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A Strategy for Enhanced Command and Control in the Canadian Army

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Abstract

Command is the most important activity in military affairs. With the emergence of information technology, there is an opportunity to apply technology to the most important military function. While information technology is ubiquitous in modern society, it has a particular applicability for military command. A commander's decision-making is predicated on timely, accurate, and relevant information. Indeed, the Canadian Army, as with other modern Allied forces, has begun to adopt information technology and automated information processing to facilitate command. However, the infusion of technology does not necessarily ensure success but it is achieved by sound strategy and non-technical supporting activities.

The aim of this paper is to articulate the strategy for an enhanced automated command support of the Canadian Army through the application of technology. To derive at the strategy, the paper examines the nature of command, the trends in information technology, the nature of information, and the key processes involved in military commanders' decision-making. At the same time, the strategy cannot be merely based on ideal or theoretical precepts but one of practicality. There will be an examination of the current Canadian Army's strategy and its approach to the implementation of the first generation of automated command support tools. The paper concludes that: As command is the most important activity in military affairs, it is also the most important force in leading change and adopting technology to enhance the command function.

Introduction

War is the most catastrophic endeavour undertaken by mankind. The very existence of nations and the way of life of their citizens are dependent upon the outcome of wars. Nations bestow the authority of command to select individuals who possess leadership and intellectual qualities needed to excel in an environment of challenge and are capable of directing military missions for the nations' defence. Indeed, "command is the most important activity in war."[1] Given its paramount importance, there has been an insatiable quest for understanding the nature of command and achieving the most effective command in war.

There are two facets of command – one on the morale plane and the other on the intellectual plane. On the morale plane, commanders provide leadership to motivate others for the attainment of the mission. On the intellectual plane, commanders devise and direct military campaigns to achieve victory in wars. Both facets of command are human endeavours requiring intellect, determination, and creativity. Centuries ago, in simpler times, heroic military figures possessing these qualities have risen to the challenge of command and led their nations' armed forces victoriously in wars. In modern times, the conduct of warfare has become tremendously complex beyond the direct control of a single military commander. To assist in the execution of modern warfare, commanders are supported by headquarters staff who in turn employ various techniques, procedures, and processes to plan, coordinate, and control military operations. The techniques, procedures, and processes employed by headquarters staff to facilitate the command function are referred to as *Command Support*.

When nations go to war, their military forces employ the weapons of contemporary technology. Throughout history, technology has had a profound impact on the conduct and outcomes of wars. During the last two decades of the 20th century, the

[1] Director of Army Training. *Canadian Land Forces Manual. Command. B-GL-000-003/FP-000.* (21 July 1996), p 1.

accelerating pace of technological advancements in the field electronics, communications and computers have brought an enormous capability to acquire, process, and exchange information rapidly. The tremendous capability of information technology to rapidly exchange information across the globe has initiated a revolutionary transformation in business and society and ushered in a new era of the Age of Information. In general, technology has been introduced in an incremental fashion, resulting in an evolutionary impact on military capability. However, when the scope and scale of technological change have profound effects on combat tactics and warfare doctrine, it is deemed a *Revolution in Military Affairs* (RMA). Indeed, the tremendous power of information technology that is driving the revolutionary transformation in society is also on the verge of causing a revolutionary transformation in the military.

While information technology is ubiquitous in modern society, it has a particular applicability for military command. A commander's decision making is predicated on timely, accurate, and relevant information. Information technology can be harnessed to acquire, process, present, and disseminate information in an efficient and rapid manner for the commander's decision. Indeed, the Canadian Army, as with other modern Allied forces, has begun to adopt information technology and automated information processing to facilitate command.

During the last decade, the Canadian Army began to acquire the equipment that harnesses the power of information technology. The foundation for the new digital communications is the Iris system procured under the Tactical Command, Control, and Communications System (TCCCS) project. As the Iris communications system sought to replace all legacy tactical communications systems in use in the Canadian Army, it was an ambitious and forward-looking program for its day. Notwithstanding various superior capabilities of the Iris segments, the system as a whole has not passed final field qualification tests and has imposed delays on subsequent information system initiatives.

While the Iris system is still undergoing remedial engineering corrections, the Canadian Army began to acquire automated command support information systems. [2] Under the over-arching program of Land Forces Command and Control Information System (LFC2IS), there are two constituent systems. The Situational Awareness System (SAS) provides an automated position reporting capability at the subunit tactical level, whereas the Land Force Command System (LFCS) provides automated tools for the unit and brigade headquarters. Both systems are in the preliminary stages of field trials and have shown promising potential to assist tactical commanders in battlefield management and battlefield planning. However, there are numerous challenges to ensure that all the command support systems being fielded for the Canadian Army are operational and successful.

While the Canadian Army is in the preliminary stages of acquiring new digital communications and information systems, lessons from the history of warfare have shown that infusions of technology have not been exploited to their maximum potential without corresponding changes in military tactics, doctrine, training, and organizational structure.[3] Given the potential revolutionary impact that information technology offers in military affairs, a corresponding coherent strategy is required to fully exploit the technological advantage it offers. Although the introduction of information technology into the field equipment of Canadian Army has been quite recent, there has been criticism to suggest that the fielding of has been technically driven in the absence of an overall operational foresight and oversight. A clear and coherent strategy is fundamental for success.

> "Go forth without having determined strategy and you will destroy yourself in battle." Sun Tzu

The aim of this paper is to articulate a strategy for an enhanced automated command support of the Canadian Army through the application of technology. The

[2] The term *automated* is used loosely to mean *semi-automated* or *assisted by automation*.

development of the strategy for an enhanced automated command support shall begin with an appreciation of the fundamentals of command and decision-making. As information is the key ingredient to decision-making, the nature of information shall be examined next. In the modern age of technology, the capacity to generate and process information has been phenomenal, thus it is necessary to understand the nature of information technology, its brief history, trends, and progression. Through the discussion of the theory of command and nature of information technology, it should be possible to outline the ideal strategy for enhanced automated command support. Indeed, the Canadian Army has begun to incorporate information technology and to field the first generation of automated command support tools. Obviously, there will be an examination of the Canadian Army's current strategy and various initiatives involved in the implementation. As it is often the case, the introduction of a new capability has resulted in less than full success, so it is necessary to appreciate the gaps and shortfalls. Ultimately, the strategy must be practicable and in keeping with the available resources and constraints. As strategy is a high level concept, the focus will be at the approach and not specific techniques or methodology.

[3] Directorate Land Strategic Concepts. *Report Number 99-2. The Future Security Environment*. (Fort Frontenac, Kingston, Ontario. August 1999), p ix.

Baseline Concepts

The application of technology to achieve enhanced command support entails two aspects – information technology and command function. Consequently, the nature of both of these aspects will be examined in this section.

Information Technology

The era of computer began fairly recently, 60 years ago, with the advent of first computer machine, called ENIAC, whose logic processing was achieved with vacuum tubes. With the development of transistors and microprocessors in the 1960s and 1970s, the computer moved from the scientific laboratories to corporate institutions. However, computers of this era were mammoth, expensive mainframes only available to government, business, and academic institutions for corporate business. It was the introduction of personal computers (PCs) in the 1980s made computers accessible to the mass of ordinary users and, thereby, propelled the launch of the Age of Information.

The procurement and use of computers in the Department of National Defence (DND) and Canadian Forces (CF), for the most part, has mirrored society at large. Prior to the emergence of PCs, DND used mainframe computers to manage corporate, personnel and financial matters, as had other large corporations and institutions. In the mid 1980s, the first PCs were employed to assist with garrison clerical functions. By the early 1990s, the use of computers began to expand beyond clerical positions to general staff positions, and computers themselves were being connected on local area networks. By the late 1990s, virtually all staff positions were using computers that were connected across the common departmental network. By the turn of the century, of particular note, computers were being introduced to tactical command posts to support military operations.

Trends in Information Technology

Through a retrospective review of the information technology of the past two decades, one can perceive dominant trends and lessons to serve as guidance for the future. Clearly, the computer technology has been progressing at an escalating pace, reflected by the adherence to Moore's Law[4]. The advancement has occurred in every aspect of the technology – hardware, software, operating system, networking, and ancillary devices. The advancement in technology has created a spiraling effect to upgrade and replace previous generations of systems. There is a constant stream of new and more powerful software applications, which run on more powerful machines, controlled by more efficient operating systems. The software applications themselves are not just performing previous functions better, but are designed to work better with other applications in an integrated fashion.

While there are challenges with new and highly progressive technologies, many of the initial challenges have been overcome. Early on in the information age, the computer industry created a dilemma for the consumer with various incompatible proprietary hardware, software, operating systems, and architectures. In due course, the computer industry has moved towards convergence to common standards and compatibility through a dichotomy of cooperative arrangement of open architecture, on one hand, and sheer market domination, on the other. With the advent of the Internet and global connectivity, the industry has propelled towards greater convergence in interconnectivity and interoperability. The range of commercial-off-the-shelf (COTS) products has provided for greater economy, inter-changeable parts, interconnectivity, and interoperability than the proprietary products. With the rapid spiral advancement in all aspects of computer technology, there has been a constant cycle of software upgrades and hardware replacements. The enduring trends of the information technology of the past decade have led to today's information phenomenon and will continue to shape the way of the future.

