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AMSC 1

Research Essay

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A CASE FOR A BALANCED APPROACH TO FUTURE OPERATIONAL-LEVEL COMMAND AND CONTROL SYSTEMS: WHEN A BUTTERFLY FLAPS ITS WINGS OVER THE BATTLEFIELD…

Colonel M.J. Dumais

AMSC 1 / Canadian Forces College

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FUTURE OPERATIONAL-LEVEL COMMAND AND CONTROL SYSTEMS: WHEN A BUTTERFLY FLAPS ITS WINGS OVER THE BATTLEFIELD…

It is 1960. The Ballistic Missile Early Warning System (BMEWS) has recently been installed. Suddenly, the computers sound the alarm, warning of a massive number of ICBMs inbound to the United States. In the excitement, one of the officers in the NORAD complex remembers that Premier Khrushchev was at that time visiting New York. The assessment is made that the Soviets would not launch a massive strike with their Premier located at the missile's destination.

Later it is determined that the new radars were so effective they could detect radar returns from the moon. The programmers had not anticipated this possibility in designing the system software.[1]

At 10:47, 3 July 1988, the Iranian Airbus A-300 departs Bandar Abbas airport on its short flight to Dubai. Flight 655 has 290 civilian passengers and crew aboard this routine, scheduled flight.

Aboard USS Vincennes, things are far from routine. Less than ten minutes prior, the Aegis cruiser had engaged and sunk two Iranian gunboats which had shot at their helicopter. Now, the Aegis system has picked up an inbound unknown target originating from Iran, squacking a mode two code typically associated with Iranian F-14 aircraft. The aircraft does not respond to seven radio transmissions from Vincennes. With the target bearing in at 450 knots, Captain Will Rogers has only seconds to decide. He orders the crew to fire upon the target.

At 10:55, two SM-2 standard missiles hit Flight 655. All 290 souls perish.[2]

INTRODUCTION

The first incident described above was the result of a technological glitch, which could have had indescribable consequences were it not for correct intervention at the man-machine interface. The second tragedy describes the result of the breakdown in the man-machine interface. The Aegis system was at that time the world's most advanced radar detection and tracking system. Designed to manage the entire engagement process

[1] Thomas P. Coakley, Command and Control for War and Peace, (Washington: National Defence UP, 1992) 83.
[2] "A300 Downing Clouds Aegis Capabilities," *Aviation Week and Space Technology* 11 Jul. 1988: 16-17.

except for one final step, it required human input only to determine if a target was hostile or friendly. In this case, the airliner was transmitting two codes. One was the standard mode used by all civilian and military aircraft. The other was a mode normally reserved for military aircraft. Iran had possibly installed this mode on civilian airliners due to its war with Iraq. The aircraft, although headed in the direction of the Vincennes, was climbing throughout the incident. Although Iranian F-14s could be armed with Harpoon anti-shipping missiles, the Vincennes sensors never detected a radar lock-on from such a weapon. The decision to fire was apparently based on the military mode transmission, compounded by an environment of ongoing high tension and hostility between the United States and Iran.

Could these incidents have been prevented? Definitely. More to the point: could these types of situations recur? The intent of these examples is to highlight two points: the best state-of-the-art technology cannot assure perfect command and control, and the human element is a critical component. Technology holds many promises in the military context and some of these are in the realm of command and control. The above examples are relevant because they graphically describe the potential result of a command and control (C^2) breakdown between technology and the human dimension.

This paper will examine the significant influence exerted by new and future technologies as an integral part of Command-and-Control systems and the potential negative implications for command in the future. It will be shown that the organizational and procedural components of Command-and-Control systems (C^2 systems), are critical elements which must be further developed. Decentralized decision-making, the "directed telescope" and the joint approach to war fighting are examined as potential organizational and procedural improvements to future C^2 systems. Of these, the concept of jointness warrants vigorous emphasis in the future. While the human dimension is a critical component of any C^2 system, leadership issues will not be discussed.

To begin, command and control roles and definitions will be reviewed. The current trend toward technological solutions to command and control and their vulnerabilities will then be examined. Finally, organizational and procedural systems with potential to enhance the effectiveness of future command and control systems will be explored.

ROLE AND DEFINITION OF C^2 SYSTEMS

When examining what is meant by the term "command and control system", the initial impression conjured up in the minds of most people is one of technology, such as the computers, radios and satellites used to provide effective command and control. However, this is only one dimension of the equation. Prior to reviewing current definitions, an examination of the role of C^2 systems will be of assistance.

The ultimate role of these systems, particularly at the operational level, must be to enable operations. Raymond Bjorklund succinctly puts the matter in perspective: "The mission of a C^2 system is not to "command and control" but to satisfy the needs of the commander and his staff in allocating and managing forces to execute assigned missions. Therefore, the objective of a C^2 system is the success of the military mission--whether a force functions more effectively and more quickly than its enemy."[3] Clearly, command and control systems must not be an entity unto themselves and must add value to the

[3] Raymond C. Bjorklund, The Dollars and Sense of Command and Control, (Washington: National Defence UP,1995) 55.

enterprise of warfighting. How, specifically, can C^2 systems enhance military operations?

A return to fundamentals can help in this regard. Carl von Clausewitz, in his timeless wisdom, referred to the uncontrollable environment in which war is waged, an environment characterized by fog, friction and chance.[4] Amplifying Clausewitz, the three characteristics of uncertainty of action, the tempo of action and the shared image, further facilitate the assessment of C^2 systems.[5] The way to improve effectiveness in war is through enhancement of these characteristics.

