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A VIRTUAL KNOWLEDGE BASE, THE FOUNDATION OF MODERN OPERATIONAL COMMAND

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ABSTRACT

Technology directly affected the tempo of military operations during the industrial age. The information age has begun to generate a comparable change in operational tempo. The United States military feels that networking is the key enabler to create this change. This paper contends that a Knowledge Management Strategy (KMS) is an essential process required by the CF to provide operational commanders with situational awareness. A Virtual Knowledge Base is the engine that facilitates the knowledge exchange or networking required to achieve increasing battlespace transparency. Canadian Strategy 2020 clearly states that interoperability with the US military is a priority for the CF. Over the last decade, ever increasing quantities of data have increasingly paralyzed the CF's industrial age designed information processes. Therefore, it is imperative that the CF strives to adopt a modern KMS to enable the Forces to keep pace with the US military and to remain relevant internationally.

> The war in Afghanistan was one for which we had not planned – never had an intention of going there with a military force. But the flexibility and adaptability of the military made it possible less than a month after the attacks of September 11th. That itself is a story of transformation. Indeed, not too many years ago, we could not have planned such a campaign so quickly and executed it so expeditiously. The high speed collaborative planning, the high-speed team building, and the quickly pulling together of diverse forces and capabilities is a property of an information-age force. **Vice Admiral Arthur Cebrowski, chief of United States Defense Department's Office of Force Transformation**[1]

Michael Hennessy, chair of the Department of History at RMC, recently discussed the role of knowledge in warfare. He postulated that the tempo of military operations over the last 150 years has been directly affected by technological developments. During the industrial age, technology increased the speed of armies from 2.5 km/hr to 30 km/hr. Since the beginning of the information age, using the two gulf wars as a comparison, knowledge has begun to generate a comparable increase in speed by increasing the commander's knowledge of the battlespace. Dr. Hennessy points out that in the ten years between these two conflicts, the average speed of advance has increased by a further 10 kms/hr. A comparable increase during the industrial age took half a century (1917 to 1960) to achieve. Furthermore, he postulates that this trend will continue, increasing to 200 kms/hr in the next ten to twenty years.[2] As articulated in Joint Vision 2020, the United States military is strenuously pursuing this speed increase. The US military feels that networking is the key enabler to creating the battlespace transparency that allows this accelerated tempo. In this instance, networking does not

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[1] United States, Department of Defence, *Cebrowski Sketches the Face of Transformation* (Washington D.C.:U.S. Government) (available at U.S. Government Internet site www.defenselink.mil/news /Dec2003/n12292003_200312291.html; accessed 6 April 2004), 1.

[2] Michael A Hennessy. *C^4ISR 'Way Ahead' Workshop—Some Historical Perspectives.* Ottawa: DND Canada, 29 Oct. 2003. Available at dcds.mil.ca/dgjfd/djfc/pages/ docs_e.asp; DWAN; accessed 4 April 2004.

mean cable and routers; networking is the free and rapid exchange of data. In the US construct, networking improves information sharing, which enhances the quality of the information and leads to a shared situational awareness that enables greater collaboration and self-synchronization. The US military clearly views this knowledge powered increase in combat tempo as "the emerging way of war".[3] Canadian Strategy 2020 clearly states that interoperability with the US military is a priority for the CF.[4] Any fighting force wishing to stay not only interoperable with but also relevant to the US military must be able to operate at this accelerating tempo. Therefore, it is imperative that the CF continues to make improvements in how it manages knowledge to enable the Forces to keep pace with the US military.

This paper contends that a Knowledge Management Strategy (KMS) is an essential process for the provision of battlespace situational awareness to Operational Commanders. The foundation of the process articulated through a KMS is a Virtual Knowledge Base (VKB). The VKB is the engine that facilitates the knowledge exchange required to achieve increasing battlespace transparency. Over the last decade, technical staffs have constructed systems that bring raw data in ever increasing quantities. This growing volume of data is then presented to an industrial age designed information process, which is increasingly paralyzed by an inability to cope with the fidelity or quantity of that information. 'Warfighters'[5] have started to articulate an information

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[3] United States, Department of Defence, *Force Transformation and Network-Centric Warfare* (Washington D.C.:U.S. Government) (available at U.S. Government Internet site www.oft.osd.mil; accessed 6 April 2004), 3-4.

[4] Department of National Defence. *Chief of the Defence Staff PartII: Strategy 2020.* Ottawa: DND Canada, August 2003. Available at http://www.cds. forces.gc.ca/pubs/strategy2K/s2k06_e.asp; Internet; accessed 2 March 2004, 1.

[5] Note: The term 'warfighters' is used to describe officers and NCOs of combat MOCs with operational and command experience.

management strategy to better fuse that data. The next step will be to evolve to a knowledge management strategy for the information age that will fulfill operational requirements well into the twenty first century and enable the Canadian Forces to remain relevant internationally.