[4] Moore's Law is a prediction by Gordon E. Moore, co-founder of Intel Corp, that processing power of computer will double every 18-24 months.

Nature of Command

The Canadian army doctrine lists six combat functions – command, maneouvre, firepower, protection, sustainment, and information operations – and places particular emphasis on *command*.

> Command is the most important activity in war. Command by itself will not ensure victory, nor drive home a single attack. It will not destroy a single enemy target, nor will it carry out an emergency re-supply. However, none of these war-fighting activities is possible without effective command. Command integrates all combat functions to produce deadly, synchronized combat power, giving purpose to all battlefield activities. [5]

Central in the exercise of command is decision-making and controlling action. Decisions are made by commanders based on available relevant information and commanders' intuition. While it is difficult to characterize the exact nature of information requirements for military planning, as it varies with the nature of mission and a variety of situational factors, there is a systematic and disciplined process to acquire the relevant information. To conduct military planning, at a minimum, information is required about strategic goals, military objectives, nature of the enemy, state of own friendly forces, and the environment of battle. However, in war and other military operations, decisions are made in conditions which are far from ideal – with incomplete information, uncertainty, and with a formidable enemy disguising its intentions. Whatever the circumstances, the key function of headquarters is to provide timely, accurate and relevant information to permit the commander to decide on military actions. Once a commander renders the decision, the headquarters promptly prepares and issues orders and monitors and controls military actions on behalf of the commander. Indeed, it

[5] Director of Army Training. *Canadian Land Forces Manual. Command. B-GL-000-003/FP-000.* (21 July 1996), p 1.

is the commander's plans and orders that provide the unity of effort and cohesion in the overall military campaign.

Cognitive Hierarchy

Information is a term that is used in a generic fashion without critical consideration to its specific meaning. It is often used interchangeably with the terms *data* and *knowledge*, when, in fact, the nuances of these terms are crucial. The Information Operations manual outlines the concept of *Cognitive Hierarchy*, which serves as a model to explain the progression of *data* being processed as *information.* Information when it is put into context becomes transformed as *knowledge* and ultimately leads to *understanding*. Stated in another way, *Data* is an item of fact on some entity. When data is organized and processed, it becomes a piece of *information*. Information that is analyzed, evaluated and presented in context creates *knowledge* to the human recipient. Knowledge in the context of previous human learning, training and experience, creates *understanding*. Understanding is the basis for military decisions and plans.[6]

The cognitive hierarchy construct helps to define the natural boundaries between data, information, knowledge and understanding. More importantly, it aids in segregating the realms of technology and the human. Actions on data are mechanical or physical when acquired, stored, and exchanged. Information is data that has been processed, fused, or grouped in some logical manner. Actions on data and information are largely mechanical or computational and thus readily performed by technology, whereas knowledge and understanding are cognitive processes achieved within the human mind. Technology can be harnessed to present quality, contextual information to human but it is not capable of cognitive process, at least with the current technology. Whereas technology is eminently capable of acquiring, retaining, and passing volumes of data and information at a rapid speed, human beings are relatively slow, error-prone, and

[6] Director of Army Training. *Canadian Land Forces Manual. Information Operations. B-GL-300-005/FP-001.* (18 January 1999), p 15.

limited. The cognitive hierarchy serves as a useful reference in applying technology to process information to facilitate human decision-making.

Situational Awareness

Military commanders have unique information requirements depending on the level of command and the type of forces they command. At the tactical level, the most basic requirement is knowing: Where am I? Where are my buddies? Where is the enemy? In the military parlance, this is called *situational awareness*, which is seeing the battlefield[7] and knowing the current state of the friendly and the enemy forces, in terms of their combat capability and their disposition on the battlefield. In the absence of technological support, tactical commanders rely upon paper maps and visual reckoning of the terrain and frequent exchange of positional information within the organization.

It may be useful to appreciate the current manner of acquiring situational awareness at the tactical level. As was mentioned, situational awareness is determining one's position on the battlefield. It entails the translation of the physical location on the battlefield to a grid reference on the map. When one's location is determined it is passed on the tactical radio net, a process taking about 30 seconds. For the recipient, it means jotting down and marking the map. This process is replicated across the tactical organization, which may consist of a number of subordinate elements, lateral units, and higher headquarters. Although it is largely a mechanical process and not a cognitive one, it is very taxing on the human brain. Overall, the process is laborious, tedious, and prone to error. It involves a series of alphanumeric elements, as in call signs and grid references, to be encoded, transmitted, received, and decoded. A tactical commander can be tied down to this process thereby diverting his attention from other critical aspects of tactical combat – thinking about tactics and conducting the fight. Nonetheless, the reporting of one's positional information is crucial as it contributes to the overall

[7] Although the term *battlefield* is used in generically in the army, a more precise term would be *battle space*.

situational awareness of the tactical organization to allow for mutual support, to avoid fratricide, and to synchronize fire and maneouvres.

Achieving situational awareness serves as a basis for further military planning, coordination, and action. Technology can be applied to automate the various procedural and mechanical processes to acquire situational awareness. Situational awareness can be broken down to three component processes – a Global Positioning System (GPS) to acquire the precise location information, a radio net to exchange acquired positional information, and a computer display to show the transmitted positional information over a digitized map. An automated situation awareness system that integrates these component processes across an organization and shares the acquired information is, in effect, providing a *common operating picture*.

Common Operating Picture

The common operating picture greatly facilitates communication, coordination, and synchronization across the tactical organization to deliver combat power on the battlefield. In the absence of a common operating picture across an organization, each element would be left to acquire its own interpretation of situational awareness and contributes to an erroneous understanding of the reality. Achieving a common operational picture could drastically reduce tragic mishaps in combat – fratricide caused by erroneous identification and targeting of friendly forces. As situational awareness is an enabler for achieving common operating picture, it is an enabler for a more significant process, known as *Battlefield Visualization*.

Battlefield Visualization

Situational awareness provides a snap shot view of the current state of disposition of forces on a battlefield. At the higher level of command, the primary role is planning and directing the actions of the forces beyond the immediate battle, so it is not sufficient to have a short term view but also a view into the future. Higher commanders need to

acquire *battlefield visualization*, which incorporates the knowledge of the current situation as well as having the intuition for the interrelationship between the forces' capabilities, intentions, and maneouvres on the battlefield as the battle develops. Indeed, situational awareness is a *static* frame of reference and battlefield visualization is a *dynamic* frame of reference.[8] Given the complexity of modern warfare – with expanded battlefield, dispersed forces, the vast array of weapon systems, and the high tempo of dynamic activity – the formulation of battlefield vision by the commander is a difficult and complicated task. [9]

An effective headquarters staff supporting the commander would have in place the staff process of acquiring data and transforming them to condensed, relevant information for the commander's decision. This information is then blended with the commander's knowledge, experience and intuition to create his visualization of the battlefield.[10] The combination of technological tools, procedural techniques, and organizational structure that facilitate the commander's battlefield visualization is the essence of enhanced command support.

Operational Planning Process

To assist the commanders acquire battlefield visualization and formulate operational plans, a standardized practice of mission planning has been adopted in the Canadian Forces. The *Operational Planning Process* (OPP) entails a six-step process of mission initiation, mission orientation, courses of action development, course of action selection, war-gaming, and mission plan development. While there may be variations in mission planning, in general, the process entails a number of standardized inputs, intermediate outputs and final products. Operational planning is largely a human endeavour requiring skills in *Operational Art* – knowledge in military tactics and strategy, creativity, and logic. However, the OPP involves a certain degree of clerical

[8] Maj Jack Gumbert, "Leadership in the Digitized Force" Military Review Jan-Feb 1988 pg 16
[9] Department of the Army. *TRADOC Pamphlet 525-70 Military Operations: Battlefield Visualization Concept*. para 2-1a

and mechanical processes that can be standardized and automated. In the absence of automated tools, valuable staff effort is spent on data entry, data cross-referencing, information layout and presentation, when the focus should be on operational concepts and design.

The automation of OPP should begin with the standardization and digitization of various templates used by the military planning staff. As the OPP is a logical and progressive process, an input in an earlier stage has linkages with the outputs of subsequent stages. Similarly, a data element entered into one OPP template has logical links with other OPP templates, therefore, an entry in one should facilitate in the automatic entry of data in subsequent templates. A more sophisticated tool would provide a series of *decision aids* tools, particularly in the war-gaming step whereby the combat effects of force-on-force can be estimated. Another critical determinant in operational level planning is the verification of the logistic support to the combat operations. As logistic planning is the management of combat supplies, largely a quantitative process, an automated process can readily and accurately perform this function. Given that the OPP is a key technique for military planning and is a standardized process, it is a prime candidate for automated support.

