Command and Control Systems: A Challenge to the Leadership.

<u>INTRODUCTION</u>

As noted by van Creveld, the problem of commanding and controlling armed forces is as old as war itself. Its dimensions however, have grown exponentially since 1939.[1] More recently, with the passing of the Cold War, Canada has left behind forty years of relative certitude and has entered an age of reduced global danger. At the same time, however, Canada has entered a world of heightened regional conflicts and increased incertitude, disorder and confusion.[2] During this period, the factors that have impacted on the growth in complexity of Command and Control (C^2) include the technological development of weapons, communications, and data processing, as well as the support that is provided to commanders. Armed forces have also become more complex than in the past due to greater mobility and a variety of specialised organisations involved in operations.[3] This was partly evident in the Gulf War where the automation of the information management functions and of the support element to the decision-making process was of prime importance. Clearly, the need for an effective C^2 system remains a vital component of successful military forces. In this post-Cold War era, the future need for an effective C^2 system is more important than ever. Moreover, it is seen as a key element in the future to waging war or maintaining peace.

This paper will demonstrate that Canada must develop a strategy for the acquisition of an effective C^2 system that will enable the Canadian Forces (CF) to operate in a joint and/or combined manner. In addition the paper will highlight the critical elements that an effective C^2 system must have to be capable of fulfilling CF requirements. Since C^2 is such a broad topic, this paper will focus on the conceptual aspect of C^2 systems and it will begin with a review of the definition and nature of C^2 and will also examine the functions of C^2 systems.

This will be followed by a brief overview of the technical evolutions that have influenced C^2 systems. Some thoughts on present and possible future technology and on the challenges we are facing will then reinforce the conclusion that the CF has a critical need for C^2 systems that are efficient and reliable. To begin, we must first establish the definition of a number of key elements.

Definition and Nature of Command

In the military sense, command is the exercise of authority and direction by a commander over assigned forces in the accomplishment of a given mission.[4] It is the legal authority to give orders and to enforce compliance. It is also, of course, a human activity that is fashioned by creative imagination and also beset with the frailties of human nature.[5] This simple interpretation of command encapsulates the most widely agreed definitions. In fact, command is simple to understand even if it has not always been exercised adequately and with clarity. In this respect, the *Canadian Forces Operations* manual defines command as "the authority vested in an individual of the armed forces for the direction, coordination, and control of military forces."[6]

Command is the most important function in the spectrum of conflict, from peace through war. It is a function that has to be exercised more or less continuously.[7] Command activities encompass planning, directing, co-ordinating, and the controlling military forces. In peace, command co-ordinates all the functions that are necessary to produce ready forces. In war, it integrates all the combat "output-related" functions to reach the mission.[8] Due to its varied functions, both in peace and in war, command embraces both management and leadership and it is supported by, and exercised through, an arrangement of personnel, equipment, facilities and procedures.[9] Command is also a human activity. It has feeling and sensing. Even though technology, directives, procedures and organisation support command, only the commander has the ability to integrate them and use them to form and support his decisions.

Definition and Nature of Control

Control, on the other hand, is considered as an aspect of command, and it is not synonymous with command. As defined by Pigeau and McCann in their work "*Putting 'Command' back into Command: The Human Perspective*:" control is a set of pre-defined processes operating within a pre-defined structure whose purpose is to efficiently accomplish goals.[10] NATO defines control as "the process through which a commander, assisted by his staff, organises, directs and co-ordinates the activities of the forces allocated to him."[11] While these two definitions focus on a process, the Canadian definition of control confirms the element of authority that the commander has in the delegation of control. Control is "that authority exercised by a commander over part of the activities of subordinate organisations, or other organisations not normally under his command, which encompasses the responsibility for implementing orders or directions. All or part of this authority may be transferred or delegated."[12] The general consensus definition of control is that it is seen as the means by which the commander exercises his authority through a process in order to implement his decisions.[13] Control is achieved by a military organisation itself, through doctrine and standing operating procedures, and through software and equipment.[14]