Before discussing how knowledge creates situational awareness, an understanding of the components that enable situational awareness is essential to appreciate the challenges and future solutions. Definitions of knowledge, types of knowledge, knowledge management, virtual knowledge bases and knowledge management strategies will be presented. Armed with a common understanding of knowledge, examples of how knowledge is essential in modern warfare will be offered to illustrate the importance of this subject to the CF and why knowledge management should be pursued. It will then be demonstrated how all these factors can be combined to create situational awareness that will enable the CF to keep pace with growing US operational tempo. From that background, current national and environmental systems will be discussed to illustrate how their shortcomings are currently limiting warfighters. With an understanding of how the Forces are currently limited, the dangers of an over-reliance on technology will be examined. Finally, the importance of insuring that future knowledge management strategies include the ability to learn, both explicit and implicit information, and have the ability to blend that data into relevant knowledge will be presented. It will be postulated that only through the effective merging of both of these types of knowledge is a continually growing knowledge base and an expanding awareness of the battlespace possible. This will led to the summation that knowledge growth is the key to maintaining the acceleration of operational tempo required to keep pace with the US military. This

paper will then conclude that situational awareness is created through an effective knowledge management strategy, and that the foundation of that KMS is a virtual knowledge base. Improved situational awareness through accelerated knowledge management will ensure that the Canadian Forces remains relevant.

A common basis for a discussion of a Knowledge Management Strategy requires a definition of both knowledge and knowledge management. Knowledge can be defined as "information combined with experience, context, interpretation, and reflection … that is ready to apply to decisions and actions."[6] There are two types of information, explicit, which is easily codified, represented, distributed, and stored in books, documents, or databases and implicit, which is heavily rooted in personal experience, subjective perception, values, and emotions. While explicit information is relatively easy to collect and store, implicit information is much more difficult to quantify, store or share in a relevant manner.[7] Knowledge management (KM) is an endeavor that draws from scientific fields as varied as economics, sociology, philosophy, psychology, library science, business and information technology (IT). KM is focused on improving productivity through learning and sharing learned knowledge.[8] In the past, KM was referred to as information management (IM) to differentiate this field from the engineering/technological field of IT, which is focused on the processing, movement, and storage of data. IM was an appropriate title for what was then being attempted, as the major thrust was collecting and storing explicit information. Therefore, knowledge

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[6] A. Beerli, S. Falk, D Diemers (ed). *Knowledge Management and Networked Environments*. (New York: AMACOM, 2003), 101.

[7] A. Beerli, S. Falk, D Diemers (ed). *Knowledge Management…,* 101.

[8] S.G. McIntyre, Marlene Gauvin, Barbara Waruszynski, "Knowledge Management in the Military Context." *Canadian Military Journal* Vol. 4, no. 1 (Spring 2003): 36.

management seeks to combine the explicit information gathering of IM, with the 'tacit' information of human experience and judgment, to create knowledge.[9] As it is an extremely relevant part of KM in military operations, an in-depth comprehension of tacit knowledge is necessary.

Military personnel acquire huge amounts of tacit knowledge during their careers that is lost to the service when they retire. Any organization that experiences a significant work force reduction has the potential to loose vast amounts of corporate memory as the number of participants within its knowledge base is reduced. This can be positive if new people are simultaneously injected into the organization with fresh experiences or knowledge. It can be negative if vital experience or knowledge is lost when there is no apprenticeship or mentoring process to enable outgoing people to pass on their experiences. It is expensive in resources to recreate lost tacit knowledge. Force reductions, such as those experienced within the CF during the 1990's, accelerate knowledge loss and have had a long-term impact on the CF's level of tacit knowledge.[10] Unfortunately, as the objective was to reduce the number of CF members, few new people were brought into the structure to absorb or generate experience, making the force reduction a negative experience or loss of tacit knowledge. That loss could have been mitigated if the CF had a process to record and save that tacit knowledge for the future. Armed with an understanding of knowledge and knowledge management, it is possible to discuss knowledge management strategies.

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[9] Note: tacit knowledge is defined as "that, which is understood, implied and exists without being stated." From: S.G. McIntyre, Marlene Gauvin, Barbara Waruszynski, "Knowledge Management …, 36.

[10] Note: Although the force reduction process in the 1990's was attritional, the number of departures were considerably higher than the level projected by military personnel planning models, with a higher proportion of middle level, experienced personnel departing than was the previous norm. McIntyre, Gauvin and Waruszynski concluded that it did have " a long term impact on the military's corporate memory." From: S.G. McIntyre, Marlene Gauvin, Barbara Waruszynski, "Knowledge Management…, 36.

Mark McElroy associates first-generation knowledge management strategies with the phrase *getting the right information to the right people at the right time*. He characterizes first generation managers with the assumption that valuable knowledge already exists, all they must do "is capture it, codify it and share it."[11] This can be overly simplified as an electronic version of a clerk and file cabinet. First-generation knowledge management, or what was previously referred to as IM, is almost exclusively driven by technology; larger and faster data warehouses with greater connectivity and accessibility. With this approach, validity and relevance are given little consideration. The currently evolving concept, second-generation knowledge management, views the production and integration of knowledge as equally important. This construct acknowledges that many procedures or processes may exist within an organization to obtain knowledge. To provide efficiency of effort and coordination of integration, all of these procedures must be monitored and regulated by a knowledge management process (KMP) involving both human and cyber creators and consumers of knowledge.[12] While first generation knowledge management seeks to build a more efficient library, second generation KM strives to increase the organization's ability to learn faster while enhancing the value of the knowledge. As the US military has found, learning faster is the key to enhanced situational awareness and the increased operational tempo it enables. To achieve this increasing knowledge, an advanced process is required.

