports/dps/main/toc_e.asp).
- . *Towards the Brave New World: Canada's Army in the 21st Century.* Kingston: Fort Frontenac, Directorate of Land Strategic Concepts, 2003.
- . "Vectors 2020." Unpublished NDHQ staff paper, Director Air Strategic Plans, dated 5 April 2002.
- Carr, James. "Network Centric Coalitions: Plug, Pass, or Plug-in?" Unpublished US Naval War College Paper, 1999.
- Cebrowski, Arthur K. and John J. Garstka. "Network-Centric warfare: Its Origin and Future." *US Naval Institute Proceedings* 124, no. 1 (January 1998), 28-35.
- Clark, Vern. "Sea Power 21: Projecting Decisive Joint Capabilities." *US Naval Institute Proceedings* 128, no. 10 (October 2002), 32-41.
- Clausewitz, Carl. *On War.* Michael Howard and Peter Paret, eds. and trans. Princeton: Princeton Univ. Press, 1976.
- Cohen, Eliot A. "Neither Fools Nor Cowards." *The Wall Street Journal* (13 May 2005), A12.
- . "A Revolution in Warfare." *Foreign Affairs* 75, no. 2 (March/April 1996), 37-54.

Coombs, Howard G. "Leadership, Command and Operational Art Project Progress Report – March 2003 to March 2004." Report written for the CF Leadership Institute, available at the Information Resource Centre, Canadian Forces College (CFC).

-----, "Perspectives on Operational Thought." In Allan English, et al., eds. *The Operational Art*, 75-96.

Coombs, Howard G. and Rick Hiller. "Planning for Success: The Challenge of Applying Operational Art in Post-Conflict Afghanistan." *Canadian Military Journal* 6, no. 3 (Autumn 2005), 5-14.

Corn, Tony. "World War IV as Fourth-Generation Warfare." *Policy Review* 135 (Feb & Mar 2006), np, <http://www.policyreview.org/135/>.

Corum, James S. and Wray R. Johnson. *Airpower in Small Wars: Fighting Insurgents and Terrorists*. Lawrence, KS: University Press of Kansas, 2003.

Cox, Jim. "Major General Andrew Leslie – Kabul & ISAF." *Frontline* Issue 4 (September/October 2004). Available at: [www.frontline-canada.com](http://www.frontline-canada.com).

Crabtree, James D. *On Air Defense*. Westport CT: Praeger Publishers, 1994.

Crockett, Michael. "Professional Notes: O Canada!" *US Naval Institute Proceedings* 124, no. 12 (December 1998), 65-7.

Crowder, Gary L. "Effects-Based Operations: The Impact of Precision Strike Weapons on Air Warfare Doctrines." *Military Technology* 27 no. 6 (Jun 2003), 16-25.

Crowl, Philip A. "Alfred Thayer Mahan: The Naval Historian." In Paret, ed., *Makers of Modern Strategy*, 444-77.

Czerwinski, Thomas J. "Command and Control at the Crossroads." *Parameters* 26, no. 3 (Autumn 1996), 121-32.

Davis, Mark G. "Centralized Control / Decentralized Execution in the Era of Forward Reach." *Joint Force Quarterly*, no. 35 (Autumn 2004), 95-9.

Echevarria, Antulio J. and Jacob D. Biever. "Warfighting's Moral Domain." *Military Review* 90, no. 2 (March-April 2000), 3-6.

English, Allan. *Understanding Military Culture: A Canadian Perspective*. Montreal and Kingston: McGill-Queen's Univ. Press, 2004.

English, Allan D., ed. *Air Campaigns in the New World Order*. University of Manitoba, Winnipeg: Centre for Defence and Security Studies, 2005.

------. *The Changing Face of War*. Montreal and Kingston: McGill-Queen's Univ. Press, 1998.

------. *Leadership and Command and the Operational Art: Canadian Perspectives*. Kingston, ON: Canadian Defence Academy Press, in press.

English, Allan, et al. *Command Styles in the Canadian Navy*. DRDC Toronto, Contract Report CR 2005-096 (31 January 2005).

English, Allan, et al., eds. *The Operational Art: Canadian Perspectives - Context and Concepts*. Kingston, ON: Canadian Defence Academy Press, 2005.

English, John A. *Marching Through Chaos: The Descent of Armies in Theory and Practice*. Westport, CT: Praeger, 1996.

English, John. "The Operational Art: Developments in the Theories of War." In B.J.C. McKercher and Michael A. Hennessy, eds. *The Operational Art: Developments in the Theories of War*. Westport, CT: Praeger, 1996, 7-27.

David S. Fadok, "John Boyd and John Warden." In Phillip S. Meilinger, ed. *The Paths of Heaven: The Evolution of Airpower Theory*. Maxwell AL: Air University Press, 1997, 357-98.

Fallows, James *National Defense*. New York: Random House, 1981.

Finch, D.P. "Approaching Transformational Coalition Operations along the Standardization, Interoperability and Integration (SI2) Continuum." Draft CCRTS Paper 024, J7 Doctrine and Standardization, Director General Joint Force Development, DND (nd, [2005]).

Forgues, Pierre. "Command in a Network-Centric War." *Canadian Military Journal* 2, no. 2 (Summer 2001), 23-30.

Fought, Stephen. "The Tale of the C/JFACC: A Long and Winding Road." *RAF Air Power Review* 7, no. 4 (Winter 2004), 10-11.

Fox, Robert. *Iraq Campaign 2003: Royal Navy and Royal Marines*. London: Agenda Publishing, 2003.