As can be seen, the raison d'être of control is to support command. While control can be delegated, the responsibilities of command always rest with the commander. The delegation of control is viewed as an attempt to reduce uncertainty and increase response time by constraining or by subdividing a problem while imposing relative order.[15] For example, at the unit level, a commanding officer may delegate control of his ship's movements to his navigator for training purposes or to simplify anti-collision procedures.[16] Or he could give control of specific weapon systems for self-defence to one of his officers, usually his executive officer, when he feels that the passing of control would enhance readiness. When control is delegated, however, it is always given with constraints. Obviously with today's technologies, that "leash" can be shortened to the point where it negates the desired effect that delegation of control was to achieve. Therein lies the danger of centralising the exercise of command by micro-managing control.

Definition and Functions of Command and Control Systems

C^2 can be defined as the process of gathering information, assessing situations, identifying objectives, developing alternative courses of action, deciding on a course of action, transmitting orders, and then monitoring execution.[17] It is more than just the abbreviation of C^4I or C^3 or C whatever. C^2 involves the complex collection and coordination of functions and systems upon which a commander draws to make decisions and to monitor their execution. As Coakley summarises, C^2 is everything a commander uses in making decisions and ascertaining they are carried out.[18] "It includes the authority accrued from his… appointment to a position and involves personnel, information, procedures, equipment, and his own mind. The C^2 process is a series of functions, including gathering information, making decisions, and monitoring results."[19] The C^2 system, called Command, Control and Information System (C^2IS) in Canadian doctrine, is defined as "an integrated system comprised of doctrines, procedures, organisational structure, personnel, equipment, facilities and communications which provide authorities at all levels with timely and adequate data to plan, direct, and control their activities."[20] Albeit more detailed, this interpretation is compatible with Coakley's definition of "a collection of personnel, procedures, and equipment that support a C^2 process."[21]

Van Creveld has simplified the terminology of C^2 systems by using the term "command systems," representing the means by which command and control is exercised. In choosing to classify the characteristics of command systems into organisations, procedures, and technical means, van Creveld has prioritised them in what he believes to be the right order.[22] In his view, C^2 systems are the means to gather information, conduct analysis, process and display the findings, make recommendations and propose solutions and finally monitor orders and the execution of the mission.

The main function of C^2 systems is to ease the burden on operational and tactical commanders in accomplishing the repetitive and often onerous tasks they encounter and to allow them the luxury of time to think, plan and *command*. The growing complexity and the sustained rhythm of today's operations are bringing increased importance to information processing and exchange in order to reduce the reaction time required to deal with dynamic events. The need and the constraint to see farther, sooner, and to react more rapidly in order to put in motion the required means of force, are a fact recognised and demanded by armies, navies, and air forces at all levels; strategic, operational, and tactical. Therefore C^2 systems must be engineered to fulfil this requirement.

To be effective, a C^2 system should marshal and co-ordinate available resources in a systematic and ordered manner. It must have the required checks and balances to accomplish the mission efficiently and with as little uncertainty as possible. It must also accomplish its goal faster than the enemy, in order to force him into a responsive and reactive posture and so control his actions.[23] Four major functions can be attributed to C^2 systems. The first is a*id in acquiring knowledge*: where the system can process, correlate and transmit information, reduce or eliminate redundancies, and incorporate and analyse historical data to reconstitute events. The second is a*id in the presentation of previous actions*: here the system should recall doctrines, analyse situations and geographic, political and meteorological environment. The third function is a*id at drafting and disseminating orders and feed back.* Finally, the fourth function is a*id in decision-making*: where the system handles evaluation, choosing of propositions and prioritisation of possible solutions.