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[11] Mark W. McElroy, *The New Knowledge Management: Complexity, Learning, and Sustainable Innovation*. (Boston: Butterworth-Heinemann, 2003), 4 - 18.

[12] Note: Since they were invented, Computers have been creators as well as consumers of information. With the increasing sophistication of software, computers are becoming a large consumer and, to a lesser extent, creator of knowledge.

The process starts with the perception of a need for specific knowledge. Once the participants within the KMP have verified that the desired knowledge does not exist within the knowledge base, the relevant procedure to seek out or create the knowledge is activated. When knowledge is obtained, it is not used once then stored for future access, but it is passed back to the knowledge management process. The KMP then assess the knowledge's subjective or objective nature, the life span of the data, its validity and relevance as variable weighting of value judgment, and provides an assessment of the source. The knowledge is then meta-tagged with these evaluations and stored within the virtual knowledge base.[13] This process is not a tool to fuse new data into a current picture, although it does greatly assist that endeavor. It is also not a tool to limit access to knowledge. This construct is designed to make knowledge more accessible to a greater range of analysts and warfighters. Meta-tagging adds tacit knowledge to explicit information to create knowledge tempered by human judgment that is usable to a wide variety of participants. This added dimension to the knowledge enables the user to more easily locate knowledge, while adding a value judgment that can be applied each time the knowledge is used. Translating these theories of knowledge management into practical processes is a knowledge management strategy. The engine that the strategy uses to regulate that increasing knowledge is a virtual knowledge base.

A virtual knowledge base is a transformational process that transports data through a number of stages in order to turn information into knowledge. While traditional IM gathered and stored information in databases, the term knowledge base evolves the process to a socially biased concept of community-based knowledge exchange. Telling an organization to collect then store specific data is inefficient, as it does not encourage

[13] Mark W. McElroy, *The New Knowledge Management:…*, 4 - 18.

an exchange of ideas between the directing authority, the collectors or other involved experts. Information is created by one small part of the organization and used once by a different part, to the exclusion of the remaining experts. The current Request for Information (RFI) process is an example of this inefficiency, as it is essentially a formal question and answer stovepipe. This process can lead to misunderstandings when the question is not expressed clearly or the analyst answering the question does not fully understand the local situation. These misunderstandings can cause the wrong data to be collected and other important data to be left out. With experience, staff officers have recognized this potential failing and frequently establish ad hoc virtual knowledge bases by encouraging close informal personal ties to form throughout the information chain. This facilitates the exchange of knowledge and reduces errors caused by misunderstanding the question or answer. A formalized process that is interactive between the users and collectors of data resolves this problem in a more efficient and repeatable manner that is not dependant on personal relations. The process takes all participants through the stages of comprehension, contextualization and valuation to achieve knowledge, ensuring the maximum number of experts address each question, giving the best possible answer. Having the requester involved in the collecting, ensures the final answer is relevant. It also enhances the requestor's judgment of the knowledge he has received, its dependability and accuracy. It is clearly desirable to have the maximum number of experts involved in any important question. The difficulty is to create a process that achieves these advantages within the personnel and resource limits of an organization.

To realize this metamorphosis of information into knowledge requires an open exchange of data between human and cyber agents that are experts in their fields.[14] Today, people meet in common interpretative spaces (CISs) to achieve the required level of knowledge exchange. While these CISs could be a meeting/briefing room, in a coffee room or via video/telephone conferences, increasingly, the easiest method for most knowledge exchange is in virtual space. The media is not important, as long as it enables interaction, where is not as important as what, why, who and how. As software becomes easier to use and people become less adverse to technology, CISs in virtual space will be used more frequently due to speed, convenience and lower cost, and thus changing the knowledge base and meeting room into a virtual knowledge base.[15] Today, when a headquarters receives a tasking and starts the operational planning process (OPP), the speed and complexity of the product is limited by the size of the headquarters staff and its operational tempo. A virtual knowledge base can reinforce the twenty or even two hundred staff officers of the HQ conducting the OPP, with two thousand from around the world. Neither the current RFI process nor the non-networked operational planning process, can achieve the speed and growth of knowledge required to keep pace in the US lead model of modern warfare. An interactive virtual knowledge base can increase the speed and ease of knowledge exchange, exponentially increasing the conversion of information into knowledge and knowledge into tempo. Therefore, a VKB is not only a place to store, transport and view information, it is also a space in which warfighters,

[14] Note: In the knowledge management field, 'cyber agents' are more frequently referred to as simply 'agents'. Currently, agents most frequently take the form of semi-automated search routines, decision aids or data fusion tools. In the near future, agent's abilities will greatly increase their value to the human analyst as they become more analytical and autonomous. Human agents are analysts and users of the VKB.