Fredette, Raymond. *The Sky on Fire: The First Battle of Britain and Birth of the Royal Air Force*. Washington D.C.: Smithsonian Institution Press, 1966.

Free, Jennifer. "Network-Centric Leadership: Why Trust is Essential." *US Naval Institute Proceedings* 131, no. 6 (June 2005), 58-60.

Friedman, Norman. *The Postwar Naval Revolution: Warships, Weapons and Policies – The Navies Which Might Have Evolved, and the Factors Which Shaped Their Actual Development*. Annapolis, MD: Naval Institute Press, 1986.

Fuller, J.F.C. *The Conduct of War, 1789-1961: A Study of the Impact of the French, Industrial, and Russian Revolutions on War and Its Conduct*. New Brunswick, NJ: Rutgers Univ. Press, 1961; reprint Cambridge and New York: Da Capo Press, 1992.

Garnett, Gary. "The Canadian Forces and the Revolution in Military Affairs: A Time for Change." *Canadian Military Journal* 2, no. 1 (Spring 2001), 5-10.

Gat, Azar. *A History of Military Thought*. New York: Oxford Univ. Press, 2001.

Geraghty, Barbara A. "Will Network-Centric Warfare be the Death Knell for Allied/Coalition Operations?" Unpublished US Naval War College Paper, 1999.

Geyer, Michael. "German Strategy in the Age of Machine Warfare, 1914-45." In Paret, ed., *Makers of Modern Strategy*, 527-97.

Gimblett, Richard. "MIF or MNF? The Dilemma of the 'Lesser' Navies in the Gulf War Coalition." In Michael L. Hadley, et al., eds. *A Nation's Navy: In Quest of Canadian Naval Identity*. Montreal & Kingston: McGill-Queen's University Press, 1996.

------. *Operation Apollo: The Golden Age of the Canadian Navy in the War Against Terrorism*. Ottawa: Magic Light, 2004.

Goette, Richard. "The Struggle for a Joint Command and Control System in the Northwest Atlantic Theatre of Operations." Unpublished MA thesis, Queen's University, 2002.

Goldrick, James. "In Command in the Gulf." *US Naval Institute Proceedings* 128, no. 12 (December 2002), 38-41.

Goldrick, James and John B. Hattendorf. *Mahan is not Enough: The Proceedings of a Conference on the Works of Sir Julian Corbett and Sir Herbert Richmond*. Newport, RI: Naval War College Press, 1993.

Gordon, Andrew. *Rules of the Game: Jutland and British Naval Command*. London: John Murray, 1996.

Granatstein, J.L. *Canada and Peace-keeping Operations: Report No. 4 Directorate of History*. Ottawa: Department of National Defence, 22 October 1965.

Grant, Rebecca. "Closing the Doctrine Gap." *Air Force Magazine* 80, no. 1 (January 1997), 48-52.

- Greer, James K. "Operational Art for the Objective Force." *Military Review* 82, no. 5 (September-October 2002), 22-9.
- Gregory, Bill. "From Stovepipes to Grids." *Armed Forces Journal International* 136, no. 6 (January 1999), 18-19.
- Griffin, Gary B. *The Directed Telescope: A Traditional Element of Effective Command*. Fort Leavenworth, KS: Combat Studies Institute, 1991.
- Grove, Eric with Graham Thompson. *Battle for the Fiords: NATO's Forward Maritime Strategy in Action*. Annapolis, MD: Naval Institute Press, 1991.
- Hall, John D. "Decision Making in the Information Age: Moving beyond the MDMP Military Decision-making Process." *Field Artillery* (September-October 2000), 28-32.
- Hallion, Richard. "Airpower and the Changing Nature of War." *Joint Forces Quarterly* (Autumn/Winter 1997-98), 39-46.
- Hammond, Grant T. "From Air Power to Err Power: John Boyd and the Opponent's Situational Awareness." In Peter W. Gray and Sebastian Cox, eds. *Air Power Leadership: Theory and Practice*. London: The Stationary Office, 2002, 107-28.
- Handel, Michael I. *Masters of War: Classical Strategic Thought*, 3<sup>rd</sup> ed. London: Frank Cass, 2001.
- Harris, John T. "Effects-Based Operations: Tactical Utility." Unpublished MA thesis US Army Command and General Staff College, 2004.
- Hattendorf, John B. *The Evolution of the US Navy's Maritime Strategy, 1977-1986*, Newport Paper #19. Newport, RI: US Naval War College, 2004.
- Hay, Bud and Bob Gile. *Global War Game: The First Five Years*, Newport Paper #4. Newport, RI: Naval War College Press, 1993.
- Heide, Rachel Lea. "Canadian Air Operations in the New World Order." In Allan D. English, ed., *Air Campaigns in the New World Order*, 77-92.
- Hillen, John. "Peace(keeping) in Our Time: The UN as a Professional Military Manager." *Parameters* 26, no. 3 (Autumn 1996), 17-34.
- Ho, Joshua. "The Advent of a New Way of War: Theory and Practice of Effects Based Operations." Singapore: Institute of Defence and Strategic Studies, Working Paper no. 57 (December 2003).
- Holley, I.B. "A Modest Proposal: Making Doctrine More Memorable." *Airpower Journal* 9, no. 4 (Winter 1995), 14-20.

Hope, Ian. "Changing a Military Culture: Manoeuvre Warfare and a Canadian Operational Doctrine, Part 1 of 2." *The Canadian Land Force Command and Staff College Quarterly Review* 5, no. 1/2 (Spring 1995), 1-6.