For C^2 systems to support command adequately they must also have relevance and applicability across the strategic, operational, and tactical levels, as well as across the multiservice, multinational, and civil-military domain, and also across the spectrum of conflict.[24] As a function of their strategic and tactical finality, C^2 systems need to be divided into three categories: strategic, operational, and tactical. The *strategic system* must be adapted to deal with conflict and crisis, and, above all, provide timely information to the strategic level commander for the direction of military forces, advice to the political authorities, and coordination at the national level. It needs to be able to discern an unstable situation or a potential crisis and conduct an appreciation of the situation based on a thorough analysis of the information. This activity should be followed by proposed measures and options presented to the political authority. The technical portion of the *strategic system* does not necessarily need to be completely built to military specification, for commercial off the self-equipment could suffice. In the field, the *tactical system* must function in real-time in order to link various weapon systems and provide the tactical commander the means to direct the use of military force in battles and engagements. Because of the environment in which this system will be operating, it will necessarily be complex, and must be built to military specifications. At the operational level, the system will span the various elements of the forces employed to attain strategic objectives through the design, organisation, and conduct of campaigns and operations. The *operational system* will be the link between the tactical and the strategic level systems. This system will also be complex and will require robustness, and therefore, some or all of the system may need to be built to military specifications.

Technical Evolution and Application

The first electronic means to support C^2 was the telegraph, developed in the 1840's. It was utilised in the Austria-Prussian and the United States Civil Wars. As compared with runners, drums and smoke signals, the telegraph presented armies with a new and an effective means for transmitting information.[25] Both the Allies and the Germans used the telegraph during World War I as this new technology brought commanders a considerable capability to inform, to be informed, and to transmit orders. The telegraph allowed for the mobilisation of large armies in a relatively short period of time and their subsequent deployment across a much larger front than had been previously possible. In battle, however, the telegraph was still a slow system and one that could not keep up with advances on the ground. It was also vulnerable to enemy action, its capacity to handle large amounts of information was limited, and coding procedures were slow and elaborate.[26] As a result, the telegraph had to be supplemented by written messages travelling by rail or by mounted orderlies.[27] On the other hand, the development of telephone and radiotelephony are among the mediums that considerably improved the functioning of C^2 systems, and can therefore be considered as the pioneers of the electronic revolution.

In its early days, however, the telephone did not provide more flexibility than the telegraph. It transmitted information faster, but it was also difficult to re-deploy because of the need for land transmission lines, and like the telegraph, it was prone to enemy destruction. The application of this new technology, for example, proved catastrophic for the British Army at the Battle of the Somme. At the Somme, Haig tried to achieve the precision he had enjoyed during the training, assembly and deployment phases. By using the same centralised command system approach, he was hoping to abolish the uncertainty and the fog of war from the battlefield through centralised command and control.[28] This doctrine, however, affected his tactical commanders in their ability to co-ordinate with each other and to use their initiative, since they were ordered to remain by the telephone awaiting orders, which prevented them from advancing with the troops, getting the feel of battle, and to command.[29] The Germans, however, had learned, recognised the limitations of the telephone, and made provisions in their doctrine that allowed for independent thinking and initiative in battles, executed trough a process of decentralised control.[30]

On the other hand, the bulky and non-transportable radio system that could only be employed at army headquarters and above during World War I, appeared in a portable format on the battlefield of World War II.[31] These radios provided for the rapid deployment and flexibility of communication. It also permitted armies to mass and manoeuvre more expeditiously, thus defeating forces that were superior in numbers. The development of the radio, in Germany, provided the German Army with the means of command and control at the operational and tactical levels. The Allies meanwhile, failed to recognise this new capability early and would suffer because of it.[32]

Post 1945, the technological advances in communications and the advent of computer-based information systems provided new abilities and a tremendous increase of information transfer capacity. In Vietnam, C^2 systems used by the United States forces were the most sophisticated available, but they also paralysed their effort. As the British had during the Great War, the Americans applied this new ability to command and control in a centralised manner (and from Washington) resulting in delays and frustration in the decision making process.[33] This was a lesson learned that would not be repeated during the Gulf War. In fact, during the Gulf War, the strategic leadership of the United States were satisfied to set overall objectives and guidelines, thus allowing the in-theatre commander, General Schwarzkopf, to develop and execute his plans.[34] It has been said that the same freedom was not existent at the tactical level.[35] It could be argued, however, that the tactical centralisation had been made possible because of the advantage in C^2 capability enjoyed by the United States over Iraq. It is also argued that a more sophisticated and more capable enemy may have created havoc in this centralised method of control. It is suggested, however, that the technology to centralise some areas of warfare is now available and does work relatively well. For example, how else could a commander run an air campaign, with the aim of destroying specific targets and at the same time minimise collateral damage, without tight control over assets, time, and space.