[15] A. Beerli, S. Falk, D Diemers (ed). *Knowledge Management…*, 157 – 177.

analysts and collectors of information can combine explicit and implicit information into knowledge, making it the foundation of the knowledge management strategy. With an understanding of KMS and VKB it is important to understand how a knowledge management strategy can create situational awareness within the battlespace.

For a commander, situational awareness is the knowledge of what is happening within his area of responsibility and is key to the decisions he makes regarding force employment. From the military perspective, situational awareness is embodied in an information or knowledge picture often called the common operating picture (COP). The COP is a constantly changing collection of knowledge, assessment and reference material displayed to the operational commander and shared with others operating in the battlespace. The COP is composed of background and current information that is constantly being analyzed and updated as directed by the knowledge management strategy.[16] The development of the COP is a highly cooperative process that, as described by Captain Knight, "is created when those that are involved in an operation compare, contrast, and analyze the relevant current and background information together to develop an assessment, or picture, of what is going on in a given situation."[17] Evolving the responsibility for creating the COP from a handful of watch-keepers and analysts to all warfighters is a significant change. Without good background information, and efficient access to shared knowledge enabled by a second-generation knowledge management strategy, the staff cannot produce an effective COP and the commander's

[16] Note: Background information is composed of reference databases and planning data, while current information is geo-referenced positional data linked to near real time readiness data. From: Captain (N) Darren Knight. "The Fourth Wish: Operational Information Management and situational Awareness." *Canadian Military Journal* Vol. 2, no. 4 (Winter 2001-2002): 34-36.

[17] Captain (N) Darren Knight. "The Fourth Wish: …, 34-36.

situational awareness suffers. With a solid foundation in knowledge management and how it produces situational awareness, the next area to address is the how knowledge effects the battlespace.

Robert Leonhard, in his book *The Principles of War for the Information Age*, postulates a construct based on seven principles of war; an independent principle and six further principles, which are dependant on the first. He theorizes that knowledge and ignorance are the two states that describe the independent principle that is the overarching principle upon which he bases his remaining modern warfare principles. He defines knowledge as the information we have about ourselves, the enemy and the environment, while ignorance is the converse lack of information. While these states have always been a factor in war, the information age has increased the exploitable possibilities of knowledge, thus increasing its importance.[18] The extension of this premise is that given unlimited time, a commander will learn everything about a given situation. Unfortunately, as war is time competitive, the commander must choose what aspects are essential for him to know, and plan to manage the remaining ignorance. On a battlefield, when a commander requires vital knowledge of the enemy, he, at times, must risk resources and lives. Resources that provide information about the enemy, but do not risk lives, are expensive and cannot accomplish as much as a man on the ground. The raw information gained through risking lives and equipment, or that gained through remote sensing, can then be used in the traditional way by on-scene warfighters to execute a limited form of non-linear warfare. However, by sharing the information through a virtual knowledge base, the US military has found that the information

[18] Leonhard, Robert R. *The Principles of War for the Information Age*. (Novato, CA: Presidio, 1998), 253.

advantage gained is translated into a decisive warfighting advantage by enabling an order of magnitude improvement in knowledge sharing. American combat experience has repeatedly found that the operational tempo generated by this knowledge sharing can "effectively lock out an opponent's ability to cope".[19] While the value of this level of knowledge supremacy is undisputed, few countries can compete with US access to resources. Does this mean only the US can practice this type of warfare?

Military leaders are constantly faced with a choice of where to invest limited resources. With regard to information, this choice can be expressed as a sliding scale between knowledge and ignorance. An example of two militaries on this scale can be found in Operation Iraqi Freedom, with the US military being high on the knowledge end of the scale and the Iraqi's at the ignorance end. It is attractive to countries with limited resources to ignore information systems and concentrate on firepower and manpower.[20] Many countries continue to follow this path, which forces their doctrine toward a more attritionist bias, relying on mass to overcome precision. Militaries that invest in information are better capable of following a more maneuverist doctrine, while militaries such as the Americans, that progress a step further and invests in knowledge, can follow a more accelerated form of maneuverist doctrine. However, more knowledge is not a panacea in itself. Military leaders must be wary of investing so heavily in information that they are unable to act on what they have purchased.

A dangerous misconception faced by the information investor is to believe that computers are the answer. Knowledge is based on a system of systems. Information

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[19] United States, Department of Defence, *Network-Centric Warfare: Creating a Decisive Warfighting Advantage* (Washington D.C.:U.S. Government) (available at US Government Internet site www.oft.osd.mil; accessed 6 April 2004), 2-4.