Digitized Map

The utility of a map depicting terrain and other natural and man-made features cannot be understated when it comes to military operations. Military planners rely heavily upon accurate maps, consequently, an automated command support tool must have a quality digitized map as a baseline capability. Paper maps are available in many forms depending on the usage. Likewise, digitized maps must cater to a variety of requirements within the military context. Early generation computers lacked the processing power and display resolution to supplant the paper based maps. However,

[10] Department of the Army. *TRADOC Pamphlet 525-70 Military Operations: Battlefield Visualization Concept*. para 2-1b

progress in computer display graphics and computer geographical applications have allowed for superior digital maps.

There is one lingering shortfall in digital map display relative to a paper-based map. Whereas a series of adjoining paper maps can be spread over a wall or a large table, the field of view for a digital map is limited to the size of the computer monitor. However, this limitation is resident with commercial-off-the-shelf equipment and can be overcome with specialized computer technologies. There have been demonstration prototypes of over-sized high-resolution computer displays that readily supplant the paper maps.[11] Moreover, whereas the paper-based maps are limited to two-dimensional representation, high performance computers are capable of three-dimensional views, which greatly assist the military planner to acquire terrain visualization.

A digitized map has tremendous utility over a paper-based map. Virtually all military assets have a reference to a location on the battle space. Likewise, virtually all terrain or man-made features or conceptual entities (political boundary, feature names) can have an informational significance for military planning. A digital map could access the dataset of geographical military assets and terrain features and display only the relevant information. Whereas the paper-based maps rely upon an *overlay* of traces which superimpose military information over the generic map, the digital map would tailor the presentation to users' requirements in a flexible manner.

Information Overload

In the era before the age of information, the preoccupation was acquiring information as a step to gain knowledge. Today, the pendulum has swung to the other side where there is too much information in danger of hindering knowledge. With the proliferation and interconnectivity of digital devices, there are more data and information being generated, transmitted and stored than ever before. Simply put, the sheer volume of irrelevant information being presented to users has created a condition of information

[11] Demonstrated during Joint Warrior Interoperability Demonstration in June 1997 in Norfolk, Virginia.

overload. While the technology is an enabler, it is the human practice that is directly responsible for the information overload. The solution lies in the proper management of information. Information management is controlling the acquisition, processing, analysis, dissemination, presentation, storage, and disposal of information.

Information Management

Achieving effective information management is no different than an organization striving to achieve any other important goal. Recognizing that information management is not a technical function but an organization's operational function, it requires the will of the senior management and discipline and cooperation throughout the organization. The essence of the information overload problem is irrelevant information in substance and poor information presentation in format. Consequently, the first step to achieving information management entails a comprehensive analysis of the nature of all information generated, transmitted, and stored relative to the actual information requirements. The information requirements need to be defined in terms of the origin and destination, in form and substance, and by criticality and priority. Furthermore, the information analysis should categorize the nature of information, the flow of information, and the information depositories. Following the comprehensive review of the information needs and processes, the organization should set out the principle, procedures and techniques to ensure sound information management practices. These procedures and techniques need to be reinforced by training, instructions, and practices. While the human user is the primary source of information overload and human practices can prevent it, there are technical tools to assist the human. For instance, documents are rarely produced for one-time use and therefore documents should have their attributes annotated to facilitate handling, distribution, storage, search and disposal.

In the context of command support, information management in military headquarters is absolutely crucial, given that effectiveness of the commander and his staff must not be encumbered by information overload. The absence of effective information

management could lead to information overload and critical information being drowned by the trivial.

Summary of Baseline Concepts

As command is the most important activity in military affairs, it has been a subject of study and enhancement. Central to command is decision-making, and the key ingredient in decision-making is information. Information technology can be harnessed to acquire, process, and present information for the commander's decision-making. As information technology is applied to automate any established military process, it must do so in a manner that serves a clear purpose and provides obvious benefits. This entails an appreciation of the nature of cognitive hierarchy and segregating the realms of the technological and the human. Automation should not be implemented for the sake of automation. Automation should be applied to processes where technology is particularly adept.

Automation should be applied to acquire, process, and present relevant military information requirements to facilitate command. At the tactical level, the basis of military operation is acquiring situation awareness and achieving common operational picture, for which information technology can be readily be applied to automate these requirements. At the unit and formation levels, information technology should be applied to assist the commander and headquarters staff with the Operational Planning Process (OPP). As the OPP is a standardized process and relies upon standardized templates, it is a prime candidate for automation. One common underlying technical requirement in any military planning is a digital map. Technological advances will soon deliver affordable quality digital displays, and computerized three-dimensional views will greatly assist military planners to acquire terrain visualization.

The aims of applying information technology to automate various processes are self-evident and axiomatic. An automated process should be more efficient and effective than the manual method. As well, an automated process should make the task easier than

the current method and not result in additional work and support. As a minimum, an automated process should not be any more unreliable than the current method. Furthermore, it should be firmly established that computers and information technology are more adept at certain functions over manual processes. Computers are particularly useful in acquiring, displaying, storing, and transmitting data. With the speed and capacity of processing power in information technology, these functions are performed infinitely faster and more precisely by machines than by humans.

As computers are better than humans in handling data, the corollary is that humans are more capable of higher cognitive process than computers. Humans are capable of analysis and synthesis of information to attain knowledge and understanding. Computers are not capable of high-level cognitive processes as human software programmers have not been able to codify intuition into computer programming language. Scientific and research development on artificial intelligence has allowed computers to achieve pattern recognition but it is still far short of human intuition and creativity. Simply put, technology and automation should be applied where it provides the maximum benefit and effect. There are functions that are best performed by technology and some are best left for human analysis and thought.

As technology is applied to acquire and process information, there is a potential for information overload to hinder command and control. The key to suppressing information overload and achieving effective control of information is information management. There is no magic solution to achieving information management. It entails a comprehensive analysis of information generation and flow within organization and adherence to disciplined procedures.

Current Situation

Introducing technology to enhance command support is not a new concept in the Canadian Forces. Indeed, the leadership at the highest level of the DND/CF has articulated that *modernization* which capitalizes on Canadian technological competencies in telecommunications and information technologies to be one of the top strategic objectives.[12] Furthermore, the CF has adopted a new doctrine of Information Operations, which recognizes the increasing dependence upon and power of information in military operations. The commitment to modernize and capitalize on information technologies is manifested in the fielding of new command and control capability.

Defence Strategy 2020

The Defence Strategy 2020 aims to articulate the strategic vision and outline the strategic framework for the DND and the CF for the future. The strategy recognizes the emergence of a Revolution in Military Affairs, given the rapid technological advances and innovative application of emerging technologies, combined with dramatic changes in military doctrine and operational concepts.[13] The strategy articulates the key imperatives of which four of the top ten directly apply to the enhancement of command and control necessary for the future security environment.[14] In outlining the Strategy 2020, the commitment for enhancing command support has the strong commitment from the Deputy Minister and the Chief of Defence Staff.

Army Strategy

In keeping with the Departmental strategic framework, the Chief of Land Staff (CLS) issued his corresponding strategic vision and direction towards the Army of

[12] National Defence. Deputy Minister and Chief of Defence Staff. *Defence Strategy 2020. (*June 1999), p 6.
[13] National Defence. Deputy Minister and Chief of Defence Staff. *Defence Strategy 2020. (*June 1999), p 6.
[14] National Defence. Deputy Minister and Chief of Defence Staff. *Defence Strategy 2020. (*June 1999), p 6. Four key imperatives are: modernization, inter-operability, jointness, command and control.

Tomorrow in the Army Strategy.[15] The CLS, representing the highest level of leadership in the Canadian Army, places his commitment for modernization as one of the four highest stated objectives. The CLS, furthermore, recognizes that the Army is on the "threshold of a revolutionary leap ahead in our system of command, control, and communications (C3)".[16] Never has there been such emphasis on the need for transformation and modernization at such a high level in the Army's strategy. Whereas the previously stated goal of the Canadian Army was the maintenance of its traditional role as a multi-purpose, combat-capable force, there is a clear shift for transformation and modernization in the Army Strategy 2020. The commitment to modernization is reflected in the prioritization of acquisition of new capabilities. The Canadian Army's first priority is to invest in information age *command and sense* capability while investing in fewer but more precise combat capabilities[17].

The Army Strategy looks to the future at emerging "technological opportunities" and cautions against "false starts and premature lock-in". [18] For the Army of tomorrow, it envisages an appropriate mix of emerging and legacy equipment systems. Furthermore, it emphasizes the need to synchronize force development with the US, other ABCA countries and selected NATO allies in order to achieve joint integration and combined interoperability those ground forces.[19] Most specifically, it directs that a command support capability be established that builds on the synergy offered by ISTAR and digitization in an appropriate structure, within a short-term target of five years.[20] Taken together, the Army is to establish an enhanced command support capability employing advanced information technologies, exploiting the synergy offered by ISTAR capabilities, and will be interoperable in joint and combined operations.