Perhaps the most discussed of these elements is uncertainty of action, which encompasses Clausewitz's fog, friction, and chance. Any system which can significantly lift the curtain of fog of war will be quickly embraced by militaries. Also, the tempo of action has been discussed in the literature using various terminology such as the decision cycle or the OODA (observation, orientation, decision, action) loop. Here, the objective is to secure victory by accelerating the decision cycle so as to "get inside" or assure a quicker phasing than the decision cycle of the enemy.[6]

The concept of a "shared image" implies two issues. First and foremost it is the ability of a commander to impart his vision, his intent, throughout his organization.[7] The more subordinates understand the reasons for the proposed course of action, the more apt they are to be in a position to cope with the uncertainty of war, to carry on appropriately in the face of unanticipated difficulties. Secondly, it consists of the dissemination of

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[4] Dennis M. Drew and Donald M. Snow, Making Strategy, ((Maxwell Air Force Base: Air UP, 1988) 149-161.
[5] Bjorklund 51.
[6] Coakly 33.
[7] Bjorklund 51-52.

critical information throughout the chain of command so that all levels have a common picture of the true battlefield situation.

Hence, any C^2 system which provides value-added must in some fashion enhance these facets of the operational art: reduced uncertainty, increased tempo and shared vision.

Having reviewed the roles of C^2 systems, definitions can now be discussed. The literature abounds with definitions of command and control, which as often as not serve to complicate the issue. Only partly tongue in cheek, Thomas Coakley refers to the "terminological thicket" surrounding command and control and its seemingly expanding derivatives C^3I (Command, control, communications, and intelligence) all the way to C^{27}E. [8] Unquestionably, C^2 (or its derivatives C^3 to C^{27}) is a complex area open to interpretation, disagreement and confusion.

Some definitions in the military doctrinal literature reflect the roles of C^2 systems as previously discussed. For example, the Canadian joint doctrinal definition is "the process by which commanders plan, direct, control and monitor any operation for which they are responsible."[9] The U.S. Department of Defense takes the definition further, encompassing the process as well as the functions:

> The exercise of authority and direction by a purposely designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment communications, facilities, and procedures employed by a commander in

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[8] C^{27}E represents command, control, communications, computers, cohesion, counterintelligence, cryptanalysis, conformance, collaboration, conceptualization, correspondence, camaraderie, commissaries, camouflage, calculators, cannon, caissons, canteens, canoes, catapults, carpetbaggers, caddies, carabineers, carrier pigeons, corn whiskey, camp followers, calamine lotion, etc. Thomas P. Coakley, Command and Control for War and Peace, (Washington: National Defence UP, 1992) 9-10.

[9] B-GG-005-004/AF-000 Joint Doctrine For Canadian Forces Joint and Combined Operations, (Ottawa: Nationa Defence: 1995) GL-E-5.

planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.[10]

For purposes of examining C^2 systems, the consideration of processes provides the necessary clarity. Van Creveld, who is highly quoted on matters of "command", uses the word to represent "command, control and communications" and states that a command system consists of three sub-systems: organizations, procedures and technical means within which the command process itself functions.[11] He goes on to indicate that people are a critical element of any C^2 system and that changing the people will inevitably change the system, no matter how it is organized or structured, and regardless of the technology involved.[12] This concept of sub-systems is echoed by Coakley, who says that C^2 can be divided into technological, human and organization issues.[13] This approach is also compatible with that of Ross Pigeau and Carol McCann who separate the functions of command from control. A human endeavour, command is defined as "…the authority over resources to achieve some goal or mission." and its key element as "…the concept of authority – the right and power to carry out actions."[14] Control is defined as "…the attempt to reduce uncertainty and increase response speed by constraining the problem [of] space and imposing order…through structure and process" and later "…control *is* simply the application of technology."[15] In essence, C^2 systems are comprised of three complementary, and often competing, elements. This reduction of

[10] Joint Chiefs of Staff, Department of Defense Dictionary of Military and Associated Terms, (Washington: GPO, 1987) 77.

[11] Martin van Creveld, Command in war, (Cambridge: Harvard UP,1985) 262.
[12] van Creveld 263.
[13] Coakley 10-11.
[14] Ross Pigeau and Carol McCann, "Putting 'Command' Back Into Command and Control: The Human Perspective," Defence and Civil Institute of Environmental Medicine, Sept. 1995, C-6/19.
[15] Pigeau C-4/19, C-6/19.

such a nebulous term as “command and control systems” into its parts--the organizational, procedural, and technical components, with the human dimension overseeing the system--clarifies the issue and is certainly useful for purposes of further analysis.

THE PROMISE OF TECHNOLOGY

The most significant changes in the realm of C^2 systems in the past few years have been in the area of technological innovation. Called a revolution in military affairs (RMA) by those who view them as radical in their impact on warfare, the changes anticipated in the next several years affect not only C^2 but also the areas of information acquisition (intelligence, surveillance and reconnaissance) and precision strike munitions.[16] Future technological applications and the digitization of the battlefield have the potential to significantly reduce the fog of war, while enhancing operational tempo and the shared image.