[20] Leonhard, Robert R. *The Principles of War…*, 253.

dominance comes from sensors, communications, computers and supporting software welded together by doctrine.[21] Doctrine must provide the guidance that determines how the other four components operate with each other and how they combine to form knowledge, which will ultimately be articulated in the knowledge management strategy. Without doctrine derived by the warfighters' operational experience, purchasers of knowledge systems run the risk of, as General Sharpe has observed that the CF has done in the past, purchasing based on what technology could do, not on the needs of the commander.[22] This has happened because it was often the technician or engineer who analyzed the requirements and evaluated the systems. Delivering a system the technician thought would produce what the operator wanted. This tendency is changing as more warfighters are becoming technologically aware. To sustain operationally biased doctrine, operators must continue to take responsibility for articulating and implementing knowledge doctrine and contributing the tacit information to the equation. Having recognized the importance of knowledge in modern military operations, the current state of knowledge management within the CF will be discussed to illustrate how it is limiting operations and how a modern knowledge management strategy could improve the Forces' operational capability.

The CF currently possesses limited capability to provide coherent and timely integrated information to commanders at all levels. At the strategic/national level, information sources have evolved independently and the integration of these sources relies on individual innovation. It is not possible to identify the unit or agency that is

[21] Ibid, 253.

[22] Sharpe, G.E. and A.D. English. *Principles for Change in the Post Cold War Command and Control of the Canadian Forces*. (Ottawa: Canadian Forces Leadership Institute, 200), 65 - 67.

accountable to ensure all available information is integrated in a timely manner and provided to the appropriate commander. Moreover, the knowledge of information sources resides separately in different organizations – there is no single coordinating tasking agency that knows the full range of information sources available and can identify and task the best sources. At the operational and tactical levels, commanders understand the information sources they control, but there is no formal mechanism to review and provide national sources of information to them in time to support their command decision-making.[23] General Sharpe noted that, NDHQ literature on this subject frequently refers to technology, process and structure (IT), but rarely about effects.[24] His article illustrates that, at the time of General Sharpe's writing, there was no coherent knowledge management strategy within NDHQ. The creation of a CF Information Officer in 1998 was an attempt to solve this shortcoming. However, the person appointed had an IT background from within the banking industry. The individual's corporate, rather than operational focus, did not allow him to remedy the operational challenges faced by the CF.[25] He left the position after two years and was replaced with a retired military officer. This level of discontinuity has been known within NDHQ for several years. As NDHQ staff tend to be too close to the problem and too busy with daily work, two retired senior commanders were tasked to investigate the problem.

A January 2001 joint report from Vice Admiral L. Mason and Lieutenant-General R. Crabbe recognized the need for better knowledge management within NDHQ. The

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[23] Department of National Defence. *Project Charter: DCDS 22; Joint Information & Intelligence Fusion Capability Project* (Ottawa: DND Canada, October 2002) (Available at dcds.mil.ca/dgjfd/djfc/jiifc/default_e.asp; DWAN; accessed 4 March 2004), 1-2.

[24] Sharpe, G.E. and A.D. English. *Principles for Change …*, 69.

[25] Note: The author gave a Navy IM vision brief to the CF Information Officer when he was first appointed, supported by Rear Admiral Miller, then commander MARLANT.

creation of the CF Command System (CFCS) Project was a direct result of this report.[26] The first step taken by the Project was to improve the National Defence Command Centre as a critical interim step. That underway, the next step was to improve the data fusion capability at the strategic level. To accomplish that, the Joint Intelligence and Information Fusion Capability Project (JIIFCP) was established to "acquire a Joint Information and Intelligence Fusion Capability that contributes to the situational awareness capability for all levels of Command, fully integrated into the CFCS."[27] To be able to conceptualize the future direction of knowledge management within the CF, a detailed understanding of the JIIFC Project is required.

The Joint Information and Intelligence Fusion Capability Project is expected to establish an operating-prototype Fusion Capability connected to the Initial Operating Capability Common Operating Picture in the National Defence Command Centre by October 2004. This test bed will be used to determine the best procedures, organization, and manning requirements for collecting and tasking intelligence sources, fusing all sources of information into a coherent and comprehensive analysis, and providing this analysis in the form of visualizations to operational decision-makers in a rapid and usable manner.[28] The completion of the JIIFC Project is a step ahead and will place NDHQ firmly on the path to achieving a first-generation knowledge management strategy. Before discussing the future, a brief investigation of the current state of the environmental services will tie their progress into the NDHQ level.

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[26] Vice-Admiral G.L. Garnett, "The Evolution of the Canadian Approach to Joint and Combined Operations at the Strategic and Operational Level." *Canadian Military Journal* Vol 3, no. 4 (Winter 2002-2003): 7.

[27] Department of National Defence. *Project Charter: DCDS 22; …*, 2.