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[15] National Defence. Chief of Land Staff. *Advancing with Purpose: The Army Strategy.* [2002]
[16] National Defence. Chief of Land Staff. *Advancing with Purpose: The Army Strategy.* [2002], p 6.
[17] Lieutenant-General M. Jeffrey, Chief of Land Staff, address to the CFCSC land component students during EXERCISE STALWART WARRIOR in Kingston on 10 April 2003.
[18] National Defence. Chief of Land Staff. *Advancing with Purpose: The Army Strategy.* [2002], p 9.
[19] National Defence. Chief of Land Staff. *Advancing with Purpose: The Army Strategy.* [2002], p 13.
[20] National Defence. Chief of Land Staff. *Advancing with Purpose: The Army Strategy.* [2002], p 21.
ISTAR stands for Intelligence, Surveillance, Target Acquisition and Reconnaissance

The strategies issued at the highest levels of Canadian Forces need to be pursued and reinforced by actions at the lower levels for implementation. One enduring method of translating strategic concepts into action is the development and promulgation of military doctrine. Indeed, the Canadian Forces has adopted a new military doctrine – *Information Operations*.

Information Operations Doctrine

The new Information Operations doctrine adopted by the CF emphasizes the critical nature of information in all aspects of military activities – information is power and the ability to acquire and transform it as a capability is the essence of information warfare. The new doctrine emphasizes the integration of information across military functions to provide synergistic advantage and effect. Furthermore, Information Operations give rise to new approaches and opportunities of warfare by taking advantage of enhanced information acquisition, information processing, and information dissemination capabilities supported by information technology.[21] Not surprisingly, however, the constituent functions of Information Operations are not new as they are the traditional approaches of information handling such as signals, intelligence, electronic warfare, civil affairs, and public affairs.

As information is ubiquitous, Information Operations apply to all facets of military activity and at all levels of command. For the military command function, pertinent information that is involved in decision-making process is the key to effective command. Given the primacy of command in military functions, the principal objective of Information Operations is to achieve information superiority to enable own commander to execute his decision-action cycle within the capability of the enemy's, and to use that advantage to enhance and enable other elements of combat power.[22]

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[21] Director of Army Training. *Canadian Land Forces Manual. Information Operations. B-GL-300-005/FP-001.* (18 January 1999), p 2.
[22] Director of Army Training. *Canadian Land Forces Manual. Information Operations. B-GL-300-005/FP-001.* (18 January 1999), p 2.

Information Operations is not synonymous with information technology but the technology serves as an enabler given that virtually all aspects of military function can be enhanced by it.[23] The emergence of new doctrine is a key step to understanding and employing new concepts, techniques, and tactics in military operations. The next step to realizing strategy and doctrine is the fielding of real equipment and technological tools.

Equipment Fielding

The Canadian Army has been undergoing modernization with the introduction of new generation of communication equipment and information systems. The most prominent of these are the Tactical, Command, Control and Communication System (TCCCS) and the Land Force Command and Control Information Systems (LFC2IS).

TCCCS

The TCCCS project was the largest capital acquisition in the history of the Canadian Army, costing $1.9 billion.[24] The project fielded a fleet of new tactical communications equipment, designated Iris, replacing legacy equipment procured in the previous decades. The requirement for TCCCS was conceived in 1980s, the contract was awarded in 1991, and the delivery of equipment was to begin in mid 1990s. The original intent for the TCCCS project was to be a three-phase program. Phase One would see the replacement of legacy tactical communications equipment; Phase Two would see the replacement of wide area communications equipment; and Phase Three would see the introduction of automated information systems. Without the funding resource to realize all three phases of the project, the first two phases were merged and few elements of the third phase were added.

The TCCCS requirement specification was ambitious and forward looking for its time in a number of ways. A number of its concepts were rather *revolutionary* for a

[23] Robert Bunker, "Information Operations and the Conduct of Land Warfare." *Military Review*. p 8

system being fielded in the 1990s relative to those systems in use or being fielded by the US Army or other modern forces. It called for an integrated systems approach. The Iris system would consist of a number of component subsystems, such as it radio, trunk, or satellite, and all would work in a seamless fashion. For instance, in the TCCCS architecture, the communications links carry both voice and data rather than the legacy approach of having two separate cables or radio sets to achieve the same function. In another example, a message traffic originated in a combat vehicle supported by a combat net radio subsystem could be passed through an area trunk subsystem and ultimately arrive at a brigade headquarters connected via a local area network.

Although TCCCS was contracted for delivery in mid 1990s, it was fielded after several years of delay and some of the complex features have not proven to be reliable in field operations and the final field qualification has not been certified. As TCCCS is the basis for the Canadian Army's tactical communication and serves as a foundation for future automated command support, it must function reliably before adding application information systems such as the LFC2IS.

LFC2IS

The Land Force Command and Control Information System (LFC2IS) is not a single information system but an over-arching program to integrate near-term constituent command and control systems. The LFC2IS program recognizes two facets – technical and operational – to ensure success. The technical dimension consists of two major equipment components – the Situational Awareness System (SAS) and the Land Force Command System (LFCS). LFCS has since been designated Athena.

[24] Department of National Defence. 2003-04 Report on Plans & Priorities – Status Report on Key Capital Projects. Page 6.

SAS

The Situational Awareness System (SAS) integrates radios, computers and GPS technology to automate the location reporting at the tactical level. At the combat team (company/squadron) level, the command posts are equipped with computers displaying the icons depicting the disposition of friendly forces over a graphic map. In effect, SAS provides automatic situational awareness in near real-time. The common operational picture application also provides for various drawing tools to be utilized thus allowing various control measures such as movement arrows and boundaries to be drawn on the digital map display. The tactical commander can then readily develop the tactical battle plan on the SAS terminal and dispatch it as a graphic overlay plan. SAS brings an automated tool that has been long sought by tactical commanders – an automated, near-real time graphic situational awareness display.

LFCS (Athena)

While SAS is a capability at the tactical level below the unit, LFCS (Athena) delivers automated staff planning capability at the unit and brigade levels. Essentially, Athena provides a variety of automated staff applications using computers that would otherwise be done with pen and paper prior to the information age. It maintains a situational awareness by graphical display of *overlays* over a digitized map depicting Blue, Red and Brown picture.[25] It provides for a variety of templates to enter electronic operational log and exchange various pre-formatted messages within and external to the headquarters. It also provides for Operational Environment and Resource Application (OPERA), formerly known as Electronic Battle Box (EBB). [26] OPERA serves as an electronic reference database for relevant military information such as doctrinal military organizations and weapon equipment statistics to permit operational and logistic staff planning.

[25] Blue SA refers to Situational Awareness pertaining to location of friendly forces; Red SA refers to enemy forces; and Brown SA refers to terrain.
[26] Electronic Battle Box (EBB) refers to the concept where staff officers held various publications and manuals in a hardened container that was carted to the field on military operations and exercises.

LFC2IS Technical Challenges

As the LFC2IS program ushers in new capabilities for the command support, it is not without technical challenges. One of the critical challenges of LFC2IS is achieving interoperability with the constituent technical systems. There are a number of obstacles that prevent seamless interoperability, and remedial engineering efforts are ongoing to find solutions. There are differing computer operating systems, functional applications, and bandwidth constraints. The computers fielded under the Iris TCCCS project and SAS system are designed to run on the UNIX operating system, whereas the Athena uses the Microsoft Windows operating system. The software applications of SAS and Athena are different and, more critically, their output files are not interchangeable.

The Athena system does not present the Blue situational awareness (SA) in the dynamic manner done in the SAS, where the icons depicting individual combat vehicles are updated automatically on the common operational picture. Instead, the Athena must update its views by downloading the most recent *overlay* of consolidated location status reports that have been transmitted as an attachment to an email.

The SAS is designed to be employed at tactical levels where the prevalent means of communication is the combat radio net. Given the limited bandwidth available on the combat radio net, the technical challenge is to minimize the information exchange packets over the radio domain and facilitate situational awareness with a single transmission burst.[27] Conversely, the Athena is designed to be employed at the higher headquarters connected on high-capacity fibre data networks supported by a high-power servers. The Athena applications employ more embedded data and tend to generate large files, which are problematic for transmission over the combat radio nets.

Clearly there is an intra-operability challenge due to differing hardware platforms, operating systems, user applications, and less-than-seamless exchange capability. The

[27] TCCCS radio protocol limits data transmission to a maximum of 10 second bursts

consequence of this is differing life cycle support, contractor support, spare parts, two-track training requirements and maintenance streams.