This emphasis on, not to say infatuation with, technology is the result of several congruent factors. Futurists, particularly Alvin and Heidi Toffler, have had a significant impact on many people, and have unquestionably influenced senior military thinking in the U.S. Complexity of command and control of ICBM arsenals to guarantee deterrence and Mutually Assured Destruction required technologically dependant sophisticated C^2 systems. This unquestionably applies in the realm of military problems.[17] Recent successes on the battlefield have lent credibility to the theory that technology may

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[16] Mackubin Thomas Owens, “Technology, the RMA, and Future War,” Strategic Review, (spring, 1998) : 67.
[17] Coakley 179.

eliminate, or at least significantly lessen, casualties, while guaranteeing overwhelming victory. Desert Storm is cited as such an example.[18] Finally, one must also keep in mind those parties in the research and development fields and the business world who have a vested interest in promoting significant technological advances in all possible areas. Returning to our earlier discussion on the definitions of C^2 systems, the debate over the primacy of the technological versus the human elements of the equation can greatly affect research and development funding priorities.[19] An estimated $150 to $160 billion is projected to be spent by the U.S. DoD on C3I systems in the next few years.[20] These factors have together heightened the interest regarding the technological aspect of C^2 systems.

A review of where technology is taking C^2 systems is appropriate at this juncture. Joint Vision 2010 is a forward-looking document issued by the Chairman of the U.S. Joint Chiefs of Staff in 1996. This document projects how new and future technologies will be used to "achieve new levels of effectiveness in war fighting,"[21] and suggests that four key areas, dominant manoeuver, precision engagement, focused logistics, and full-dimensional protection, will provide a new conceptual framework for U.S. joint forces of the future. Of note, "the basis for this framework is found in the improved command, control, and intelligence which can be assured by information superiority."[22]

The U.S. Army approach to future warfare has been documented by their Training and Doctrine Command (TRADOC). Their futuristic gaze, although not doctrine, is

[18] U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 525-5 , (Fort Munroe: TRADOC Pam, 1 Aug 1994) 2-7.
[19] Coakly 43.
[20] Kenneth Allard, "Interoperability is Hilt of Information Based Sword," C^4I News, 5.22 (6 Nov, 1997): 3.
[21] Joint Vision 2010, (Washington: Pentagon, 1995) 1.
[22] Joint Vision 19.

intended to influence the way ahead for war-fighting. TRADOC describes the future battlefield to provide an understanding of the broad scope of the expected change.

Battle Command. Advances in information management and distribution will facilitate the horizontal integration of battlefield functions and aid commanders in tailoring forces and arranging them on land. New communication systems allow non-hierarchical dissemination of intelligence, targeting, and other data at all levels. This new way of managing forces will alter, if not replace, traditional, hierarchical command structures with new, internetted designs. Accordingly, units, key nodes, and leaders will be more widely dispersed, leading to the continuation of the *empty battlefield* phenomenon. Because this internetted structure can diffuse command authority, new leadership and command approaches will be required of many militaries. Thus, in most modern armies, this diversity in operating environments, equipment sophistication, increased tempo, and substitution of situational knowledge for traditional physical control will place unprecedented demands on soldiers and leaders. To win on future battlefields future leaders of all armies must be skilled in the art of military operations, capable of adjusting rapidly to the temporal and spatial variations of new battlefields.[23]

The TRADOC vision of a likely future army structure, referred to as Force XXI, is based on the key underlying characteristics of flexibility and modularity. Organizations will be tailored to suit the particular operation. The structure will be organized around information processing and dissemination. Leader-to-led ratios will change and will vary and staff sizes will be mission-specific. Deployed forces will be organized around the division, with both combat and service support being modular. Headquarters staffs will be smaller, requiring highly mobile command posts at all levels of command. Finally, new information technology will allow lower levels to carry out functions previously done at higher levels.[24]

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[23] TRADOC 2-8, 2-9.
[24] TRADOC 4-5.

As just stated, proponents of the RMA suggest that this burgeoning of new capability will dramatically alter the means of waging warfare. Albert states: "We will move from a situation in which decision-making takes place under 'uncertainty', or in the presence of incomplete and erroneous information, to a situation in which decisions are made with nearly 'perfect' information."[25] Admiral Owens, when Vice-Chairman, U.S. Joint Chiefs of Staff, firmly believed in Joint Vision 2010's prognosis for eliminating the fog of war. Comparing the Gulf War, where fifteen percent of significant military information was available on a continuous basis, to the turn of the century, where he projects that more than fifty percent of such information will be available, he suggests the trend is clearly towards eradication of the uncertainty of war. The technological capability which will lead to this heightened level of certainty is a system-of-systems – the integration of the three key areas of Joint Vision 2010 – ISR (Intelligence collection, Surveillance, Reconnaissance), C^4I (Command, Control, Communications, Computers and Intelligence processing), and precision weapons systems. Owens states: "The emerging system-of-systems promises the capacity to use military force without the same risk as before—it suggests we will dissipate the fog of war." [26]

The heart of the C^2 system currently being developed by the U.S. Army is called the Army Battle Command System (ABCS), which will comprise a composite of information received from the battlefield and other sources, including friendly and enemy status and will be integrated into digitized format for manipulation and presentation as

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[25] David Alberts, "The Future of Command and Control with DBK (Dominant Battlespace Knowledge)," Dominant Battlespace Knowledge, eds. Stuart E. Johnson and Martin C. Libiki, (Washington: National Defense UP, 1995) 80.
[26] William A. Owens, "System-of-Systems," Armed Forces Journal International, Jan. 1996: 47.

necessary.[27] In addition, voice-encryption will result in burst transmission of reports. Computers on all vehicles will make for instant reporting, and will allow headquarters to extract information directly from these tactical-level platforms. Position location transmitters on vehicles will allow precision-following.[28] In summary, all levels will theoretically have real-time access to all aspects of a tactical operation and perhaps the entire theatre.

A debate is currently underway as to whether the concept of RMA is in fact an evolution rather than a full-blown revolution, an issue best left to future historians to assess.[29] Notwithstanding, new technologies will inevitably influence the battlefield of the 21st Century and will be incorporated to enhance war-fighting capabilities.