In the 1970's, President Carter realised that existing C^2 facilities for responding to a nuclear attack were not adequate and were severely limiting his options to retaliate. In a series of directives, he called for measures to strengthen the United States strategic C^2.[36] These initiatives, coupled with the growing enthusiasm for theories about executing C^2 faster in order to get inside the enemy's decision cycle, led to an unprecedented interest in C^2 at all levels and it became the fastest growing part of the United States defence budget throughout the following decades.[37] With the outbreak of the Gulf War in 1991, C^2 systems received much attention and it became a hot topic of discussion in the media, especially CNN. [38] However, the issue is not new. For example, throughout the 1970's and 80's and continuing to date, the United States has paid much attention to this fundamental aspect of the art of war.

Canada has benefited moderately from these initiatives and from the resulting explosion of technology since the 1970's. The CF has been suffering for many decades from a lack of capable operational level C^2 systems and in some instances a lack of performing tactical C^2 systems. In some areas, however, Canada has paid more attention to C^2 systems and has done relatively well. Since 1971, the Navy has developed an excellent tactical and operational level C^2 systems capability. Meanwhile, in terms of C^2, the Air Force has benefited from the NORAD agreement. These two services, by the nature of their operations and the fact that they have often operated together, are very well integrated at the tactical level, sharing commonality in communications and automated data transfer. The Canadian Navy is integrated with the NORAD defence programme and exercises are conducted regularly to consolidate this capability. Unfortunately, these two services lack inter-service integration at the operational level. In fact they are better integrated at this level with their United States counterparts than they are with each other. The Army, on the other hand, is not integrated with either service. At the joint operational level, the JFHQ has yet to field a C^2 system capable of efficiently supporting Canada's joint and combined operations. Meanwhile, in the United States, the pace has not slowed down, and consequently their advances and applications of technology have created a challenge for Canada to maintain interoperability with its main ally.

"Navy Satellite Rockets Into Orbit:" this was the headline of an article announcing the launch of the United States Navy's ninth, of a programme of ten, advanced ultra-high frequency, high-speed communications satellite designed to broadcast information to ships, submarines, aircraft and ground troops.[39] Since the invention of the telegraph, technology has undergone incredible development. Technological improvements in weapons systems range, speed and lethality and also the explosion of space development and the availability of information resulting from it, has and continues to compress time and space. It dictates an increased importance on technology to aid and complement command and to support C^2 systems.[40] The speed and capacity of communications and computer systems in this decade are close to providing "real time" capability in C^2. In fact, in some areas, it has arrived. Data link transfer systems such as LINK 4 and LINK 11 are examples of field real-time systems.[41]

In the 1970's and 1980's, the engineering of C^2 systems took at least ten years. Even then, these systems were frequently incomplete and required more development work once delivered. For example, originated in 1978, the IRIS radio system, designed to provide the Canadian Army with an integrated battlefield and operational level communication capability, is not yet operationally deployed, twenty years later.[42] It must be pointed out, however, that not only technical difficulties are accountable for the delays, for budgetary priorities are also responsible for long development periods. Today, a first version of a system, which includes both hardware and software components, is often available in two to five years and often immediately upon its implementation, improvements are made to the software, firmware, or even the hardware itself. For example, the processors supporting the IROQUOIS class

Combat and Control System (CCS 280) were replaced with fewer, less expensive, more reliable, more powerful and faster ones only six months after the systems became operational. The operational software for both the CCS 280 and the CCS 330 for the Canadian Patrol Frigate undergoes constant evolution and improvement at a rate of two revisions per year.