[28] Department of National Defence. *Report on the Trials Methodology for the Risk Mitigation Initiative in support of the Joint Information & Intelligence Fusion Capability Project.* (Ottawa: DND

Within a single service context, the operational level COP is provided by MCOIN III for the Navy and in the future, LFC^{2}IS for the Army and AFCCIS for the Air Force.[29] The Navy's MCOIN III system has been in service since 1997. With the standing up of TRINITY as the Atlantic joint ocean surveillance and information centre 1998, and ATHENA as the west coast equivalent the following year; the Navy has the most mature capability in this area. The national level Canadian Forces Command System, is based on the experience gained in these units.[30] Although the naval system is more mature, it is firmly rooted in first generation KM, while taking steps towards second-generation processes. The Army's LFC^{2}IS is still under development and is being designed to provide commanders with secure communications over a network, as well as operational planning and C^2 tools. It was tested by 2 CMBG during 2003 and is expect to achieve initial operating capability with that unit in 2004.[31] The system also has a rudimentary knowledge management system that is envisioned to be a web based solution that can hold documents such as publications, doctrine manuals, procedure, and lessons learned. Currently, only the Lessons Learned Knowledge Warehouse (LLKW) component is available for testing, other components will be implemented latter. LFC^{2}IS is currently not compatible with existing Canadian systems, but it is envisioned by the LFC^{2}IS project, that the Canadian Forces Command System (Land) (CFCS (L)) will enable

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Canada, October 2003),iii [report on-line]; available at dcds.mil.ca/dgjfd/djfc/jiifc/default_e.asp; DWAN; accessed 4 March 2004.

[29] Note: The conceptual foundation for AFCCIS is too immature to be considered a viable system in the near future and will not be discussed further.

[30] Department of National Defence. *Integrated Intelligence, Surveillance & Reconnaissance (ISR) Capability : Planning Guidance.* (Ottawa: DND Canada, 15 April 2002) (Available at dcds.mil.ca/dgjfd/djfc/pages/docs_e.asp; DWAN; accessed 10 January 2004), 10.

[31] LCol J.L. Chevalier. *C^{4}ISR 'Way Ahead' Workshop—Director Land Command & Information Presentation.* (Ottawa: DND Canada, 29 Oct. 2003) (Available at dcds.mil.ca/dgjfd/djfc/pages/ docs_e.asp; DWAN; accessed 2 April 2004), 21, 38.

compatibility. There is also an ongoing consideration to provide interoperability with the Global Command and Control System (GCCS), which is the US produced software suite used to display current information in the joint COP.[32] The US Army uses a system called "Blue Tracker" to achieve this interoperability. The CF uses GCCS to exchange information with the US military at the joint operational and strategic levels. Currently, full time interfaces are in use daily with the US Navy, Coast Guard, Air Force, and Army. The CFCS Project's efforts are focused on the Joint Intelligence and Information Fusion Capability Project (JIIFCP) and the project is not planning to provide a sub-component CFCS(L) in the foreseeable future. Until this disconnect is resolved, the LFC^{2}IS has the potential to seclude Land Forces from participation in a joint Canadian knowledge management strategy, reducing the value and effectiveness of the CF system.[33] What would be the repercussions to operational commanders of not realizing a joint knowledge management strategy?

Martin van Creveld, in his book *Command in War,* postulated that when confronted with a knowledge organization that does not provide the commander with enough information, the commander could either try to increase the information processing ability of his organization, or design the task to be achievable with less information. Due to sensitivities to casualties, most western militaries have opted for investing heavily in the first option while discounting the second. This preference towards the technical solution brings us back to Leonhard's knowledge principle of war. Western militaries cannot afford to be forced into an attritionist doctrine, and therefore

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[32] LFC^{2}IS System Overview [CD-ROM]. Ottawa: NDHQ/DLCSPM 4, 2004.

[33] Note: Although LFC^{2}IS has adopted a common international army standard agreed upon by twenty other countries, none of the required software, exchange agreements or testing regimes are in place

must invest in knowledge. A successful second generation KMS not only increases information processing, but also increases usable knowledge, reducing van Creveld's information deficiency. To address the remainder of this deficiency, commanders must reach a balance, which provides enough vital knowledge to overcome the fog and friction inherent in the operation, while leaving enough flexibility to react to inevitable uncertainties that will be generated once the battle is joined.[34] A danger of technology is that it may disconnect the leader from those being led. Command and control during WWI is an example of this trap. The development of telegraph, telephone and wireless communications led the generals to believe they could more efficiently lead their men from a remote position. Robert Leonhard believes this physical separation of the army from its general led to poor moral and resulted in operational stagnation.[35] New technology makes this tendency even more attractive, as it allows the commander access to more information. However, too much information can paralyse a force as quickly as too little, if the commander fails to follow his own coup d'oeil while waiting for information to be analysed and displayed.[36] Only current operators can ensure the proper balance is maintained between knowledge and flexibility or determine when personal leadership is more effective than more information. This ability is gained through experience and is why operators are essential to the design and use of an effective KMS and why tacit knowledge is vital within a virtual knowledge base. Having addressed the volume and value of knowledge, in what direction should this lead the CF in the future?

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to make interoperability with these countries a reality in the near future without considerable resource investment.

[34] Newell, Clayton R. *The Framework of Operational Warfare*. (London and New York: Routledge, 1991), 136.

[35] Leonhard, Robert R. *The Principles of War …*, 15.

[36] Newell, Clayton R. *The Framework of Operational Warfare*…, 135, 136.