------. "Manoeuvre Warfare and Directive Control: The Basis for a New Canadian Military Doctrine Part 2 of 2." *The Canadian Land Force Command and Staff College Quarterly Review* 5 no. 1/2 (Spring 1995), 7-15.

------. "A Strategic Concept for the Development of Afghanistan." Unpublished ISAF presentation June 2004.

Hsu, Spencer S. and John Mintz. "Military Was Set to Down Cessna: Authority Granted as Plane Strayed Deep Into Capital." *Washington Post* (25 May 2005), A01.

Hughes, David. "'New Orthodoxy' Under Fire." *Aviation Week & Space Technology* (29 September 2003), 57-8.

Hughes, Wayne P. "Naval Maneuver Warfare." *Naval War College Review* 50, no. 3 (Summer 1997), 25-49.

Ignatius, David. "Standoffish Soldiering." *Washington Post* (5 August 2003), A15.

International Crisis Group (ICG). "Disarmament and Reintegration in Afghanistan." ICG Report No. 65. Kabul/Brussels, 30 September 2003.

Jarymowycz, Roman J. "Doctrine and Canada's Army." *The Army Doctrine & Training Bulletin* 2, no. 3 (August 1999).

Johnson, Chris. "Net-centric Fogs Accountability." *US Naval Institute Proceedings* 129, no. 5 (May 2003), 32-5.

Johnston, Paul. "Doctrine Is Not Enough: The Effect of Doctrine on the Behavior of Armies." *Parameters* 30, no. 3 (Autumn 2000), 30-9.

------. "The Myth of Manoeuvre Warfare: Attrition in Military History." In Allan English, ed. *The Changing Face of War*, 22-32.

Kagan, Frederick W. "War and Aftermath." *Policy Review Online* 102 (August/September 2003). Available at <http://www.policyreview.org/aug03/kagan.html>.

Kaplan, Robert. "How we would fight China: The Next Cold War." *The Atlantic Monthly* (June 2005), 49-64.

Keegan, John. *The Mask of Command*. London: Jonathan Cape, 1987.

Krulak, Charles C. "The Strategic Corporal: Leadership in the Three Block War." *Marine Corps Gazette* 83, no. 1 (January 1999), 18-22.

Kolenda, Christopher D. "Transforming How We Fight: A Conceptual Approach." *Naval War College Review* 56, no. 2 (Spring 2003), 100-21.

Kuhn, Thomas S. *The Structure of Scientific Revolutions*, 2nd ed. Chicago: Univ. of Chicago Press, 1970.

Lautenschläger, Karl. "Technology and the Evolution of Naval Warfare." In Steven E. Miller and Stephen Van Evera, eds. *Naval Strategy and National Security: An International Security Reader*. Princeton: Princeton University Press, 1988.

Leonard, Raymond W. "Learning from History: Linebacker II and US Air Force Doctrine." *Journal of Military History* 58 (April 1994), 267-303.

Leonhard, Robert R. "Factors of Conflict in the Early 21<sup>st</sup> Century." *Army Magazine* 50, no. 1 (January 2003), 31-5.

Lescher, William K. "Network-centric: Is it worth the risk?" *US Naval Institute Proceedings* 125, no. 7 (July 1999), 58-63.

Liddell, Daniel E. "Operational Art and the Influence of Will." *Marine Corps Gazette* 82, no. 2 (February 1998), 50-5.

Lind, William S. "All War All the Time: The Military Game has Changed and the US isn't Ready." *San Francisco Chronicle* (6 July 2003), D1.

Lind, William S., et al. "The Changing Face of War: Into the Fourth Generation." *Military Review* 69 (October 1989), 2-21.

McAndrew, William. "Operational Art and the Canadian Army's Way of War." In McKercher and Hennessy, eds., *The Operational Art*, 87-102.

------. "Operational Art and the Northwest European Theatre of War 1944." *Canadian Defence Quarterly* 21, no. 3 (December 1991), 19-26.

------. "Soldiers and Technology." *The Army Doctrine and Training Bulletin* 2, no. 2 (May 1999), 20-4.

McCann, C., R. Pigeau and A. English. "Analysing Command Challenges Using the Command and Control Framework: Pilot Study Results." Technical Report, DRDC-Toronto # TR-2003-034 (1 February 2003). Available at [http://pubs.drdc-rddc.gc.ca/pubdocs/pcow1\\_e.html](http://pubs.drdc-rddc.gc.ca/pubdocs/pcow1_e.html).

McCrabb, Maris. "Effects-based Coalition Operations: Belief, Framing and Mechanism." In Austin Tate, ed. *Proceedings of the Second International Conference on Knowledge Systems for Coalition Operations*, 23-24 April 2002, Toulouse, France, 134-46. Available at <http://www.aiai.ed.ac.uk/project/coalition/ksco/ksco-2002/pdf-parts/S-ksco-2002-paper-02-mccrabb.pdf>.

McKenzie, Kenneth F., Jr. "Elegant Irrelevance: Fourth Generation Warfare." *Parameters* 23, no. 3 (Autumn 1993), 51-60.

McKercher, B.J.C. and Michael A. Hennessy, eds. *The Operational Art: Developments in the Theories of War*. Westport, CT: Praeger, 1996.

Maddison, Paul. "The Canadian Navy's Drive for Trust and Technology in Network-Centric Coalitions: Riding Comfortably Alongside, or Losing Ground in a Stern Chase?" Unpublished paper prepared for Advanced Military Studies Course (AMSC) 7, CFC, 2004. Available at <http://wps.cfc.dnd.ca/papers/amsc/amsc7/maddison.htm>.