Further, as alluded to in the TRADOC pamphlet, some have advanced the argument that the new technologies will further erode the demarcation lines between strategic, operational, and tactical levels of war. Increased C^2 capability will permit the coordination of formerly strategically controlled assets at the tactical level, thus enabling the concentration of diverse weapons systems at the required location and time from the battlefield. "All of this means that in future conflict the three levels of war, as separate and distinct loci of command and functional responsibilities, will be spaced and timed out of existence." [30] The implications of this are significant. Given the broader control exercised by the tactical level, decisions and activities on the battlefield could result in major and direct consequences for the strategic and political levels. The ability to exploit

[27] TRADOC 3-4.
[28] James K. Morningstar, "Technologies, Doctrine, and Organization for RMA," Joint Force Quarterly spring 1997: 39.
[29] Williamson Murray, "Thinking About Revolutions in Military Affairs," Joint Force Quarterly summer 1997: 69-76.
[30] Douglas A. MacGregor, "Future Battle: The Merging Levels of War," Parameters, winter, 1992-93: 42.

the potential for increased rapidity of the decision cycle will depend on the organization's ability and willingness to decentralize decision-making.

Technology appears to be the defining element in the ways of future war fighting. In fairness, disciples of RMA most certainly recognize the future need for strong and innovative command and leadership. However, the concern remains that these technological innovations could easily drive the future direction of C^2 systems heavily in favour of the technological side of the triad at the expense of procedure and organization.

The very real potential for over-reliance on technology in the realm of C^2 systems raises many caution flags. Although technological advances are not only inevitable, but desirable, extreme care must be taken to avoid repeating the mistakes of the past. One is again reminded of the Vincennes incident, where technology was not adequately assimilated into the decision-making process.

Several hidden traps which technology can set for the unwary are discussed by Coakley. These include uncertainty, overconfidence, information overload, high support requirements, narrowness of vision, illusion of timeliness and accuracy, hidden flaws, and dependence.[31] There are theoretical and practical reasons why uncertainty will always be prevalent and can not be eradicated by technology. Some of these will be briefly examined to better understand the challenges which the introduction of exotic technology could place on future C^2 systems and the leaders that will command them.

From the more theoretical perspective, uncertainty can never be totally eliminated. While, as some claim, technology could in theory manipulate all the necessary information to eliminate uncertainty, most would agree that this assumption is

[31] Coakley 75-91.

fraught with danger. Van Creveld has analysed the issue of uncertainty and, relying heavily on Clausewitz, has identified the human element as a fundamental reason why uncertainty cannot be eliminated. Firstly, the nature of war itself is a human enterprise and a very emotional event, based on violent action and hence, by its very nature, is unpredictable. Secondly, two sides are required, and science can ill predict the (sometimes irrational) decisions of an opponent. [32]

Also in the theoretical realm, some authors have attempted to apply the concept of chaos theory to the discussion of uncertainty on the battlefield. Much has been written about this new view of uncertainty and its interpretation of activity in non-linear terms vice the Newtonian, linear perspective of old.

Chaos theory explores the complex interrelationships between seemingly unrelated events, which can lead to identification of recognizable patterns in an apparently chaotic environment. An apparently minor action or event in an unrelated area could lead to an unpredictable yet significant effect on the major event. One can not discount the analogy of the Lorenz effect, where the flapping of a butterfly's wings in a far-away continent could lead to a development of a major unstable weather pattern half way around the world. As a perhaps somewhat imperfect yet dramatic example of the application of this concept, the Odyssey of Apollo 13 comes to mind. The otherwise inconsequential knocking of an oxygen tank aboard the service module, resulting in damage to a relief valve used only in ground tests and not relevant to the flight regime of the mission, led to almost disastrous results.[33]

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[32] van Creveld 266-267.
[33] Charles Murray and Catherine Bly Cox, Apollo: The Race to the Moon, New York: Simon and Schuster, 1989) 404-407.

It could be argued that the Lorenz effect has increasing relevance on the battlefield of today. Given the realities of today's intense media and public scrutiny of all issues, the rapidity with which large amounts of information are disseminated, and the political sensitivity to public reaction, a tactical-level event can have non-predictable strategic and political repercussions. The dissolution of the Canadian Airborne Regiment, and the even more significant post-Somalia trauma which afflicts the Canadian Forces to this day, were precipitated from a despicable act of murder by a few soldiers, which simultaneously and with one stroke erased the exceptional work done in Somalia by the Regiment. Similarly, in today's climate, a tactical-level error in an air interdiction sortie resulting in collateral damage could bring an entire theatre campaign to a halt.

The trench warfare of World War I is held as an example of linear thinking in war. The defeat of Napoleon at Waterloo reinforced the notion of geometric warfare as a superior methodology compared to Napoleon's fluid, decentralized approach. This resulted in the inflexible, direct approach with the ignominious result of the unimaginable casualties and suffering witnessed in World War I.[34]

Since that time, the advent of manoeuver warfare, attack in depth and multi-dimensional weapons systems have further increased the complexity of the battlefield. In the recent past, attempts have been made to bring order to this complexity through extrapolation of chaos theory into the realm of war fighting. Proponents of chaos theory advocate that it has definite practical military applications in very specific areas such as predicting onset of chaotic states and identifying underlying patterns in chaotic systems.[35]

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[34] Roger Beaumont, War, Chaos, and History, (Westport: Praeger, 1994) 6.
[35] Glenn E. James, Chaos Theory: The Essentials For Military Applications, (Newport: Naval War College P, 1996) 57-95. See also Beaumont 4, 10.