Non-Technical Fielding Activities of LFC2IS

The Canadian Army commenced the initial fielding of LFC2IS in 2002. However, preparations for the fielding began with a trial of the LFC2IS prototypes under the supervision of Land Force's Doctrine and Training System (LFDTS) in order to develop technical and procedural manuals in time for the full fielding. LFDTS has also conducted two formal army experiments to test the operational utility of both SAS and Athena. The lessons from these experiments served to gain user feedback and cue future enhancements for the SAS and Athena. Furthermore, these experiments served to appreciate the potential organizational impact and to suggest the optimized structure to support and capitalize on the capability.

The organizational impact due to the LFC2IS is expected to be profound and one particular Canadian Army brigade is to undertake a formal experiment to determine the optimal organization. Contrary to popular myth, the application of technology to automate various functions has not resulted in reduced personnel support. The LFC2IS provides a promise of enhanced command support capabilities but it has been suggested that the current structure of brigade headquarters will be inadequate.[28] The optimized structure will require a realignment of operational and support functions. A series of experiments and studies will be undertaken in the coming years to trial the LFC2IS and set the intermediate and final milestones for the LFC2IS fielding across the Canadian Army.

[28] Memorandum 3350-1 (DLCI 6) Command Support Pilot Project - Implementation Plan 28 February 2002

PLOTED process

The fielding of LFC2IS is being coordinated at the highest level within the Chief of Land Staff under the supervision of Director of Land Command and Information (DLCI). Recognizing that the fielding of LFC2IS is about more than technology, the Land Staff has initiated a range of supporting activities to ensure that the capability will be fully exploited. The Canadian Army has adopted a process encapsulated by the acronym PLOTED, which stands for Personnel, Leadership, Organization, Training, Equipment and Doctrine. Applying the PLOTED process ensures that the non-technical dimension is being considered in a holistic manner and not as marginal or trivial problems, in the aftermath.

Recognizing that LFC2IS will have an impact on the personnel, the organization is poised to evolve. With automation, various manual functions will become obsolete while the requirement for the technical support and management functions will rise. There is an ongoing review of functions and processes within the existing organization with the view to develop the optimum structure. Recognizing that LFC2IS will impose new skills depending on the role of personnel as users or system support staff, training 7sonnel aspose

PLOTED process sets the conditions for success for the Canadian Army to maximize on the capabilities of the LFC2IS, when it is fielded.

ISTAR

In addition to automated command support, the tremendous growth in information technology has given impetus to another emerging military capability, known as the ISTAR, standing for *Intelligence Surveillance Target Acquisition and Reconnaissance*. The concept of ISTAR is not new as they are traditional military functions. In the past, each of these elements existed as functions unto themselves. The modern information technology will revolutionize these functions in two ways. First, the technological advances in electro-optics, electronics, miniaturization, microprocessors, and communications are introducing powerful high fidelity sensors to the military inventory. Second, information technology can be capitalized upon to integrate the ISTAR functions and achieve synergistic effects.

ISTAR has a critical interplay with automated command support systems. It acquires and relays information on the battle space to the command support system in order to bring real-time situational awareness and support battlefield visualization for the commander. When the Canadian Army acquired the Coyote reconnaissance vehicle in the late 1990s, it represented the first bold initiative in the new age ISTAR concept. Mounted on its forty-foot mast were an array of surveillance capabilities including video, infra-red, night-vision, and radar, whose reach could be 14 kilometres forward in all conditions of darkness and weather.[29] The Coyote's state-of-the-art surveillance technology has been the envy of other Allied forces. Notwithstanding the Coyote's superb surveillance capability, there is an acknowledgement of its limitation. The Coyote acquires high fidelity sensory information of the battle space but that information cannot be readily passed to the chain of command for further exploitation. The power of information starts with the acquisition but gains its synergistic power with the sharing

[29] Elinor Sloan, *The Revolution in Military Affairs: Implications for Canada and NATO*. (Montreal: McGill-Queen's Press. 2002), p 134.

and collaboration of the acquired information. Indeed, the technical architecture of ISTAR is critical, and it must be designed to be integrated with the LFC2IS.

Summary of the Current Situation

The strategy at the highest level of Canadian Forces provides the impetus for modernization and embracing new technologies to enhance command. The strategy is reinforced by the development and promulgation of new Information Operations doctrine. The doctrine serves as a precursor to the implementation of technologies to bring enhanced command support. The implementation of technology has begun with the fielding of the TCCCS and the LFC2IS.

The TCCCS provides the communications foundation for information systems to be built upon. The LFC2IS brings two constituent systems in SAS and Athena. Whereas the SAS provides an automated battlefield management capability at the subunit tactical level, the Athena provides an automated battle-planning tool at the unit and formation levels. The LFC2IS is delivering some of critical automated capabilities required by commanders for military operations in the modern battlefield.

The Canadian Army's approach to LFC2IS fielding has been holistic and not focused on the technology only. The range of supporting activities covered by the PLOTED process are being diligently applied to ensure successful implementation and exploitation of the LFC2IS technical capabilities.

As the TCCCS and the LFC2IS are being fielded to deliver a range of automated tools, there are critical shortfalls. The TCCCS system has encountered technical problems and has not proven reliable under field qualification tests. The LFC2IS relies upon the underlying TCCCS architecture, but given its instability, the full implementation of LFC2IS has been put on hold. Meanwhile, there are interoperability gaps between the SAS and the Athena. The contractors have the responsibility to deliver

fully operational systems in the TCCCS and the LFC2IS. Clearly, the current situation is not desirable with less than fully working systems.

Examination of Strategy

Ideal Strategy

A strategy is a plan of a future action. It should define the desired goal, key objectives, priorities, resources, and sequence of steps and should be guided by reasoned principles and approach. A strategy should be comprehensive from the outset in so far as it is practicable to do so but allow for flexibility and adjustments given changing circumstances whilst progressing towards the desired goal. In the circumstance that the path to the desired goal has unforeseen interim results, a measure of risk analysis and a plan to mitigate the risk is required. The value of a strategy should manifest itself in its goal and objectives and be able to be evaluated against a criteria or measurable benchmarks. A strategy is a road map of a journey to a desired destination.

Desired Goals and Key Objectives

The desired goal of applying information technology for the Canadian Army is to achieve *enhanced* command support. Enhanced command support entails a *marked* improvement over current capability in facilitating the commander's primary role in decision-making for military mission planning and execution.

With the desired goal firmly articulated, key objectives should be selected. The key objectives are those particular functions and tasks that directly contribute to the commander's decision-making process. A functional review of the commander's activities and interaction, particularly with regards to information requirements and staff interface, should draw out the key functions and tasks. It has been established that situational awareness and common operating picture are the foundation for military planning and execution. Furthermore, priorities need to be established to ensure that the primary objectives are achieved by affording requisite resources. However, a measure of balanced effort 4j10.0018ed.dc9 0 0 12 89.9997926 Tmby afford7's

Core Requirements

The core requirement of automated command support is achieving situational awareness, as it is clearly the basis for tactical level military planning. Situational awareness entails the capability to portray Blue, Red, and Brown SA over a digital map. Having situational awareness across the organization leads to a common operational picture. The next core requirement is providing the tools to automate the Operational Planning Process, as it is the basis for operational level military planning. The OPP entails the use of standardized inputs and products, which are particularly apt for automation. The third requirement is achieving interoperability and being able to exchange common operational pictures with coalition forces.

Examination of Current Canadian Land Force's Strategy

Having outlined the elements of an ideal strategy for command support, one can review the strategy being pursued by the Canadian Forces. The Defence Strategy 2020 issued by the highest levels of leadership of the Canadian Forces espouses a strong commitment towards a transformation that embraces the new information age notions of command-centric and knowledge-centric armed forces. This is a significant departure from the traditional notion of maintaining a multi-purpose, combat-capable land force, articulated in the Canadian Defence strategies of the previous decade. However, written strategies are mere hollow words without the commitment of resources and tangible action. It is necessary to examine what actions have been implemented from the written Canadian Defence Strategy 2020.

The commitment to transform the Canadian Army towards the new age command-centric and knowledge-based army requires strong leadership and considerable re-allocation of resources from the status quo. The Chief of Land Staff (CLS) has directed funds to support capital projects that deliver automated command support and set the foundation to integrate emerging ISTAR capability. The Athena and the SAS each

previously received $200M and $70M to launch their respective programs.[30] Furthermore, $200M has just been allocated to integrate the TCCCS with the Athena and the SAS and lay the foundation for emerging ISTAR capabilities. Although these capital funds are typically spread over 3-5 year procurement period, they are significant given the severe resource constraints of the Canadian Forces. By way of comparison, the Canadian Forces is spending $225M for a new fleet of light wheeled vehicles, approximately 1600 vehicles in total, to be in service for 20 years.[31]

The commitment towards the enhanced command support is not limited to capital project funds and has crossed over to a more contentious issue of personnel reassignment. With the pending fielding of LFC2IS, an analysis of personnel requirements was conducted. The current organizational structure of the Brigade Headquarters and Signal Squadron was severely deficient and various options were outlined to address the manning shortfalls. One initial proposal deemed a requirement for additional 180 personnel but was since pared down to 80 personnel. Given the overall funding constraints and imposed manning ceiling within the Canadian Forces, the new requirement for 80 positions in command support had to be offset by eliminating 80 positions elsewhere in the Canadian Army. The CLS decided that two subunits, namely mortar and pioneer platoons within the infantry battalions, will be manned by the affiliated artillery and engineer regiments in the brigade, thus allowing for a reassignment of these combat personnel to the new command support organization. This decision by the CLS was a momentous one and clearly demonstrated the Army leadership's commitment to the transformation towards the new age Army.