Mandales, Mark D., et al. *Managing "Command and Control" in the Persian Gulf War*. Westport, CT: Praeger, 1996.

Mann, Edward, et al. "Dominant Effects: Effects-Based Joint Operations." *Aerospace Power Journal* 15, no. 3 (Fall 2001), 92-100.

Masson, P. "Alfred Thayer Mahan." Entry in André Corvisier ed., English edition edited by John Childs. *A Dictionary of Military History and the Art of War*. London: Blackwell, 1994, 478-9.

Meilinger, Phillip S. "The Origins of Effects-Based Operations." *Joint Force Quarterly* 35 (October 2004), 116-22.

Menning, Bruce W. "Operational Art's Origins." *Military Review* 77, no. 5 (September-October 1997), 32-47.

Metz, Steven. "A Wake for Clausewitz: Toward a Philosophy of 21<sup>st</sup>-Century Warfare." *Parameters* 24, no. 4 (Winter 1994-95), 126-32.

Miller, Duncan (Dusty) E. and Sharon Hobson. *The Persian Excursion: The Canadian Navy in the Gulf War*. Clementsport, NS: Canadian Institute of Strategic Studies, 1995.

Milner, Marc. "Rear-Admiral Leonard Warren Murray: Canada's Most Important Operational Commander." In Michael Whitby, et al., eds., *The Admirals: Canada's Senior Naval Leadership in the Twentieth Century*. Toronto: Dundurn Press, 2006, 97-124.

Mitchell, Paul T. "Small Navies and Network-centric Warfare: Is There a Role?" *Naval War College Review* 56, no. 2 (Spring 2003), 83-99.

Morse, David and Douglas Thomas. "STANAVFORLANT Under Canadian Command." *Canadian Military Journal* 1, no. 2 (Summer 2002), 61-4.

Morton, Desmond. *A Military History of Canada*, 4<sup>th</sup> ed. Toronto: McClelland & Stewart Ltd., 1999.

Murray, Williamson. *The Making of Strategy: Rulers, States and War*. Cambridge: Cambridge University Press, 1994.

Myatt, J. Michael. "Comments on Maneuver." *Marine Corps Gazette* 82, no. 10 (October 1998), 40+.

Naveh, Shimon. *In Pursuit of Military Excellence: The Evolution of Operational Theory*. London and Portland: Frank Cass, 1997.

"Network Centric USW – Exploring the Realities." *Semaphore: Newsletter of the Sea Power Centre, Australia*, Issue 12 (November 2004).

Noonan, Michael P. "Foreign Policy Research Institute E-Notes: The Military Lessons of Operation Iraqi Freedom." Available at: <http://www.fpri.org/enotes/20030501.military.noonan.militarylessonsiraqifreedom.html>.

Oliviero, Chuck. "Response to 'Doctrine and Canada's Army – Seduction by Foreign Dogma: Coming to Terms with Who We Are.'" *The Army Doctrine and Training Bulletin* 2, no. 4 (Winter 1999), 140-1.

Owens, Mackubin Thomas. "Reshaping Tilted Against the Army?" *The Washington Times* (24 November 2002), at <http://www.washtimes.com/commentary/20021124-22611196.htm>.

Palmer, Michael A. *Command at Sea*. Harvard University Press, 2005.

------. *Origins of the Maritime Strategy: American Naval Strategy in the First Postwar Decade*. Washington, DC: Naval Historical Center, 1988.

Pape, Robert A. *Bombing to Win: Air Power and Coercion in War*. Ithaca, NY: Cornell Univ. Press, 1996.

Paret, Peter, ed., *Makers of Modern Strategy*. Princeton: Princeton Univ. Press, 1986.

Park, W. Hays. "'Precision' and 'Area' Bombing: Who Did Which, and When?" *Journal of Strategic Studies* 18 (March 1995), 145-74.

“Peacebuilding in a Regional Perspective: Government of Afghanistan.” Chr. Michelsen Institute. *Afghanistan - Peacebuilding in a Regional Perspective*. Available at: <http://www.cmi.no/afghanistan/background/ata.cfm>.

Pearson, Lester Bowles. “Nobel Lecture.” Given 11 December 1957. Available at: <http://nobelprize.org/peace/laureates/1957/pearson-lecture.html>.

Peskett, Gordon R. “Levels of War: A New Canadian Model to Begin the 21<sup>st</sup> Century.” In Allan English, et al., eds. *The Operational Art*, 97-128.

Pigeau, Ross and Carol McCann. “Re-conceptualizing Command and Control.” *Canadian Military Journal* 3, no. 1 (Spring 2002), 53-63.

Polk, Robert B. “A Critique of the Boyd Theory — is it relevant to the Army?” *Defense Analysis* 16, no. 3 (December 2000), 257-76.

Porch, Douglas. “Bugeaud, Galliéni, Lyautey: The Development of French Colonial Warfare.” In Paret, ed. *Makers of Modern Strategy*, 408-43.

Pratt, David. “The Way Ahead for Canadian Foreign and Defence Policy.” Keynote address at the 20th Annual Conference of Defence Associations Institute Seminar. Available at <http://www.cda-cdai.ca/seminars/2004/pratt.htm>.

Pratt, Gerald M. “A Clash of Service Doctrines.” In Allan English, et al., eds. *The Operational Art*, 225-48.

Pugh, Michael. *Regeneration of War-Torn Societies*. New York: St. Martin’s Press, 2000.