This dynamic evolution is crucial to stay current not only with the benefits of technological changes, but also with the changes in tactics. This approach also allows for the commissioning of equipment and or systems that may not be fully developed, though mature enough to fulfil most of the stated requirements, thus providing an immediate capability instead of waiting for delivery months or years down the road. The reduced development and production timeline is also made possible by relying more on "off the shelf technology", by providing a better definition of the requirement, and through the availability of a more adaptable technology. In the medium term, however, it is always a challenge to predict the effect of new technology, especially with regard to microprocessors and the miniaturisation of equipment.

These technological advancements may soon be revolutionised with the possible breakthrough in "laser chip" technology. Work on this new type of light-driven computer chip is now advancing at the Nova Scotia Technical Institute and could reform miniaturisation and computer processing power. For example, with a device the size of a wrist watch you will be able to communicate by voice and exchange data using a satellite, consistently know your position via the Global Positioning System (GPS), or watch your favourite television programme.[43] The "speed of light" processing power capability will be phenomenal. It may permit more and more commonality of complex systems and be able to provide for each service's needs with common hardware and at the same time be able to interact and interface up and down and across the chain of command and across Forces boundaries. Artificial intelligence, the dream of the future, may then be possible and provide systems that are really capable of aiding the commander's decision making process; commanders may then be able to process knowledge as well as information. Will it propel us towards the next step of confrontation between machines? Future wars or aspects of future wars where humans have to deploy may be coming to an end.

The United Kingdom, incidentally, is studying options for its "Future Offensive Air System" (FOAS) for circa 2020. This is a system or combination of systems to provide air interdiction, offensive counter air, offensive air support, anti-surface warfare against ships as well as suppression of enemy air defences and tactical reconnaissance roles. The United Kingdom will be studying various platform options such as unmanned aircraft.[44] In the final analysis, technology has supported command for many years albeit with varying success. In the future, if C^2 systems continue to benefit from technological evolutions, will commanders remember the past and employ these systems paying due regard to their limitations?

Challenges

Because of the expansion in operational flexibility and capability, the challenge to build C^2 systems has become more difficult.[45] Technology itself may have created a leadership nightmare. Over the past twenty years the Canadian Army, Navy and Air Force have acquired or are in the process of acquiring C^2 equipment. While the capabilities are in part fulfilling NATO or bilateral needs, they also answer a unique service demand. There is some connectivity in Canadian C^2 systems, but it is mostly at the tactical level and between the Navy and Air Force. Radios are in most cases compatible, providing for data link exchange capability and secure communications. However, as mentioned earlier, the Canadian Army has limited connectivity with the other two services. It is not proposed that this reality is a result of inter-service rivalry. Rather, it has more to do with different needs and a lack of joint C^2 systems acquisition management. It is also the result of the different nature of ground, air and sea warfare and a lack of a joint C^2 systems acquisition strategy.

The development of C^2 systems has become more complex in today's dynamic technological environment and given the current climate of financial restraint, such development needs to be coordinated. A "joint" project office is required to balance and evaluate the needs of each service and rationalise the acquisition of an operational level C^2 system. Such a project would prove valuable in assuring commonality, interoperability and jointness. Canada has made some progress with the creation of DISO in National Defence Headquarters, but has not gone far enough. We need a published doctrine, a clear vision and a firm mandate. The award of a contract, in October 98, to acquire a common and classified electronic mail and message handling system for the CF is a step in the right direction.[46] However, the project does not include the Canadian Reserve Forces. In the meantime, the CF will continue to struggle with different versions of word processing programmes. Such failures as the Reserve Force pay system or the difficulties with PEOPLESOFT, the CF's new human resource information system, reinforce the need for better management in the acquisition of C^2 systems.

In discussing the issue of capability and commonality of C^2 systems with the Maritime Component Commander of Operation ASSISTANCE, the Winnipeg flood relief operation of 1997 and of the APEC Summit in Vancouver, it became evident that there is a need to develop systems that are capable and interoperable.[47] As examples, the Army and Navy use different radio frequency bandwidths and the mapping coordinate system is different.[48] This inability to integrate is even more pronounced when operating with other government departments.