However, whether war will forever remain a chaotic activity or whether it consists of some as yet unexposed form of predictability which can be exploited by chaos theory remains a debated issue.[36]

From a practical approach, technology has inherent limitations. One is communications capacity, a term for ability to transmit data. Although somewhat dated, the comparison is made between the amount of trans-Atlantic data capacity in World War I and in 1985. From an insignificant amount in the former time frame, capacity has grown to the order of from between 500 mega-bits per second to one giga-bits per second. The point is not only the exponential growth in capacity but more importantly the seemingly insatiable demand for more capacity. [37] Similarly, bandwidth requirements for transmission of high-resolution data of large terrain sectors are staggering. Such bandwidth capability exceeds the physical limits of the radio spectrum.[38] Whether future satellite capacity will meet the needs of the next-generation army is unknown.

Assured standardization and interoperability are similar areas of concern which are in practice more difficult to implement than would theoretically seem possible. One needs look no further than the Gulf War for examples of interoperability problems. A computerized system known as the Standard Army Retail Supply System (SARSS) had been developed to handle massive logistics requirements, an upgrade to a previous computerized system. As with such systems, implementation in the field takes time, and

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[36] Beaumont 175-178.
[37] Harry L. Van Trees, "C3 Systems Research: A Decade of Progress," Science of Command and Control: Part II Coping With Complexity, eds. Stuart E. Johnson and Alexander H. Levis, (Fairfax: AFCEA International Press,1989) 38.
[38] Martin C. Libicki, "DBK and its Consequences," Dominant Battlespace Knowledge, eds. Stuart E. Johnson and Martin C. Libiki, (Washington: National Defense UP, 1995) 32-33.

Desert Storm saw some units deploy with the old system vice the upgraded version. The result was a return to the low technology system of carbon invoices, telephones, file cards and despatch riders.[39] Similarly, a technological gap was evident in the transmission of the daily air tasking order (ATO). During Desert Shield, difficulties were encountered in rapidly disseminating this voluminous work of some 300 pages from CENTAF in Riyadh to the field. The Navy's problem was most acute, due to lack of the appropriate hardware, the Computer Assisted Force Management System (CAFMS). Despite trying four alternate technical means of receiving this document critical to the air campaign, including satellite link, the final solution consisted of a daily S-3 aircraft flight to hand-carry the ATO to the aircraft carriers.[40]

Information overload will increasingly be a critical concern with implementation of new C^2 technology. Vietnam provides a clear example of such a situation. In 1966, two communications centres were generating some 500,000 messages per month.[41] This created information bottlenecks of such magnitude that workarounds such as a new message category, "superflash", and the installation of sole user circuits, or "hot lines", were deemed necessary. The "information pathology" evident in the Vietnam War had a significant detrimental effect on the command process.[42]

As technology advances in significant bounds, will the organization's ability to process the influx of data be manageable? Although technology is masterful in its ability to gather and present data, processing and analyzing this data into a format usable by a

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[39] John Pimlott and Stephen Badsey et al., ed, The Gulf War Assessed, (London, Arms and Armour Press: 1992) 90.
[40] Gulf War Air Power Survey (GWAPS), Volume I,(Washington: U.S. Govt. Printing Office, 1993) Part II Command and Control, 153-154.
[41] Trees 39.
[42] van Creveld 248-249.

commander or his staff is the critical issue. Despite the promises of technology, artificial intelligence will never be permitted to replace the human element of C^2 systems. Therefore, the deluge of information could render a system inoperative if not designed to be user-friendly in the context of battlefield conditions.

We have examined the potential limitations of technology on the future battlefield. Focus will now be returned to the three desirable characteristics of command and control at the operational level which could be enhanced by C^2 systems, the shared image, increased tempo of action and reduced uncertainty of action. Relegating these elements to the promise of RMA technology in isolation could be characterized as questionable, given the inherent risk associated with over-reliance on technology. Van Creveld's conclusion is relevant: "…since a decisive technological advantage is a fairly rare and always temporary phenomenon, victory often depends not so much on having superior technology at hand as on understanding the limits of any given technology, and on finding a way of going around those limitations."[43] If technology is to be viewed with a sceptical eye in matters of C^2 systems, where then should the emphasis be placed to ensure reliable systems in the future?

In keeping with the assessments of van Creveld and Coakley, it is suggested that the two other aspects of the C^2 systems triad, organization and procedures, require renewed emphasis as they are critically relevant to discussions of successful future C^2 systems. Three systems will be reviewed: decentralization of decision-making, the "directed telescope" and the concept of joint operations.

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[43] van Creveld 231.

ORGANIZATIONAL AND PROCEDURAL SYSTEMS

It has been argued that the TRADOC concept is heavily techno-centric, with the implication that the RMA will shape the future battlefield. Given the fallibility of technology and the tenacity of uncertainty, a more holistic and generic model of command structures, founded on immutable principles and gleaned from historical precedent, is an appropriate alternative. Van Creveld has identified five principles relevant to the organization of command systems based on an extensive historical analysis. These are:

> - the need for decision thresholds to be fixed as far down the hierarchy as possible, and for freedom of action at the bottom of the military structure;
> - the need for an organization that will make such low-decision thresholds possible by providing self-contained units at a fairly low level;
> - the need for a regular reporting and information-transmission system working both from the top down and from the bottom up;
> - the need for the active search of information by headquarters in order to supplement the information routinely sent to it by the units at its command; and
> - the need to maintain an informal, as well as formal, network of communications inside the organization.[44]

There are clearly similarities between the van Creveld principles and the TRADOC vision reviewed earlier, particularly as regards the issue of devolution of decision-making. However, one must keep in mind that van Creveld's principles were

[44] van Creveld 270.

derived from a historical perspective rather than being technology-driven. In other words, one is cautioned not to build capabilities around technological methodology, as was implied in the TRADOC iteration, as it is argued this could lead to a breakdown of the entire system for the reasons previously cited above.