Ricks, Thomas E. and Josh White. “Scope of Change in Military Is Ambiguous.” *Washington Post* (1 August 2004), A06.

Roddy, Kimberly A. “Network-Centric Operational Warfare: The New Science of Operational Art.” Unpublished US Naval War College research paper, 16 May 2003.

Rousseau, Christian. “Command in a Complex Battlespace.” In Allan English, ed. *Leadership and Command and the Operational Art*, in press.

Rudd, David. “Canada’s New Defence Policy.” The Canadian Institute of Strategic Studies: Commentary (April 2005). Available at [http://www.ciss.ca/Comment\\_Newpolicy.htm](http://www.ciss.ca/Comment_Newpolicy.htm).

Schmitt, John F. “Command and (out of) Control: The Military Implications of Complexity Theory.” *Marine Corps Gazette* 82, no. 9 (September 1998), 55-8.

Schneider, James J. *The Theory of Operational Art, Theoretical Paper No.3*. Fort Leavenworth, KS: United States Army Command and General Staff College, 1988.

------. "Transforming Advanced Military Education for the 21<sup>st</sup> Century." *Army* 55, no. 1 (January 2005), 15-22.

"Security Issues Dampen Afghan Investments." *The Associated Press*, 13 July 2004.

Segre, Claudio. "Giulio Douhet: Strategist, Theorist, Prophet?" *Journal of Strategic Studies* 15 (Sept 1992), 351-66.

Sharpe, G.E. and Allan English. *Principles for Change in the Post-Cold War Command and Control of the Canadian Forces*. Kingston, ON: Canadian Forces Leadership Institute, 2002.

"Shock and Awe the Idea Behind the Buzzwords." *Washington Post* (30 March 2003), p. B03.

Shy, John. "Jomini." In Paret, ed. *Makers of Modern Strategy*, 143-85.

Shy, John and Thomas W. Collier. "Revolutionary War." In Paret, ed., *Makers of Modern Strategy*, 815-62.

Simpkin, Richard E. *Race to the Swift: Thoughts on Twenty-First Century Warfare*. London: Brassey's Defence Publishers, 1985; paperback reprint, 2000.

Sloan, Elinor. *The Revolution in Military Affairs*. Montreal & Kingston: McGill-Queen's University Press, 2002.

------. "The United States and the Revolution in Military Affairs." Ottawa: NDHQ, Directorate of Strategic Analysis, Project Report No. 9801, February 1998.

Soeters, J. and R. Recht, "Culture and Discipline in Military Academies: An International Comparison." *Journal of Political and Military Sociology* 26, no. 2 (Winter 1998), 169-89.

Strange, Joe. *Centers Of Gravity and Critical Vulnerabilities: Building on the Clausewitzian Foundation So That We Can All Speak the Same Language*, 2<sup>nd</sup> ed. Quantico, VA: Defense Automated Printing Service Center, 1996.

Starry, Donn A. "A Perspective on American Military Thought." *Military Review* 69 (July 1989), 6-10.

Stavridis, Jim. "They Got Game." *US Naval Institute Proceedings* 125, no. 6 (June 1999), 51-4.

Sumida, Jon Tetsuro. *Inventing Grand Strategy and Teaching Command: The Classic Works of Alfred Thayer Mahan Reconsidered*. Baltimore, MD: Johns Hopkins, 1997.

Swain, Richard M. *Neither War Nor Not War, Army Command in Europe During the Time of Peace Operations: Tasks Confronting USAREUR Commanders, 1994-2000*. Carlisle, PA: United States Army War College, Strategic Studies Institute, May 2003.

Sweetman, Jack, ed., *The Great Admirals: Command at Sea, 1587-1945*. Annapolis, MD: US Naval Institute Press, 1997.

Swettenham, J.A. *Some Impressions of UNEF, 1957 to 1958: Report No. 78 Historical Section (GS) Army Headquarters*. Ottawa: Department of National Defence, 2 January 1959.

Szafranski, Richard. "Peer Competitors, the RMA and New Concepts: Some Questions." *Naval War College Review* 49, no. 2 (Spring 1996), 113-19.

Thomson, Michael H. and Barbara D. Adams. "Network Enabled Operations: A Canadian Perspective," Humansystems Incorporated report written for DRDC [nd, 2005].

Toffler, Alvin. *The Third Wave*. Toronto: Bantam Books, 1981.

Toffler, Alvin and Heidi Toffler. *War and Anti-War*. New York: Warner Books, 1993.

Tritten, James J. "Naval Doctrine... From the Sea." Norfolk, VA: Naval Doctrine Command, December, 1994.

Ullman, Harlan and James Wade. *Shock and Awe, Achieving Rapid Dominance*. Washington, DC: National Defense Univ. Press, 1996.

United Nations Organization on Drugs and Crime and the Government of Afghanistan Counter Narcotics Directorate. *Afghanistan Opium Survey 2003* (October 2003). Available at [http://www.unodc.org/pdf/afg/afghanistan\\_opium\\_survey\\_2003.pdf](http://www.unodc.org/pdf/afg/afghanistan_opium_survey_2003.pdf).

US Air Force. *Air Force Basic Doctrine*, Air Force Doctrine Document 1 (AFDD 1) (September 1997).

US Army. *Operations*, Field Manual 3-0 (FM 3-0), (14 June 2001).

US Department of Defense, Office of Force Transformation. *The Implementation of Network-Centric Warfare* (5 January 2005). Available at [http://www.oft.osd.mil/library/library\\_files/document\\_387\\_NCW\\_Book\\_LowRes.pdf](http://www.oft.osd.mil/library/library_files/document_387_NCW_Book_LowRes.pdf).