The first challenge then, is to define what type of C^2 system must be acquired by the CF: a family of systems as described earlier, or a global system that would embed the needs of the three services as well as the operational and strategic levels. Such a system is likely to be extremely complex, very costly and difficult to engineer with existing and projected near term technology. Probably an array of tactical systems interfaced with an operational system that would link the services at the operational level and provide the connectivity with the strategic level is the most realistic solution to ensure jointness, effectiveness and economy of effort.

A second challenge is to find the right balance in system design. This balance is very important in designing C^2 systems. It ranges from the introduction of new technologies, to reorganisation, to changing the balance between collection and analysis of information, balancing systems design and evolutionary technology, planning and flexibility. It must be kept in mind that every time a choice is made, an adjustment occurs and it will affect the other activities or entities within C^2.[49]

A number of constraints also challenge the development of effective C^2 systems and leading the pack is interoperability. If the CF intends to operate a joint force of two or more elements, it must develop not only the C^2 organisation but also the much needed integrated and/or interfaced equipment and systems. Furthermore, to continue to provide elements to a larger organisation, under the United Nations or a coalition led by another country, the CF must take into account the C^2 system development and capabilities of its allies. Interoperability rests on the definition of the uniqueness of the information that needs to be exchanged and shared by a great number of users and it must also be detailed and precise to alleviate all ambiguity. The trade-off between integration and interrelation must be addressed and must be based on interoperability requirements. The right balance of interoperability must be defined.

The financial dimension must also be kept in mind when developing C^2 systems. The type of system, the balance, and the interoperability will have an impact on the cost. It requires a prudent and lucid approach. Realism must also be a dominant factor when stating our requirements and evaluating options so that the programme will not succumb to the very attractive proposition of spinning gadgetry and futuristic technology that could result in a costly failure and/or a tool rendered obsolete by the time it is fielded. Requirements should be limited to those clearly deemed essential and technical risks reduced to an acceptable level. To address this difficulty, an interesting concept was espoused in the United States Navy in the early 1990's.

During the conception phase of the JMICS, the United States Navy realised that the software package was so large and complex that existing processors would not be able to handle it.[50] Their technical risk assessment of future computer capability was that, by the time the software package would be written, the hardware to support it could be available. So the United States Navy proceeded with the writing of the software using a modular approach to minimise the risks. In doing so, some of the modules had an immediate application in existing systems. Eighteen months later, the processor and the software modules were married and the system was made operational.[51] This modular approach allowed the Americans to field JMCIS much sooner then they would have otherwise been able. This technical design feature also permits commanders to immediately use some modules, while allowing for realistic technical application in the short term and a prioritisation of the longer-term technical development.

Because C^2 systems are complex and costly, it is clearly evident that Canada must address those challenges and adopt an approach that will ensure that future systems will fulfil the CF needs.

CONCLUSION

Is Van Creveld's conclusion, that today's C^2 systems have not demonstrated a marked improvement in their ability to approach certainty, still valid?[52] It is true that technology, with its ability to transmit and process information faster than ever before can contribute to the challenge of exercising effective command and control. Information overload, the illusion that certainty and precision is attained, and the temptation to centralise the execution of command at the operational and tactical levels, are errors that have occurred too often in the past and are elements which must be balanced in the future.[53] However, the complexity of today's forces and the widening of the battlefield (bringing with it an increased number of situations and possibilities in the management of peace, crisis and war) calls for an increased capability and flexibility that only good C^2 systems can provide. As well, the necessity to rapidly digest the volume of information from varied sources implies the capability to have systems not only responding to a hierarchical structure but also to all interested parties. It is argued that while complete certainty will never be achieved, today's technology closes the gap at a pace never before seen. The battlefield will soon be visible to everyone, including the public. This will result in added pressure for success, both at the strategic and operational levels.

Therefore, the importance of strategic, operational and tactical goals and the consequences of the decisions taken, reinforce the need for C^2 systems that are extremely efficient. However, these systems must be conceived with realism and a realisation of their limitations. This pragmatic approach must, however, be compatible with the need to field capable systems as early as possible, while taking into account the technological evolutions. In the end, the challenges to be faced in the future will demand nothing less.