LFC2IS will deliver a range of automated command support tools for the Canadian Army. First, LFC2IS will deliver the SAS thus satisfying the first core requirement of situational awareness. Second, it will also deliver the Athena that will provide a number of staff planning tools, although it falls short of automating the suite of

[30] Department of National Defence. 2003-04 Report on Plans & Priorities – Status Report on Key Capital Projects. Page 28?
[31] Department of National Defence. 2003-04 Report on Plans & Priorities – Status Report on Key Capital Projects. Page 4

tools required for the OPP, the second core requirement. The third core requirement is achieving interoperability with other joint and combined command and control systems. As the SAS and LFC2IS are not fully interoperable themselves, and while the TCCCS remains instable, the third requirement is far from being realized.

Within the Canadian Army in general, the equipment fielding activities do not receive significant operational oversight. Equipment fielding activities tend to be seen as service support programs that require minimal coordination. However, the Canadian Army's approach to fielding LFC2IS has been profoundly engaging. There is a strong recognition by the Army leadership that the LFC2IS is not a technical program but an operational program. The Army is committed to applying the PLOTED process to ensure that the enabling activities are in place. In particular, the Army has sponsored a series of formal experiments, commissioned new manuals to be written, and allocated new personnel to be recruited to fill the vacancies in the new command support organization. Overall, the Canadian Army deserves high credit in outlining the strategy, its commitment to pursue the strategy, and managing the implementation of the strategy.

While the Canadian Army is credited for its strategy and commitment to automated command support, there are certain gaps and shortfalls in its implementation. The critical shortfall is the technical deficiency in the TCCCS system to permit the full operation of Athena and SAS. The next critical shortfall is the non-homogeneity between Athena and SAS, which further contributes to the lack of seamless interoperability between them. The final shortfall is the lack of interoperability of LFC2IS in the joint and combined environment.

Problems with TCCCS

The TCCCS is to serve as the foundation for LFC2IS but it has failed in its field system qualification tests. While various segments of TCCCS are operational, the end-to-end transmission of message traffic and instability of the system as a whole remains problematic. Without a stable underlying communications network, LFC2IS is operable

in stand-alone mode for the most part. Clearly, this is unacceptable, as an enhanced command support capability requires the automated exchange of situational awareness data elements to provide a common operational picture across the organization.

The failure of TCCCS is clearly a technical problem to be addressed by the prime contractor awarded with the project. The DND project office supervising the work of the contractor must continue to apply leverage to ensure the TCCCS system is delivered fully operational as contracted. Accepting TCCCS while it is less than fully functioning system will transfer the problem to DND and the CF, inviting further complications to integrate LFC2IS and ISTAR in the future. Simply put, having paid $1.9B to develop the TCCCS, the contractor must solve this technical problem and deliver the goods.

Non-homogeneity of SAS and Athena

Essentially, the Canadian Army is a tactical level field force of three under-sized brigades groups. Despite the modest size of force focused at the tactical level of military operation, it is endowed with two sets of command support suites in SAS and Athena. There is a commonality of functions between Athena and SAS, yet they exist as non-homogenous systems, with two differing platforms, operating systems, and software applications. This places the additional burden of two streams of user training, maintenance, and system support. Given that the technology is converging towards one *de facto* standard in PCs, the same movement of convergence in SAS and Athena would be advantageous.

The convergence between SAS and Athena would eliminate the lack of seamless interoperability between them, albeit one of the restricting components is due to bandwidth limitation over the combat net radio domain. The lack of seamless interoperability has given rise to an unforeseen technical initiative to define the common data exchange protocol between the two systems. The convergence of SAS and Athena will result in an upgraded capability, which would take the best features of both systems in terms of functionality, information presentation, and user interface techniques.

Interoperability

Except for domestic operations, the Canadian Forces is likely to operate with forces of other nations in an alliance or coalition. Indeed, every military operation that Canadian Forces has undertaken abroad throughout its existence has been a part of coalition of allies or United Nations sanctioned missions. Interoperability is the ability between forces of different nations or armed services (navy, army, air force) to operate in a cohesive manner notwithstanding differences in tactics, doctrine, equipment, language, etc. Interoperability can be greatly facilitated by commonality of tactics, doctrine, equipment, language, and training. Given the prominence of *information operations* in modern military operations and the expectation of instantaneous communication, the requirement for *interoperability* has never been higher. In fact, the ability to achieve interoperability with our traditional allies has been enunciated as one of the strategic goals of Canadian Forces in the Strategy 2002.[32]

Interoperability is more than about technology; however, technology is a critical factor. In the context of automated command support, the ability to exchange and share information in a joint and/or combined operations in order to achieve common operating picture is crucial. Ideally, the Canadian Army should be equipped with a command support system that is interoperable with those of our traditional ABCA allies and NATO members. As demonstrated by the recent interoperability exercise, CID BOREALIS 2002, the reality is that the ABCA forces do not have interoperable capability beyond the single channel voice or single channel messaging exchange.[33] There is a potential for interconnection using the commercial TCP/IP protocol at the data and transport layer using the OSI model as a prelude to interoperability between the respective information systems providing the common operational picture.[34]

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[32] National Defence. Deputy Minister and Chief of Defence Staff. *Defence Strategy 2020. (*June 1999), p 6. Traditional allies are the armed forces of ABCA – US, UK and Australia

[33] Communication Interoperability Demonstration (CID) BOREALIS conducted by ABCA countries in Kingston, Ontario, in June 2002.

[34] TCP/IP is the *de facto* communications protocol due to the wide use of Internet. It fits within the transport and data link layer of the OSI model.

The strategy for enhanced command support must firmly place the requirement for interoperability at the outset and not as an afterthought. This is easier said than done, as there is no common standard for achieving interoperability for respective military command support systems.

Interoperability could be achieved through a number of techniques and approaches. The first obvious approach would be to adopt one homogenous system (common platform, common software suite) throughout the coalition. The difficulty of actually accomplishing this approach is that commonality is not limited to a single set of equipment but to the full range of communications and information system equipment. It would mean the abandonment of current fleet of equipment, which would be cost prohibitive. The second approach to interoperability would be to acquire one stand-alone system of the coalition force. Essentially, this would provide a remote access to the coalition system but it remains that the incumbent system is not interoperable with the coalition system. The third approach would be to adopt a common data exchange format to achieve compatibility within the coalition. A technical working group would have to define the protocol for the common data exchange structure and ensure a rigid implementation of the protocol. Indeed, the Canadian Army has initiated the formation of a technical working group as a step to facilitate the interoperability between the SAS and the Athena. The same endeavour could be directed to facilitate interoperability in joint and combined environments. While achieving interoperability will be major technical challenge, the difficulties are compounded by national agendas, as nations will want to promote their unique national systems given the considerable investment made in their own systems.

Summary of Ideal Strategy and Current CF Approach

The ideal strategy defines the desired goal, key objectives, and priorities and is implemented through leadership, resources, and operational oversight. The desired goal is to achieve enhanced command support by incorporating advanced information technologies. Given the limited resources, priority of effort must be directed to the core

requirements. The core requirements are those in direct support of the commander's decision-making process. The top three core requirements are automating Situational Awareness, provision of automated tools for the Operational Planning Process, and facilitating Interoperability in joint and combined operations.

The analysis of the current CF strategy and approach clearly demonstrates that the leadership is committed to the modernization of the forces and has allocated resources to initiate the implementation of LFC2IS. With the conviction that modernization is more than fielding of equipment, the Canadian Army has been engaged in a range of supporting activities to prepare for the LFC2IS fielding, including the development of new doctrine, the initiation of personnel training, and the conduct of series of formal experiments. The non-technical aspects of LFC2IS fielding have been well-coordinated and are being implemented successfully. The Army deserves credit for these successes.

LFC2IS will deliver two constituent systems in SAS and Athena. Both systems satisfy the first core requirement for enhanced command – Situational Awareness. Although both systems provide a limited staff support capability, the second core requirement for enhanced command is not being met – Operational Planning Process. Neither system provides interoperability capability for a joint/combined operational environment. More critically, TCCCS is failing to provide a reliable foundation for LFC2IS and thus has caused a delay in the fielding of LFC2IS.