US Navy. "FORCEnet: A Functional Concept for the 21<sup>st</sup> Century." (nd, [2005]?). Available at <http://www.chinfo.navy.mil/navpalib/policy/forcenet/forcenet21.pdf>.

------. *Multinational Maritime Operations Doctrine Manual*. US Naval Doctrine Command, 1999.

Vallance, Andrew G.B. *The Air Weapon: Doctrines of Air Power Strategy and Operational Art*. London: Macmillan, 1996.

Van Creveld, Martin. *Command in War*. Cambridge, MA: Harvard University Press, 1985.

------. "High technology and the Transformation of War, Part 2." *JRUSI* 137, no. 6 (December 1992), 61-4.

Warden, John A. *The Air Campaign: Planning for Combat*. Washington, DC: Pergamon-Brassey's, 1989.

Warner, Oliver. *Command at Sea: Great Fighting Admirals from Hawke to Nimitz*. New York: St Martin's, 1976.

Wattie, Chris "Absent-minded Professor didn't expect a Nobel." *Kingston Whig-Standard* (13 October 1994), 9.

Westrop, John. "Aerospace Doctrine Study." Unpublished report dated 30 April 2002, copy at Canadian Forces College library.

Wilson, G.I. et al. "4GW – Tactics of the Weak Confound the Strong." *Military.com* (8 September 2003). Available at [http://www.military.com/NewContent/0,13190,Wilson\\_090803,00.html](http://www.military.com/NewContent/0,13190,Wilson_090803,00.html).

"Windfalls of War: US Contractors in Iraq and Afghanistan." *The Center for Public Integrity*. Washington, DC, 29 September 2004. Available at <http://www.publicintegrity.org/wow/default.aspx>.

Winton, Harold R. "A Black Hole in the Wild Blue Yonder: the Need for a Comprehensive Theory of Air Power." *Air Power History* 39 (Winter 1992), 32-42.

Wyly, Michael Duncan. "Teaching Maneuver Warfare." In Richard D. Hooker, Jr, ed. *Maneuver Warfare: An Anthology*. Novato, CA: Presido Press, 1993.

Young, Richard J. "Clausewitz and His Influence on US and Canadian Military Doctrine." In Allan D. English, ed. *The Changing Face of War*, 9-21.

Zinni, Anthony. "How Do We Overhaul the Nation's Defense to Win the Next War?" Speech given at Arlington, VA, 4 September 2003. Available at <http://www.mca-usniforum2003.org/index.html>

## Endnotes

- <sup>1</sup> Michael H. Thomson and Barbara D. Adams, “Network Enabled Operations: A Canadian Perspective,” (Defence Research and Development (DRDC) - Toronto contract report CR-2005-162, 13 May 2005), 5.
- <sup>2</sup> Michael H. Thomson et Barbara D. Adams, « Network Enabled Operations: A Canadian Perspective, » (Rapport contractuel de Recherche et développement pour la défense (RDDC) – Toronto CR-2005-162, 13 mai 2005), 5.
- <sup>3</sup> Vice Admiral Arthur K. Cebrowski and John J. Garstka, “Network-Centric warfare: Its Origin and Future,” *US Naval Institute Proceedings* 124, no. 1 (January 1998), 28-35; later expanded in David S. Alberts, John J. Garstka and Frederick P. Stein, *Network Centric Warfare: Developing and Leveraging Information Superiority* (US Dept of Defense [DoD], C4ISR Cooperative Research Program [CCRP], 1998) and subsequent editions.
- <sup>4</sup> David Hughes, “‘New Orthodoxy’ Under Fire,” *Aviation Week & Space Technology* (29 September 2003), 57.
- <sup>5</sup> Bill Gregory, “From Stovepipes to Grids,” *Armed Forces Journal International*, 136, no. 6 (January 1999), 18.
- <sup>6</sup> US DoD, Office of Force Transformation, *The Implementation of Network-Centric Warfare* (5 January 2005), 3. Available at [http://www.oft.osd.mil/library/library\\_files/document\\_387\\_NCW\\_Book\\_LowRes.pdf](http://www.oft.osd.mil/library/library_files/document_387_NCW_Book_LowRes.pdf).
- <sup>7</sup> Sandy Babcock, “Canadian Network Enabled Operations Initiatives” (Ottawa: National Defence Headquarters [NDHQ], Directorate Defence Analysis [nd, 2004?]), 4.
- <sup>8</sup> US Department of the Navy, “FORCENet: A Functional Concept for the 21<sup>st</sup> Century,” (nd, [2005]?), 1.
- <sup>9</sup> US Department of the Navy, “FORCENet...,” 12.
- <sup>10</sup> The six dimensions are physical, information technology, data, cognitive, organizational, operating. US Department of the Navy, “FORCENet...,” 19-20.
- <sup>11</sup> David Hughes, “‘New Orthodoxy’ Under Fire,” 57.
- <sup>12</sup> D.P. Finch, “Approaching Transformational Coalition Operations along the Standardization, Interoperability and Integration (SI2) Continuum,” draft CCRTS Paper 024, J7 Doctrine and Standardization, Director General Joint Force Development, (nd, [2005]), 18.
- <sup>13</sup> John English, “The Operational Art: Developments in the Theories of War,” in B.J.C. McKercher and Michael A. Hennessy, eds. *The Operational Art: Developments in the Theories of War* (Westport, CT: Praeger, 1996), 20.
- <sup>14</sup> Thomson and Adams, “Network Enabled Operations: A Canadian Perspective,” 4-6.
- <sup>15</sup> The latest proposed official “definition” of NEOps is a rather long statement of intent for NEOps and not a definition as such. See Canada, DND, “DND/CF Networked Enabled Operations: Keystone Document (Final Draft) - A DND/CF Concept and Roadmap Paper,” (Ottawa: NDHQ, 30 May 2005), 10.
- <sup>16</sup> Babcock, “Canadian Network Enabled Operations Initiatives,” 4.
- <sup>17</sup> Alvin Toffler and Heidi Toffler, *War and Anti-War* (New York: Warner Books, 1993), as a follow-on to Alvin Toffler, *The Third Wave* (1980).
- <sup>18</sup> Chris Wattie, “Absent-minded Professor didn’t expect a Nobel,” *Kingston Whig-Standard*, 13 October 1994, 9.
- <sup>19</sup> Loren B. Thompson, chief operating officer of the Lexington Institute public-policy think tank and a national security specialist, cited in David Hughes, “‘New Orthodoxy’ Under Fire,” 57.
- <sup>20</sup> These are the definitions of “theory” selected by the authors of the latest official NCW policy statement: “A theory is ‘a hypothesis assumed for the sake of argument or investigation, an unproved assumption.’ It is also ‘a formulation of apparent relationships or underlying principles of certain observed phenomena which has been verified to some degree.’” US DoD, Office of Force Transformation, *The Implementation of Network-Centric Warfare*, 15.
- <sup>21</sup> Many versions exist, but the best known modern is the one edited and translated by Michael Howard and Peter Paret (Princeton University Press, 1976).
- <sup>22</sup> Richard J. Young, “Clausewitz and His Influence on US and Canadian Military Doctrine,” in Allan D. English, ed. *The Changing Face of War* (Montreal & Kingston: McGill-Queen’s Univ. Press), 1998, 14-15. Like Clausewitz, the Chinese writer on military strategy, Sun Tzu, is frequently quoted out of context to support or “validate” modern doctrine.