The procedural issue of decentralized C^2 is a key principle proposed by van Creveld, and a cornerstone of the TRADOC vision. TRADOC projects RMA technologies will dramatically enable the tactical level, causing significant reorganization of the C^2 structure. This topical issue, which has received much attention in recent literature, is often discussed using the German monicker "auftragstaktik", which means mission-type orders. Essentially, given the TRADOC concept that all levels would share the same image of the situation, and given the more precise and lethal weapons which will be available, smaller tactical-level units would be in a position to execute the mission at a lower level, themselves coordinating fires from various sources. The new technologies would in theory allow the tactical-level to remain inside the OODA loop of the enemy, if the structures of higher levels of command are redesigned so as to eliminate their participation, not to say interference, in decision-making. As one author describes the requirement: "The solution to this dilemma lies in organization. We must "de-massify" the production of combat power while decentralizing decision-making."[45] Those who make the argument in favour of decentralization have grave concerns that decision-making will be retained at the highest levels, particularly as RMA will blur the lines of demarcation between the strategic, operational, and tactical levels, leading to micro-management from the very top.

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[45] Morningstar 42.

Advocates for lowering decision levels as far down as possible and minimizing perceived interference from higher headquarters must nevertheless use caution. Applications of extremes in this regard has had significant detrimental impact on operations, not only at the tactical and operational levels, but ultimately strategically and politically. Two examples showing the range of command in this regard are offered. During the Vietnam War, the C^2 system became so burdened with data transmission that commanders required direct observation of tactical-level action to have an understanding of the situation. Using helicopters as the means of transport in a country where land travel was difficult, commanders up the chain of command, from battalion to brigade, division and corps, would hover in position one above the other. Each successive commander would overlook the ground battle, insisting the next lower level dial up on their frequency either to obtain updates or to direct some aspect of the battle. This multi-layered over-controlling had a distinctly negative impact on operational effectiveness.[46] At the other extreme of the spectrum, General Schwarzkopf's decision to give the Marine Corps a free hand in their drive to Kuwait City, beginning prior to the official start of the ground war, had a significant impact on the war's success. Their rapid advance initiated an unexpected withdrawal by Iraqi forces, making their encirclement, particularly the Republican Guard, an impossibility.[47] Clearly, extreme positions on this issue are to be avoided.

Decentralization as a concept could in fact lead to disastrous consequences in terms of its application to C^2 systems. For example, the intent to provide the full

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[46] Van Creveld 255-256.
[47] Michael R.Gordon and Bernard E. Trainer, The General's War, (Boston: Little, Brown and Co., 1995) 159-162.

battlefield picture to the tactical level could compromise an entire campaign should a vehicle with the appropriate computers be captured or come into enemy hands.

It would appear that viewing C^2 in terms of either centralization or its alternative is an oversimplified perspective of the situation. Although the trend towards downward delegation of functions will undoubtedly continue, there are some issues which will invariably need to be addressed at higher levels under any circumstances. Coordination of strategic air and sea lift, addressing the military/political interface, re-assignment of forces, and short-notice change to campaign plans due to new information are but a few of the critical tasks which will need to be completed at the operational level. These tasks will not simply disappear due to greater information flow nor would it be reasonable to expect them to be addressed at the tactical level.

In some instances, technological evolution has in fact forced decision-making upward. The reconnaissance mission is a case in point. Historically, reconnaissance has resided within the domain of the operational and primarily the tactical commanders on the ground. With the advent of the U2, SR 71 and satellites, reconnaissance is now often controlled at the strategic level, with resulting products clearly of use to the tactical level. The fact that, in some cases, information has been requested by the tactical level is secondary. The resultant is that the visibility of tactical-level issues is increased and the operational and strategic levels are unavoidably drawn into the decision-making process. Given the close public and media scrutiny experienced in today's military operations and the potential strategic impact of tactical-level activity, this is not necessarily undesirable.

Rather than dealing in extremes, Coakley advocates a balanced approach in several areas critical to successful command and control. He states:

> The perfect, to paraphrase Voltaire, is the enemy of the good. In war, business, sports, or any form of competition, the goal is not to be perfect, but to be good enough to beat the competition. More often than not, what a commander needs to get "right" are balances rather than ultimates.[48]

Some specific examples of "balances" are offered. When problems in a headquarters organization become evident, there are times where changing the leader may be more appropriate than restructuring the organization. This has become clearly evident in today's quest for jointness, where personalities can literally determine the extent of service cooperation. At a higher level, service rivalry, turf-protection and differing priorities result in interoperability problems. A second example is the balance between amount of information transmitted upwards compared to information moved downwards to the field. Here, the issue is "how much do the troops need to know to be effective?" The TRADOC pamphlet suggests that future technology will give everyone the same image of the battlefield, in a literal sense, along with all the required information, allowing for independent action at the lowest level. This refers to the discussion of centralization versus decentralization. A third example is the balance between extreme secrecy in planning a campaign versus cooperative effort to ensure comprehensive planning.[49] Again, the Gulf war serves as an example, as extreme secrecy hampered development of both the air and land campaign plans which all component commanders could buy into.