General Sharpe noted that no matter what style of command is adopted by a commander, the critical characteristic of any system is its ability to learn while executing a mission. He also notes that no matter what technical or structural innovations are attempted, programs and policies must be devised to change the culture of the organization. Research has indicated that western militaries have been unsuccessful in creating the required change unless the leader has forcefully overcome the bureaucratic inertia through personal leadership.[37] Technology has not been a panacea for the CF, partially due to a lack of involvement by warfighters and a resistance to cultural change.[38] Therefore, to enable a system and culture to evolve, it is important for CF commanders to be involved and strongly committed at every stage of KMS development and maintenance. Finally, the ability of that system to learn implicit or tacit knowledge is imperative if the CF is to remain inter-operative and relevant to the US military.

Knowledge and knowledge management are key to an operational commander's situational awareness and have been considered by some to be the new overarching principle of war for the information age. It has been demonstrated that situational awareness is created through an effective knowledge management strategy and that the foundation of that KMS is a virtual knowledge base. It has been postulated that a VKB must not only collect and store explicit information, but must also collect and process implicit information. Interactive common interpretive spaces, which allow the free exchange between agents to combine both types of information, ultimately result in the creation of an increasing amount of knowledge. That knowledge growth is essential to achieving the accelerating operational tempo currently being exploited by the US

[37] Sharpe, G.E. and A.D. English. *Principles for Change…*, 69.
[38] Captain (N) Darren Knight, "The Fourth Wish: …, 34-36.

military. Current Canadian command systems at the environmental and national levels are not supporting their commanders as effectively as the modern battlespace requires. This deficiency has been noted at the highest levels of NDHQ and initiatives are underway to solve this problem. More computers and information are not a solution unto themselves. Operators and leaders must be involved at every step of the creation and implementation of a second-generation knowledge management strategy for the information age. If the Canadian Forces are to remain interoperable with the US military and relevant internationally, accelerated knowledge management strategies must be pursued.

BIBLIOGRAPHY

BOOKS

A. Beerli, S. Falk, D Diemers (ed). *Knowledge Management and Networked Environments*. New York: AMACOM, 2003.

Holsapple, Clyde W. (ed). *Handbook on Knowledge Management 1: Knowledge Matters.* Berlin Heidelberg New York: Springer-Verlag, 2003.

Holsapple, Clyde W. (ed). *Handbook on Knowledge Management 1: Knowledge Directions.* Berlin Heidelberg New York: Springer-Verlag, 2003.

Laudon, Kenneth C. and Jane P. Laudon. *Management Information Systems: New Approaches to Organization and Technology,* 5th ed. New Jersey: Prentice-Hall, 1998.

Leonhard, Robert R. *The Principles of War for the Information Age*. Novato, CA: Presidio, 1998.

McElroy, Mark W. *The New Knowledge Management: Complexity, Learning, and Sustainable Innovation*. Boston: Butterworth-Heinemann, 2003.

Newell, Clayton R. *The Framework of Operational Warfare*. London and New York: Routledge, 1991.

Sharpe, G.E. and A.D. English. *Principles for Change in the Post Cold War Command and Control of the Canadian Forces*. Ottawa: Canadian Forces Leadership Institute, 2002.

PUBLISHED REPORTS

Davis, Karen D, *Knowledge Management and Human Resources in the Canadian Forces*, Report prepared for the Directorate of Strategic Human Resources and Operational Research Division: Social Science Operational Research Team. Ottawa: Canada, September 2003.

Report on Air Force Command and Control: The Path Ahead. Volume 1: Summary. SAB-TR-00-01. Dr. Peter R. Worch, Study Chair. Washington: United States Air Force Scientific Advisory Board, December 2000.

PUBLISHED PROCEEDINGS

U.S. Army War College. *Proceedings of the Ninth Annual Strategy Conference: Challenging the United States Symmetrically and Asymmetrically*. Carlisle Barracks, Pennsylvania, 1998.

ARTICLES IN JOURNALS

McIntyre, S.G., Marlene Gauvin, Barbara Waruszynski, "Knowledge Management in the Military Context." *Canadian Military Journal* Vol. 4, no. 1 (Spring 2003): 35-40.

Rousseau, Colonel Christian. "Complexity and the Limits of Modern Battlespace Visualization." *Canadian Military Journal* Vol. 4, no. 2 (Summer 2003): 35-43.

Knight, Captain (N) Darren. "The Fourth Wish: Operational Information Management and situational Awareness." *Canadian Military Journal* Vol. 2, no. 4 (Winter 2001-2002):33-40.

Barber, Commander Josh. "An intelligence, Surveillance and Reconnaissance (ISR) Vision for the Canadian Forces." *Canadian Military Journal* Vol. 2, no. 4 (Winter 2001-2002): 41-46.

Garnett, Vice-Admiral G.L. "The Evolution of the Canadian Approach to Joint and Combined Operations at the Strategic and Operational Level." *Canadian Military Journal* Vol 3, no. 4 (Winter 2002-2003): 3-9.