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- <sup>23</sup> This definition of theory has been modified from *Funk & Wagnalls Canadian College Dictionary* (Toronto: Fitzhenry & Whiteside, 1986), 1389.
- <sup>24</sup> John Shy, "Jomini," in Paret, ed., *Makers of Modern Strategy*, 143-85.
- <sup>25</sup> According to conventional wisdom, science is a strictly logical process. However, while objectivity is the essence of the scientist's attitude to his/her work, in the acquisition of knowledge scientists are not guided by logic and objectivity alone, but also from such non-rational factors as rhetoric, propaganda, and personal prejudice. Therefore, science should not be considered the guardian of rationality in society, but merely one major form of its cultural expression. See for example William Broad and Nicholas Wade, *Betrayers of the Truth* (New York: Simon and Schuster, 1982).
- <sup>26</sup> Steven Metz, "A Wake for Clausewitz: Toward a Philosophy of 21<sup>st</sup>-Century Warfare," *Parameters* 24, no. 4 (Winter 1994-95), 126-32.
- <sup>27</sup> See Young, "Clausewitz and His Influence on US and Canadian Military Doctrine," 9-21, for a summary of this issue in a Canadian context.
- <sup>28</sup> Paul Johnston, "Doctrine is not Enough: The Effect of Doctrine on the Behavior of Armies," *Parameters* 30, no. 3 (Autumn 2000), 30-9.
- <sup>29</sup> Military theorists, such as Shimon Naveh, of the Department of History Tel Aviv University, note that Kuhnian theory regarding the progress of science and the processes by which paradigms are replaced by the scientific community has application in the realm of warfare theory and history. See for example, Shimon Naveh, *In Pursuit of Military Excellence: The Evolution of Operational Theory* (London and Portland: Frank Cass, 1997), xiii-xv. Kuhn argued that when in the development of a natural science an individual or group is able to produce a synthesis, or a new form of the older theory, and is able to attract most of the next generation's practitioners, the older schools disappear. Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: University of Chicago Press, 1970), 18-19.
- <sup>30</sup> Azar Gat, *A History of Military Thought* (New York: Oxford Univ. Press, 2001), 824.
- <sup>31</sup> Williamson Murray, *The Making of Strategy: Rulers, States and War* (Cambridge: Cambridge University Press, 1994), 1, 7.
- <sup>32</sup> Sloan, *The Revolution in Military Affairs*, 149.
- <sup>33</sup> For example, Rudy Romero, "Afghan ARR Notes," email in author's possession.
- <sup>34</sup> Stephen Biddle, "Assessing Theories of Future Warfare," *Security Studies* 8, no. 1 (Autumn 1998), 140, 162, 178-9.
- <sup>35</sup> Owens, "Reshaping Tilted Against the Army?"
- <sup>36</sup> Leonhard, "Factors of Conflict in the Early 21<sup>st</sup> Century," 2 of 4.
- <sup>37</sup> "Network Centric USW – Exploring the Realities," *Semaphore: Newsletter of the Sea Power Centre, Australia*, Issue 12 (November 2004).
- <sup>38</sup> Barnett, "The Seven Deadly Sins of Network-Centric Warfare, 38-9.
- <sup>39</sup> William K. Lescher, "Network-centric: Is it worth the risk?," *US Naval Institute Proceedings* 125, no. 7 (July 1999), 60, 62-3.
- <sup>40</sup> Kagan, "War and Aftermath," *Policy Review*, 6.
- <sup>41</sup> Kolenda, "Transforming How We Fight: A Conceptual Approach," 103, citation from 114.
- <sup>42</sup> David Hughes, "'New Orthodoxy' Under Fire," 57.
- <sup>43</sup> David Ignatius, "'Standoffish Soldiering,'" *Washington Post* (5 August 2003), A15.
- <sup>44</sup> Quote from an email from the operations officer of a task force in Iraq dated 26 May 2005.
- <sup>45</sup> van Creveld, *Command in War*, 9, 262-3.
- <sup>46</sup> Polk, "A Critique of the Boyd Theory," 272.
- <sup>47</sup> "Vectors 2020," unpublished NDHQ staff paper (5 Apr 2002), 14-15.
- <sup>48</sup> van Creveld, *Command in War*, 9, 262-3.
- <sup>49</sup> Forgues, "Command in a Network-Centric War," 23-30.
- <sup>50</sup> See Johnson, "Net-centric Fog's Accountability."
- <sup>51</sup> Forgues, "Command in a Network-Centric War," 23-30.
- <sup>52</sup> Cebrowski in US DoD, Office of Force Transformation, *The Implementation of Network-Centric Warfare*, 1.
- <sup>53</sup> Babcock, "Canadian Network Enabled Operations Initiatives," 4.
- <sup>54</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 10.
- <sup>55</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 12.
- <sup>56</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 13-14.