To close the gap, the first priority is to ensure that TCCCS is operational. The second priority is to field the LFC2IS in its current form with the view to improving on the deficiencies. The third priority is to address the intra-operability requirements between SAS and Athena and, subsequently, focus on achieving interoperability requirements to operate in a joint/combined environment.

Practical Markers

An armed force of a medium power, such as the Canadian Forces, with a limited defence budget cannot acquire the ideal system. The practicable approach is to apply priority and pursue select objectives that deliver the critical core capability while maximizing the application of limited resources. It also entails observing and incorporating the best practices of allied forces and industry. This section examines various important *markers* that should be considered in implementing enhanced command support.

The Directorate of Land Strategic Concepts (DLSC) has outlined a number of key guidelines in pursuing modernization in general.[35] A first of the DLSC recommendation is the revamping of the usual "excessive bureaucratic" equipment procurement system that has been entrenched in the federal government, including DND, to one that is streamlined for procuring rapidly advancing technologies. The second key recommendation is the vigilance in the selection of technology based on factors of affordability, dual-use (military/civilian), accelerated prototyping, and strong, stable technological base. The third recommendation is the need to collaborate with industry, allies, government, academic and research institutes in a coordinated manner to capitalize on mutual synergy and minimize duplication of effort. While there are other recommendations, the most enduring recommendation is instilling the culture and attitude in the Army leadership that embraces innovation, technological competence, and promotion of training and education.

Rapid Cycle of Procurement

There must be a faster cycle of "concept-to-fielding" military procurement when incorporating technology.[36] Experience has shown that the risk with procuring

[35] Directorate Land Strategic Concepts. *Report Number 99-2. The Future Security Environment*. (Fort Frontenac, Kingston, Ontario. August 1999), p 31.
[36] Directorate Land Strategic Concepts. *Report Number 99-2. The Future Security Environment*. (Fort Frontenac, Kingston, Ontario. August 1999), p ix.

technology-oriented equipment has been rapid equipment obsolescence. The traditional manner of equipment acquisition in the Canadian Forces is one that begins with a definition of all-encompassing requirements and concludes with a massive total system design and build. By the end of the prolonged multi-year procurement process, the resultant product would be on the verge of obsolescence due to new emerging technologies. The experience of industry and defense has shown that the better approach to procurement involving information technology is one that is characterized by compact iterative cycles of modular definition of requirements and rapid prototyping.[37] Given that the highly progressive nature of computer technology, the modular approach makes it possible to readily adopt new emerging technologies from the commercial sector into the military product.

Economic Approach

The cost of military hardware has risen considerably over the past decades.[38] The dominant cost drivers are the sophistication of the technology, military environmental specifications and the lack of economy of scale. Military forces seek to employ leading edge technology that gives them superior advantage over their adversaries; consequently, the best of technology often comes at an exorbitant cost. As military equipment is used under severe physical conditions, they must withstand the exposures due to extreme weather, temperature, and physical rigor. Consequently, military equipment is often engineered and manufactured with the full application of *military environmental specifications,* which can raise the costs ten-fold. Finally, most military equipment is procured for specialized military applications and do not enjoy the cost savings of economy of scale relative to other equipment of non-military applications.

A practical strategy must consider ways of procuring equipment for command support that does not incur exorbitant cost that is prevalent with many of today's military

[37] Directorate Land Strategic Concepts. *Report Number 01/01 Future Army Capabilities*. (Fort Frontenac, Kingston, Ontario. January 2001), p 4.

hardware. As the types of equipment employed for command support are largely compact desktop computers, computer servers and network devices, they should be readily available as commercial-off-the-shelf and available at competitive prices. In general, the equipment for use in the tactical domain needs to withstand the hardships of field environment, however, most of command support systems in higher headquarters are employed in an benign environment and it is possible to get by without the full application of military environmental specifications. The strategy would be to use commercial-off-the-shelf (COTS) equipment and, thereby reduce the overall cost of acquiring the command support capability.

Need for technical exchange

No one has a monopoly on ideas. The Canadian Forces does not have the resources to apply *independent* research and development. There must be a concerted effort to learn from the experiences and experiments of our allies and industry. It is not simply a matter of economics, but a matter of simple fact that the best ideas will come from a result of collective effort. As well, independent effort will likely result in divergent products and processes, whereas cooperative effort will likely result in interoperable products and processes. In fact, the Athena originated with the French Army's *System de Commandement et Informatique* (SCIF) and SAS has been adopted from the program intended for the Australian Army.

As a member of ABCA and NATO, Canadian Forces has participated in various forums for technical standardization and exchange of emerging military concepts. For instance, the technical standardization has ensured a common standard in tactical radio systems and compatible messaging systems within the alliance. With the emergence of computers in the information age, there have been developments in technical standards to permit interoperability of military information systems. Notwithstanding the progress

[38] Cost of Sherman tank in 1945 funds was $45,000, which would be approximately $422,000 in today's funds and is still just 10% of the cost of Abram tank $4.3M. Source of information at www.web.inter.nl.net/users/spoelstra/g104/cost.htm and www.haidekker.org/mae152/final/m1abram

made in establishing the standards, very little has been implemented in real terms. Virtually all the national forces of the alliance have adopted their own unique tactical information systems with varying degree of success. Clearly, the US is far ahead in developing its tactical information systems with the Force XXI and the Canadian Forces engaged in the initial stages of LFC2IS fielding. It remains that the various national systems will be *stove-pipe* systems and information as fundamental as situational awareness cannot be exchanged within the alliance. Clearly, there needs to be reprioritization of effort to ensure that the alliance acquires tactical information systems and command support systems that are interoperable. The strength of an alliance is the cohesion in the collective effort even if the cost of individual member is the compromise of its unique requirements.

Given the tremendous effort made by the US armed forces in adopting information technology for their tactical information systems, there is much for the Canadian Forces to learn from their progress and lessons learned. Unfortunately, there is very little commonality between the CF and the US Army in their respective tactical communications and information systems. There is a token capability of information exchange by a dialing up to a common web-server to exchange HTML-enabled documents[39]. Clearly, given the strategic goal of interoperability enunciated by the CF's Chief of Defence Staff in Strategy 2002, the current state of incompatible communications with the ABCA and NATO forces is unacceptable and must be rectified. The strategy for enhanced command support for the Canadian Army must address the interoperability requirement for LFC2IS with its ABCA and NATO allies.

The US Army Force XXI

As the lone superpower in the world, the United States has unparalleled resources for maintaining its armed forces at the highest level of readiness and capability. Moreover, its armed forces maintain their technological edge through innovation and

[39] HTML stands for Hyper Text Marked-up Language, a common format used for publishing documents on the Internet.

modernization. The US Army embarked on capitalizing on the digital technology starting in the early 1990s. The focus of US Army digitization[40] effort is Force XXI established in the mid 1990s. This unique organization is a mechanized division-size force based in Fort Hood, Texas, that has been equipped with the latest digital technology to complement the normal armaments. As an experimental force, it is subjected to a series of exercises and wargames to determine the combat effects of digitization and to develop new techniques and concepts to capitalize on the technology.

The central component of Force XXI is Army Battle Command System (ABCS), which itself is a *system of systems*, encompassing various generalized and specialized combat functions such as manoeuver, all-source intelligence, artillery, air defence, combat service support, and command and control. These systems are fed data from satellites, aerial and ground reconnaissance, weapon systems, sensors, and soldiers. The ABCS is interconnected by Warfighter Information Network, consisting of both long-haul and combat net radios and providing tactical Internet.[41]

The extent of the aggressive push to adopt information technology by the US Army is exemplified in its implementation of *digitized warrior* concept right down to dismounted soldiers. Whereas the Canadian Army is challenged to develop a command support capability for a weapon system such as an infantry combat vehicle or armour tank, the US forces has begun to trial a prototype system for dismount soldiers.[42] A soldier would have miniaturized versions of state-of-the-art technology that are available in combat vehicles to give him graphic display of the battlefield, while connecting him to the tactical digital network.

The success of US Army's move towards digitization lies with the leadership's belief in technology. The US Army fosters a culture of commitment to maintain

[40] Digitization. "Is the generally used to describe the process in which all elements on the battlefield are bound together by an electronic web that permits the rapid transfer of data to commander …" Alister Irwin. B02 0 0 10.02 263.4885603/r96 T2 0 92 174.89561 120T999r.02 393.85361ah

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superiority over their adversaries in all aspects of warfare and readiness. They are committed to exploiting technology to equip their force and maintain technological superiority over their adversaries. This leadership translates to billions of dollars of budget for research and development and funds for new equipment acquisition. The US Army's pursuit of new technology is not driven by technology but driven by leadership. Technology is not the goal but a means to a goal.