ELECTRONIC SOURCES: DND DOCUMENTS

Canada, Department of National Defence. *C4ISR Campaign Plan: and then a Miracle Occurs?*. Ottawa4 -0.0002 Tw 12 094aSe002 T1b0 Tc 0 Tc 0.0002 Tw 12 0 0 12 90 419.344515.06

Canada, Department of National Defence. *Options Analysis Report on Joint Information & Intelligence Fusion Capability for the Director of Joint Force Development Department of National Defence.* Ottawa: DND Canada, February 2004. Available at dcds.mil.ca/dgjfd/djfc/jiifc/default_e.asp; DWAN; accessed 4 March 2004.

Canada, Department of National Defence. *Project Charter: DCDS 22; Joint Information & Intelligence Fusion Capability Project.* Ottawa: DND Canada, October 2002. Available at dcds.mil.ca/dgjfd/djfc/jiifc/default_e.asp; DWAN; accessed 4 March 2004.

Canada, Department of National Defence. *Project Profile and Risk Assessment: Joint Information and Intelligence Fusion Capability*. Ottawa: DND Canada, December 2002. Available at dcds.mil.ca/dgjfd/djfc/pages/docs_e.asp; DWAN; accessed 22 November 2003.

Canada, Department of National Defence. *Report on the Trials Methodology for the Risk Mitigation Initiative in support of the Joint Information & Intelligence Fusion Capability Project.* Ottawa: DND Canada, October 2003. Available at dcds.mil.ca/dgjfd/djfc/jiifc/default_e.asp; DWAN; accessed 4 March 2004.

Canada, Department of National Defence. *Chief of the Defence Staff PartII: Strategy 2020.* Ottawa: DND Canada, August 2003. Available at http://www.cds.forces.gc.ca/pubs/strategy2K/s2k06_e.asp; Internet; accessed 2 March 2004.

Chevalier, LCol J.L.. *C4ISR 'Way Ahead' Workshop—Director Land Command & Information Presentation.* Ottawa: DND Canada, 29 Oct. 2003. Available at dcds.mil.ca/dgjfd/djfc/pages/ docs_e.asp; DWAN; accessed 2 April 2004.

Hennessy, Michael A. *C4ISR 'Way Ahead' Workshop—Some Historical Perspectives.* Ottawa: DND Canada, 29 Oct. 2003. Available at dcds.mil.ca/dgjfd/djfc/pages/ docs_e.asp; DWAN; accessed 4 April 2004.

LFC2IS System Overview [CD-ROM]. Ottawa: NDHQ/DLCSPM 4, 2004.

ELECTRONIC SOURCES: US GOVERNMENT DOCUMENTS

United States, Department of Defence, *Network-Centric Warfare: Creating a Decisive Warfighting Advantage* (Washington D.C.:U.S. Government Internet site www.oft.osd.mil; accessed 6 April 2004.

United States, Department of Defence, *Cebrowski Sketches the Face of Transformation* (Washington D.C.:U.S. Government Internet site www.defenselink.mil/news /Dec2003/n12292003_200312291.html; accessed 6 April 2004.

ELECTRONIC SOURCES: PUBLIC DOCUMENTS

Caterinicchia, Dan. "DOD awards intell net-centric pilot," *Federal Computer Week*. March 18, 2003. Article on line; available at http://www.fcw.com/fcw/articles/2003/0317/web-nces-03-18-03.asp; Internet; accessed 11 February 2004.

Cebrowski, V Admiral Arthur K. *Network-centric Warfare: An Emerging Military Response to the Information Age*. Speech to 1999 Command and Control Research and Technology Symposium; Available at http://web.archieve.org/200010101820…w.nwc.navy.mil/pres/speeches/ccrp2_.htm; Internet; accessed 2 March 2004.

Daconta, Michael C. *Central Data exchange (CDX): Then, Now and in the Future.* PowerPoint presentation on line; available at http://www.web-services.gov/CDX-future-vl.ppt; Internet; accessed 11 February 2004.

Dashiell, James. "70 – Joint Intelligence Virtual Architecture Program (JIVA)." *FBO Daily Issue of January 17, 2002*, FBO #0046. Available from http://www.fbodaily….nuary/17-Jan-2002/FBO-00014970.htm; internet; accessed 11 February 2004.

L. Cogoi, L. Di Gaspero, V. Della Mea, V. Roberto. *Seamless Access to Databases through KQML in an Agent-enriched Web*. Paper on line; available from http://www.

S. Ryan, A Bansal, T. Kapoor. *A Distributed Multimedia Knowledge Based Environment for Modeling over the Internet*. Paper on line; available from http://www.cs.kent.edu/~arvind/Papers/ictai00.pdf; Internet; accessed 11 February 2004.

Smith, Kevin T. *Solutions for Web Services Security: Lessons Learned in a Department of Defense Program*. PowerPoint presentation on line; available at http://www.omg.org/news/meetings/workshops/web%20Services%20USA%20Manual/02-3_K_Smith.ppt; Internet; accessed 11 February 2004.

Wu, Dr. Zhaohui. *Knowledge Base Grid: Power the Internet By Intelligence*. PowerPoint presentation on line; available at http://www.gcc2002.ict.as.cn/reports/26A/sA5.ppt; Internet; accessed 11 February 2004.