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- <sup>57</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 15.
- <sup>58</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 15-16.
- <sup>59</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 16.
- <sup>60</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 16.
- <sup>61</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 17.
- <sup>62</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 19.
- <sup>63</sup> Sloan, *The Revolution in Military Affairs*, 152-3.
- <sup>64</sup> Thomson and Adams, "Network Enabled Operations: A Canadian Perspective," 5.

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(U) Network Enabled Operations (NEOps) seems poised to become the driving concept behind CF transformation for a number of reasons, not the least of which is Canada's tendency to follow the American lead in new concepts related to war and other operations. This paper concludes that Canada and the CF should be cautious about using NCW as the foundation for NEOps, because the context and needs that are the basis for NCW may not be congruent with Canadian requirements.

The paper noted that NCW is not really a theory of war, as its proponents claim, but a series of largely untested hypotheses or assumptions that require validation before they should be accepted as a basis for transformation.

Recent Canadian Forces' (CF) operations have shown that a "one size fits all" approach to command and control, as proposed by many NCW advocates, may not be the best approach for networked operations, even in an increasingly integrated joint and combined operating environment.

Perhaps most importantly, from a Canadian point of view, using NEOps in the Joint, Interagency, Multinational, and Public (JIMP) or integrated context will require network architects not only to consider the use of information technology as an enabler, but also for them to address the much more complex issue of the creation of effective social networks.

In summary, NEOps as a concept has a promising future if it is predicated on Canadian needs and culture. However, there is significant risk in placing too much reliance on concepts like NCW which put the technology before the human requirements. Therefore, future development of the NEOps concept should be firmly rooted in the Canadian context and based on Canadian experience. NEOps concept development should be complemented by the relevant experience of others, but it should avoid slavishly copying other frameworks as DND has sometimes done in the past.

(U) Les opérations facilitées par réseaux (OFR) semblent actuellement devenir le concept moteur de la transformation de Forces canadiennes (FC). Plusieurs raisons expliquent ce fait, la plus importante étant sans doute la tendance du Canada à suivre la voie tracée par les États-Unis dans les nouveaux concepts liés à la guerre et à d'autres opérations. Les conclusions du présent article indiquent que le Canada et les FC devraient faire preuve de discernement dans l'emploi de la guerre réseaucentrique (GR) comme fondement des OFR, car le contexte et les besoins qui motivent le recours à la GR ne correspondent peut-être pas aux conditions canadiennes.

L'article fait valoir que la GR ne constitue pas vraiment une théorie de la guerre, comme l'affirment ses adeptes, mais plutôt une série d'hypothèses et de suppositions généralement non vérifiées qui ont besoin d'être validées avant d'être acceptées comme base d'une transformation.

De récentes opérations des FC ont démontré que l'approche uniformisée en matière de commandement et de contrôle que préconisent plusieurs partisans de la GR n'est peut-être pas la plus adéquate pour les opérations en réseau, même dans un contexte

d'opérations interarmées et interalliées de plus en plus intégrées.

Sans doute plus important encore, du point de vue canadien, est le fait que l'utilisation des OFR dans un cadre interarmées, interinstitutions, multinational et public ou intégré exigera des architectes de réseaux qu'ils considèrent la technologie de l'information non seulement comme un outil habilitant, mais aussi comme un moyen de relever le défi beaucoup plus complexe de créer des réseaux sociaux efficaces.

En résumé, le concept des OFR a un avenir prometteur s'il se fonde sur la culture et les besoins canadiens. Par contre, le fait de trop se fier à des concepts comme la GR, qui accorde plus d'importance aux besoins technologiques qu'aux besoins humains, comporte un risque considérable. Il est donc essentiel que le développement futur du concept des OFR soit fondamentalement lié au contexte de notre pays et qu'il se fonde sur l'expérience canadienne. S'il est vrai que l'expérience pertinente d'autres nations peut alimenter ce développement, il faudrait toutefois éviter de copier aveuglément d'autres structures, comme l'a déjà fait le MDN.

14. **KEYWORDS, DESCRIPTORS or IDENTIFIERS** (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

(U) Network Enabled Operations; Human Factors; Network–Centric Warfare; CF Transformation

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