Need for Selective R&D

While funding resources are limited, the Canadian Forces cannot afford to invest in a full and independent research and development program, it is advantageous to make selected strategic investment in research and *technological demonstrations*. Indeed, the Defence Research and Development Canada (DRDC) at Valcartier has embarked on several initiatives to develop prototypes for demonstrating innovative techniques in automated command support and ISTAR capabilities. The work of DRDC can serve a range of benefits. First, it can demonstrate the technical feasibility to implement an operational requirement. For example, a prototype of innovative information technologies has been demonstrated to military commanders that a high fidelity Common Operational Picture is technically feasible in modern command posts. Seeing a prototype can readily lead to affirmation of the concept and visualization of other possibilities. Second, a prototype can assist with the definition of operational requirements as a step towards a full-fledged development when the Army decides to procure formally from industry. Third, the prototype can give the assurance of lowered risk in a venture that has been proven technically feasible in defence research laboratory at a fraction of the cost of the eventual system to be developed by industry. Ultimately, demonstrations of technology serve as catalysts for a vision and future endeavours.

Leadership

A strategy begins and ends with command and leadership. It is fitting that as command is the most important activity in military operations, it is also the most

important step in developing a strategy for enhanced command support. Leaders should instill in an organization to transform and innovate. Military leadership in the information age begins with a positive attitude regarding technology. While it is not entirely factual to generalize, one can derive an interesting viewpoint from the following:

> Whereas in the navy and the air force, the sailor and the airmen man their equipment, the army equips the man.[43]

Military scholars have suggested that the senior leadership in the Army is less inclined than their counterparts to embrace technology.[44] The prevailing view in the Army is that technology is subordinate to human and technology must support human process and not the other way around. It has been suggested that the Army leadership is slow-paced to adopt technology over their service counterparts. The Army's delayed progress to adopt information technology may have been caused by senior officers, who have not gained technical training or experience in their formative years in the organization.[45] In fact, the Army's prevailing attitude in the past was to discourage training in technology for the combat arms officers and this attitude impeded professional progression to those officers attaining technical training.[46] With the growing use of information technology, the Canadian Army appears to have fostered a new generation of officers embracing technology. The renewed positive attitude for technology is reflected in the actions of the Chief of the Land Staff to include the Director of Research and Development as a member of the Army Council and to hold senior leadership focus sessions on emerging technologies.

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[43] Brigadier-General Matthew Macdonald, Director General Land Staff address to CFC in Gagetown September 2002
[44] Chief Land Doctrine and Operations. *Army ADP Strategy Framework*. 28 April 1988.
[45] Jacob Kipp and LCT Lester Grau, "The Fog and Friction of Technology." *Military Review (*Sep-Oct 2001), p 88
[46] Chief Land Doctrine and Operations. *Army ADP Strategy Framework*. 28 April 1988.

Appreciation of Potential Problems

Although the application of technology can bring about tremendous enhancements to command support, it is crucial to appreciate its limitations and potential unintended pitfalls. Technology is enabling a common operational picture to be acquired and readily accessible to all levels of command depending on the communications connectivity. The commanders higher up the hierarchy are supported by high capacity communication networks and therefore could acquire higher fidelity picture of the battlefield from an array of strategic sensors which are not available at the lower levels. In this age of information, given the acute scrutiny of military operations by the media and the public, there is a potential for overt centralization and micromanagement by higher commanders. This would violate one of the central tenets in Canadian Land Force doctrine, *mission-command*, which is entrusting lower level tactical commanders to take initiative and action whilst in keeping with the intent of the higher commanders. Mission command is a concept that has been thoroughly studied and validated as a key to success in modern warfare.[47] More than ever, the doctrine of mission-command must be reinforced and the infusion of technology must not displace the fundamentals of chain of command in military operations.

Another unintended pitfall of the application of technology is the over-reliance on technology that could lead to command indecision and paralysis. Technology will deliver high fidelity common operating pictures in so far as the sensors are capable of acquiring and the entire network is functioning. Technology cannot eliminate the *fog of war* and the enemy may disguise its intentions, therefore, it is unrealistic to expect an all-encompassing situational awareness. There may be a human tendency to delay decision-making to acquire that last minute piece of information, which is euphemistically called *paralysis by analysis*. The nature of command is a fine art and decision-making is a cognitive process which considers all the relevant factors in context. Clearly, there is a fine line as to what constitutes the last critical piece of information to sway the decision.

[47] Director of Army Training. *Canadian Land Forces Manual. Command. B-GL-000-003/FP-000.* (21 July 1996), p 20

The advantage in waiting for a critical piece of information must be weighed against the disadvantage in delayed action and delayed operational tempo.

As information technology is introduced to the Canadian Army, the advantages offered to enhance command support shall be exploited and the potential disadvantages must be guarded against. There must be a critical examination of the current military practices and doctrine due to technology. The effects of technology should be trialled extensively through experiments, exercises, and research. One of the fundamental tenets must be that technology supports the human in command and does not supplant the human dimension in command.

Summary of the Markers

Given the fiscal reality of defence budget and conflicting requirements, the strategy must consider practical approaches to maximize the effort of incorporating technology to enhance command support. There are *markers* that should serve as practical benchmarks and reference points in pursuing the strategy. The use of COTS equipment is one proven way of reducing the cost of equipment and a departure from the traditional procurement of mil-spec equipment without an apparent loss in functionality. The procurement process for adopting new technology must be revamped from the traditional practice. Instead, the new procurement is one predicated on a rapid cycle of modular development and prototyping.

The incorporation of information technology to support command is not limited to the Canadian Forces. Similar endeavours are being made in other armed forces, and in particular, in the US armed forces. It would be both practical and economical to learn from the experiences and lessons of our allies. There should be an active technical exchange program and selective investment in research and technology demonstration projects.

Lastly, the successful achievement of any technical initiative is made possible with the will of human leadership and overcoming the limitation of technology. While the Canadian Army has stressed the notion of operational competence in its personnel, it must also promote one of technological awareness and innovative. These notions must be reinforced throughout.

Conclusion

Command is the most important activity in military affairs. With the emergence of information technology, there is an opportunity to apply technology to the most important military function. However, the infusion of technology does not necessarily ensure success but it is achieved by sound strategy and non-technical supporting activities.

The first step to deriving a strategy requires an understanding the essence of command and the nature of information. Information is an ingredient for the commander's decision-making. Decision-making is a cognitive process that is initiated by data being processed and organized as information, leading to the attainment of knowledge and, ultimately, of understanding.

Technology is adept at acquiring, storing, and transmitting data and then processing and organizing data as information. Technology and automation should be applied so as to liberate commanders and their staff from mundane processes and to allow human analysis, intuition and experience to be applied to the operational art.

The basis of tactical military planning is situational awareness, which is the knowledge of the state of friendly forces, the enemy, and the environment. Technology can readily automate the process of delivering situational awareness as a common operational picture throughout the tactical organization. Having a common operational picture facilitates the commanders in acquiring battlefield visualization which is a prelude to effective operational planning.

The Operational Planning Process is a technique used by military staffs to support the commander in designing the military campaign. The OPP itself is an established process with standardized inputs and products, which can readily adopt technology to automate many of the mechanical and clerical procedures.

The strategy for enhanced command support begins by defining the priority objectives. The focus of technology and automation should be on acquiring situational awareness and delivering a common operational picture. The next effort should be directed at providing automated tools for the Operational Planning Process. The third priority objective is achieving interoperability with tactical information systems of coalition allied forces.

The ideal strategy on paper needs to be assessed with the reality. The Canadian Forces has embarked on fielding the Land Force Command and Control Information System (LFC2IS). The LFC2IS has constituent components in the Situational Awareness System (SAS) and the Land Force Command System (LFCS), which delivers the first of the priority requirements and provides some staff tools but falls short of automating the Operational Planning Process. Achieving interoperability will be a significant challenge. The first hurdle is achieving seamless interoperability between the SAS and the Athena as the computing platforms run on different software operating systems and transmission bandwidth is limited on the combat radio net domain.

In fielding the LFC2IS, the Canadian Army recognizes that the endeavour is more than technology. For the technology to be capitalized upon, an array of enabling activities is required. The tactics and doctrine must be updated and new training needs to be introduced. The LFC2IS will have an impact on the current functions of personnel and the organization will have to evolve.

Given the constrained resources, the strategy to achieve enhanced command support must be practical and opportunistic. There should be a concerted effort to adopt the lessons learned and best practices of the industry, academic and research institutes, and other armies as they precede the efforts of Canadian Forces. The past has amply demonstrated that Canadian Forces will be engaged in coalition operations. The future points to the prominence of information operations and the requirement for unencumbered interoperability within the coalition forces.

As command is the most important activity in military operations, it is also the most important force in leading change and adopting innovation. Leadership is required in overcoming the cultural obstacles and redefining new vision, particularly in times of constrained budget and limited resources. Indeed, the leadership at the highest level in the Canadian Army has staked its commitment for command-centric, knowledge-based Army of Tomorrow. Much work awaits but opportunities are also abound.

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