This balanced approach is supported by others. Alberts argues that two factors would suggest a moderate approach. Cost of providing the bandwidth necessary to distribute overwhelming amounts of information to all levels will in his view be

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[48] Coakley 140.
[49] Coakley 164.

prohibitive. Secondly, this hierarchical flow of information to the lower levels will also be prohibitive in terms of time, impeding the decision cycle.[50]

Van Creveld proffers a somewhat different perspective on a "balanced" approach in the distribution of ever-present uncertainty. Based on assessment of historical evidence, he has determined that organizations can deal with uncertainty in one of two extremes. The higher headquarters (operational level) can attempt to exert as much control as possible in order to minimize uncertainty at that level, with the resultant increase in uncertainty at the lower (tactical) level. Conversely, decision-making can be devolved to the lower level, thereby reducing uncertainty at that level while increasing it at the higher level. Hence, in van Creveld's words " under the first method the security of the parts is supposed to be assured by the certainty of the whole; under the second, it is the other way around."[51] In his evaluation, history has shown that the latter has produced better results. However, he does clarify that no method is absolute, and circumstances will dictate the appropriate approach.

Ultimately, devolved decision-making results in less uncertainty and quicker decision-making at the tactical level, with commensurately greater uncertainty at the higher levels of command. While these principles are accepted in theory, the issue becomes one of degree. An appropriate distribution of information, or certainty as described by van Creveld, coupled with balanced devolution of decision-making authority, will be increasingly critical on the high-paced battlefields of the future.

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[50] David Alberts, "The Future of Command and Control With DBK," Dominant Battlespace Knowledge, eds. Stuart E. Johnson and Martin C. Libiki, (Washington: National Defense UP, 1995) 96.
[51] van Creveld 274.

Another of Van Creveld's principles, the need for active search of information by headquarters, deserves further examination, and is a natural extension of the issue of devolution of authority. Called the "directed telescope"[52], this procedural system allows the commander to obtain accurate and rapid information from the tactical level, without it being filtered by the chain of command. First used by Napoleon, this technique has been used with significant effect by other commanders, including Rommel, Patton and Montgomery.[53] In an environment of rapidly changing situation on the battlefield, the ability to obtain direct information is a way to reduce uncertainty and accelerate the decision-making process at the operational level.

Examples of directed telescopes were as varied as the commanders who used them. A formal system of Phantom patrols was used by the Allies in Belgium and France in 1939-1940, which circumvented the chain of command and kept higher headquarters informed as to the situation at the front lines. Signal Information and Monitoring (SIAM) units were also similarly and effectively used by the American VII Corps in the Italian campaign. Field Marshal Montgomery used between six and eight hand-picked young staff officers to visit the front and report tactical information directly to him. These directed telescopes allowed senior commanders to obtain a true picture of the battlefield situation.[54]

Interestingly, this command system has come into disuse over time, the Israelis' use of this method in the 1967 and 1973 wars being the most recent application.[55] Such a

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[52] van Creveld 75.
[53] Gary B. Griffin, The Directed Telescope: A Traditional Element of Effective Command, (Fort Levenworth: Combat Studies Institute Publications, 1991) 21.
[54] Griffin 20-32.
[55] Griffin 33.

system could have allowed General Schwarzkopf to have a better understanding of the tactical situation in VII Corps during the great wheel manoeuver of the Gulf War. In the battlefield of the future, the rapidly evolving ground situation, coupled with the vision of the "empty battlefield", could eventually render this technique unworkable. However, this system could provide a simple and highly effective low-technology means to provide redundancy for existing high-technology C^2 systems in the interim.

The join approach to war fighting has emerged as an increasingly powerful C^2 systems. Requiring significant organizational and procedural changes to a military's system, the concept has not yet fully evolved. However, jointness has many arguments in its favour. As a C^2 system, jointness provides the optimum means to coordinate otherwise diverse weapons systems in accordance with a master campaign plan, thus minimizing uncertainty at the operational level, while ensuring all components and elements share a common picture of the commander's intent.

As proposed by the TRADOC pamphlet, reductions in numbers of forces will force greater cooperation between services. In keeping with the modular concept, different specialized packages tailored to the contingency will coalesce at the appropriate time and space to carry out the mission. Under the heading of "joint – multinational and interagency connectivity" the TRADOC pamphlet states "to fully execute full-dimensional operations throughout the depth, height, width and time of the particular battle space demands use of other service assets."[56] Again, one of the TRADOC assumptions is that technology will allow a greater amount of the joint coordination to be done at the lower level. A second factor promoting the joint approach is cost.

[56] TRADOC 3-2.

Increasingly complex technological solutions to C^2 systems will result in increased system costs. It would seem rather self-evident that militaries can ill-afford to procure systems in triplicate (or more) for each service, systems which, as seen in the past, likely would not be interoperable. The view has even been expressed that additional legislation should be passed imposing greater jointness on the services. The former vice chairman of the Joint Chiefs of Staffs, retired Admiral Owens, estimates that up to ten billion dollars annually could be saved through consolidation in key areas, including C^2 systems.[57] Finally, modern and future weapon systems will blur the traditional demarcation of areas of responsibility between services. Coupled with the diffusion of distinctions between the strategic, operational and tactical levels, these changes will also catalyse and impose increased jointness.[58]

Based on the above, the joint approach to war fighting is perhaps the single most important development in C^2 systems with the potential to provide the greatest increase in combat capability effectiveness. Not a technologically-dependant change, jointness rather requires organizational and procedural shifts which, taken to their logical conclusion, could be quite radical.