Much has changed about war, but the commander who performs the decision and execution cycle faster and better will have a decisive advantage.[54] It is important not to loose sight of the primary objective of the C^2 system, which is to lessen the commander's repetitive and onerous tasks, so that he can command more effectively. Command and Control are the most important functions of a military commander, and must be given the attention they deserve. Canadian military professionals desperately need to better prioritise and manage this sphere if they hope to be able to fully integrate their future operations in a joint or combined fashion and be capable of contributing more fully to world security.

NOTES

[1] Martin, van Creveld, Command in War (Cambridge: Harvard University Press, 1985) 1.

[2] Thomas P. Coakley, Command and Control for War and Peace (National Defence University Press: Washington D.C., 1992) xi.

[3] van Creveld 2. Also Canada, B-GL-300-003/FP-00 Command, "The Nature of Command," The AMSC Admiral/Generalship Programme Anthology, Aug., 1998., 55.

[4] Joint Chiefs of Staff, Department of Defence Dictionary of Military and Associated Terms (Washington, DC: GPO, June 1987, Cited in Coakley 17.

[5] Douglas L. Bland, National Defence Headquarters: Center for Decision. 1997, 1,12.

[6] Canada, B-GG-005-004/AF 000 Canadian Forces Operations (Ottawa: Minister of Public Works and Government Services Canada) 1997. Chap. 2.

[7] van Creveld 5.

[8] van Creveld 5.

[9] Canada, B-GL-300-000/FP-000 Conduct of Land Operation - Operational Level Doctrine for the Canadian Army (Ottawa: Minister of Public Works and Government Services Canada) 1996. 2-1.

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[17] Martha, E. Maurer, Coalition Command and Control (National Defence University, Fort McNair, Washington, DC 1996) 16.

[18] Coakley 53.

[19] Coakley 53.

[20] Canadian Forces Operations Chap. 2.

[21] Coakley 53.

[22] van Creveld 10

[23] Pigeau and McCann 97.

[24] Maurer 24.

[25] van Creveld 104.

[26] van Creveld 104-108, 146, 154.

[27] van Creveld 146.

[28] van Creveld 154-160.

[29] van Creveld 160-168.

[30] van Creveld 183-184.

[31] van Creveld 107.

[32] Beare 14.

[33] Beare 17-18.

[34] Beare 20.

[35] R. Leonard, The Art of Maneuver (Novato: Presidio Press, 1991) 284-286.

[36] Coakley 58.

[37] Coakley 59.

[38] Coakley 4.

[39] "Navy Satellite Rocket Into Orbit," Washington Post 20 Oct. 1998.

[40] "The Nature of Command," 56.

[41] LINK 4 and 11 are the secured means of transferring tactical data in a digitised manner between ships, aircraft's, submarines, and shore authorities. It provides the means to display and share the Maritime Recognised Picture (below, on, and above the water) in real time. It is also capable to transmit and receive engagement orders and weapons status sitreps. It widely used by NATO maritime and air forces.

[42] "Iris radio system" Jane's C4I Systems Tenth Edition, 1998-99, 161-162.

[43] "News Paper Article," Halifax Chronicle Herald, 1997.

[44] "The UK's Future Offensive Air System" Defence Systems Daily 15 October 1998.

[45] Maurer 42.

[46] "National Defence awards e-mail contract to SHL Systemhouse" The Press Room, 6 October 1998.

[47] Capt(N) J.Y. Forcier, MCC for Winnipeg Flood Operation and APEC Summit, personal discussions, various times.

[48] Canada, Lessons Learned Op ASSISTANCE. Annex A Detailed Report, (Information Warehouse (LLIW/DDLR) CD-ROM Version 5.0, Nov. 1997.

[49] Coakley 141-150.

[50] The United States Navy Joint Maritime Information Communication System (JMICS) is an operational system that ties the shore authorities with the tactical maritime assets (ships, aircraft, submarines). The Canadian Navy also employs it.

[51] Briefing. JMICS Project Office, Dam Neck, Virginia, U.S.A. 1992.

[52] van Creveld 266.

[53] "The Nature of Command" 56.

[54] Maurer 25.

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