The Commander in Chief (CINC) structure in the United States is a case in point. The joint headquarters of Unites States Atlantic Command (USACOM) enjoys a direct link to the Secretary of Defense. Critical to the functioning of this concept, specific service forces have been earmarked and maintain readiness postures to react to USACOM responses to crises. A key determinant in the effectiveness of this joint

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[57] Sheila Foote, "Owens Says Congress Should Require More Military Jointness," Defense Daily 7 Nov. 1997: 1

[58] David Jablonsky, "US Military Doctrine and the Revolution in Military Affairs," Parameters, Autumn 1994: 27.

structure is interoperability, the ability of forces from the separate services to communicate. This is not necessarily a high-technology problem, but rather a question of spending priorities and coordination between services.

Most significantly, a joint approach to war fighting requires a culture shift in two areas: within the command structures of the various services, and within the individuals who are posted to serve in the CINC headquarters. In both cases, service concerns must be subsumed in favour of a more "purple" approach to ensure the success of the joint concept. Jointness will only work with the will of the command system.

Perhaps more than any other area, service parochialism remains the main barrier to jointness. The latest United States Air Force (USAF) doctrine manual will be used as a case in point. In this manual, the USAF has unquestionably injected the lessons learned from the Gulf War – most of them positive and seen in the eyes of the USAF as justifying the existence of the Air Force on its own terms. The unique flexibility of air power, particularly with today's satellite and precision-munition technology, is described as follows:

> Versatility in air and space power stems from the fact that it can be employed equally effectively in the strategic, operational and tactical levels of warfare. Unlike other forms of military power, air and space forces have the versatility to be employed globally with unmatched responsiveness in support of strategic, operational and tactical objectives and can simultaneously achieve objectives at all three levels of war- in parallel operations.[59]

Further, the decisive edge provided by the initial air campaign of the Gulf War lends credibility, arguably for the first time, to this statement:

[59] Air Force Doctrine Document AFDD-1, (Washington: Dept. of the Air Force, 1997) 24.

> All Service air arms operate in the third dimension to attain strategic-, operational-, and tactical-level objectives. However, **it is the global strategic perspective that differentiates Air Force forces from the air components of the other Services. The Air Force's assigned mission is…-to provide the nation's air and space power**- *not in support of other tasks as with the air arms of the other Services but* **as its sole reason for being**. (bold & italics in the original)[60]

The U.S. Navy has a similarly strategic outlook on joint operations. Protection of sea lines of communications will continue to dominate their doctrine and priorities. Therefore, direct support to a theatre land campaign is of secondary consequence.[61]

This service-first mind-set, while considered essential for self-preservation in an arena of diminishing resources, can only conflict directly with the concept of jointness.

Interoperability will remain a critical issue for joint operations for the foreseeable future. A key aspect of jointness is the ability of forces from various services and nations to be able to communicate. Connectivity has been identified by Bjorklund as a key desired characteristic of C^2 systems.[62] The solution to this issue does not require new technology, but rather requires procurement reprioritization to ensure compatibility and connectivity within existing structures. The U.S Navy's Gulf War difficulty in receiving ATOs serves as an example clearly highlighting this requirement.

The concept of joint operations holds merit for smaller militaries. For Canada, a more coordinated joint approach would seem to offer greater efficiencies. While none would argue that Canada would possibly deploy a joint task force with its own sea, land and air components, other scenarios would readily lend themselves to a joint approach,

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[60] AFDD-1 43-44.
[61] Drew 98.
[62] Bjorklund 62.

primarily in the area of operations other than war (OOTW). Familiarity with joint concepts and practices would allow us to more readily plug into a joint and combined operation, as experienced in the Gulf War.

CONCLUSION

To conclude, C^2 systems are of value to military operations when they serve to reduce uncertainty, enhance operational tempo, and provide a capability for a common image of the battle space shared between the tactical, operational and strategic levels.

There exists a growing perception that future technologies hold promise to provide breakthrough and unparalleled assistance in these areas. Digitization of information and its instant availability at all levels, more sophisticated electronic collection capabilities and precision munitions, have the potential to speed up combat operations, keep everyone informed of real-time events, and allow lower levels to coordinate effective fires from a wide range of platforms. However, history would suggest a more cautious approach.

A critical deduction is that C^2 systems of the future must not be designed solely around the capabilities which technology would deliver. This paper has argued that, for a multitude of complex reasons, technology will remain forever fallable, as will the humans who use them.

Rather than focussing primarily on technological applications, the organizational and procedural dimensions of the C^2 system must receive increased consideration. Implied in this is the fact that the human dimension must also receive commensurate emphasis, given the exponential streams of raw data and rapid pace of the modern and future battlefield. The arena of command and control is a complex one with many competing demands made on these systems.

While there will be continuing rationale for pushing decision making to lowest possible levels, with resulting enhanced effectiveness in the OODA loop, too much devolution entails excessive risk. A balanced approach to this application, as for other aspects of the C^2 system, is the most reasonable approach with the greatest chance of success.

Jointness will be an increasingly critical organizational and procedural element of future C^2 systems. Although requiring technological connectivity, jointness is essentially a human convention based on the willingness of diverse groups to combine their efforts towards a synergistic effect. Perhaps more than any other area, service parochialism remains the main barrier to jointness.

Finally, it is proposed that Clausewitz's fog of war shows no sign of lifting in the foreseeable future and uncertainty will remain as a prime characteristic of the battlefield. Therefore, C^2 systems must in future ensure they can cope, notwithstanding their hi-technology pre-disposition, with the flutter of the butterfly's wings over the battlefield.

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