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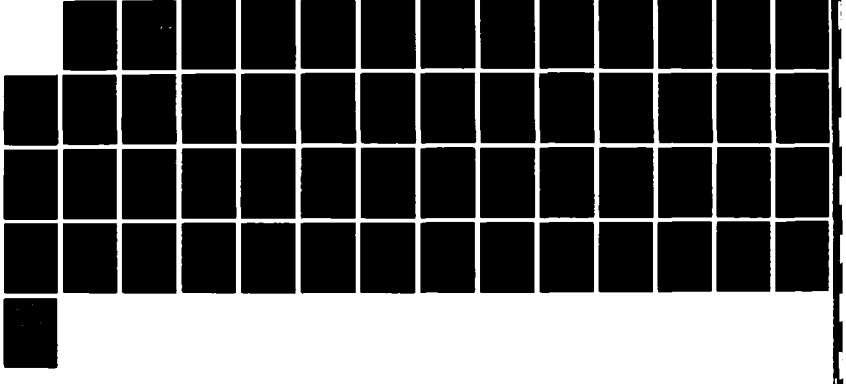

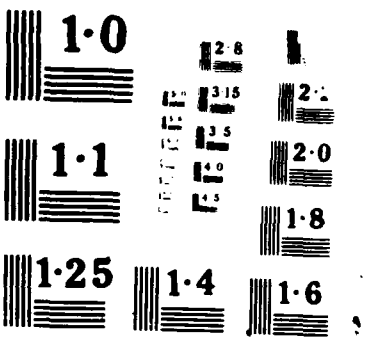
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Automation:
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or Another Source of Friction

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Major William S. Pennypacker
Infantry

AD-A191 780

School of Advanced Military Studies
U.S. Army Command and General Staff College
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This monograph examines the effect on the division command and control system of developing automation. As twentieth century war has gained in complexity, the U.S. Army has attempted to improve the means available for tactical command and control. A major part of that effort has been the incorporation in recent years of automated command and control devices in the Army Tactical Command and Control System (ATCCS). This paper asks what will be the impact of the emerging automation technology on the division commander's ability to command and control the division in battle.

The monograph seeks to answer that question through the following methodology. It first examines the theoretical basis of tactical command and control. Having established a foundation, it reviews the evolution of divisional command and control from World War II to the present.

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The paper concludes that automation will be an essential tool in the AirLand Battle. Without its ability to provide information management for decision support, the division commander cannot effectively employ his forces in depth on the battlefield. For the future, the study suggests current acquisition efforts need to become more focused to ensure the best tools are chosen from the plethora available. Finally, it is recommended that integration of automation into the force structure deserves more attention in order to overcome user resistance and to make the best use of this command and control aid.

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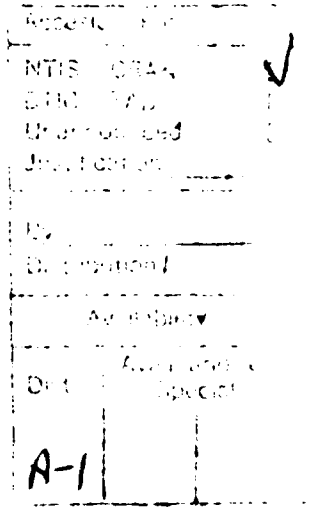

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ABSTRACT

AUTOMATION: THE COMMANDER'S KEY TO VICTORY IN THE AIRLAND BATTLE OR ANOTHER SOURCE OF FRICTION by Major William S. Pennypacker, USA, 47 pages.

This monograph examines the effect on the division command and control system of developing automation. As twentieth century war has gained in complexity, the U.S. Army has attempted to improve the means available for tactical command and control. A major part of that effort has been the incorporation in recent years of automated command and control devices in the Army Tactical Command and Control System (ATCCS). This paper asks what will be the impact of the emerging automation technology on the division commander's ability to command and control the division in battle?

The monograph seeks to answer that question through the following methodology. It first examines the theoretical basis of tactical command and control. Having established a foundation, it reviews the evolution of divisional command and control from World War II to the present. It next describes current U.S. Army doctrine for tactical command and control, recent developments in the Army Tactical Command and Control System architecture, and the structure of the automated Maneuver Control System. Finally, recent experiences with the Maneuver Control System are reviewed to illustrate the benefits and drawbacks of automation to the division commander.

The paper concludes that automation will be an essential tool in the AirLand Battle. Without its ability to provide information management for decision support, the division commander cannot effectively employ his forces in depth on the battlefield. For the future, the study suggests current acquisition efforts need to become more focused to ensure the best tools are chosen from the plethora available. Finally, it is recommended that integration of automation into the force structure deserves more attention in order to overcome user resistance and to make best use of this command and control aid.

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INTRODUCTION

> "Technology is not an end in itself. Technology is a means to an end: that is, to give our commanders and our people the edge in battle. People are at the heart of our command and control system. We must ensure that the technology we employ serves our fighting men and women and their commanders and that it supports the way we fight, not vice versa".[1]

As war has gained in complexity, the problem of how best to exercise command has been closely tied to to the available control apparatus. Together command and control represent the commander's means to achieve his intent on the battlefield. The increasing lethality and mobility of weapons have greatly increased the range and tempo of battlefield operations resulting in a more demanding environment for the exercise of command and control. In an effort to confront this environment armies are devoting an increasing share of their resources and force structure to command and control functions.[2] Emerging automation and communication systems may represent a significant enhancement to existing command and control systems and hence an increase in available combat power. However, if the process of developing, integrating and employing these systems is not thought through, then this potential combat multiplier could well become a source of unnecessary friction.

Automation systems will be addressed from the perspective of divisional command and control because that is the first level where all elements of combat power -- combat, combat support and combat service support -- are integrated. This paper asks what the impact of emerging automation technology will be on the division commander's ability to command and control the division

in battle? The answer to this question will be pursued using the following methodology. I begin by defining command and control and will discuss the subject from a theoretical perspective. Subsequently, current United States command and control doctrine will be examined. Next several historical cases will be considered to demonstrate the evolution of division command and control since World War II. Then oncoming automation systems will be described with emphasis on the maneuver control systems. Finally, the results of recent experiences with automated command and control systems at division level -- in both the United States and Great Britain will be evaluated.

Based on an analysis of theory, historical experience, and current developments, judgments will be made of the usefulness of automated systems to division command and control. Based on this judgement, methods for improving their development and acquisition will be addressed. The judgement and methods will form the paper's conclusion.

COMMAND AND CONTROL -- DEFINITION AND THEORY

Any inquiry into the mechanics of command and control must begin with a definition of command and control terms followed by a discussion of their theoretical application to combat units. In recent years the United States Army has given significant attention to this issue as a part of its effort to provide an integrated command and control system throughout the force. The current focus is on ensuring any command and control system is integrated both vertically (among layers of command) and horizontally (among functional areas).[3]

The terms requiring definition include "command"," control", "command and control", and "command and control system". Command as defined in JCS Pub 1 is:

> "The authority that a commander in the military service lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions..."[4]

Control is described as the:

> "...process by which commanders and staffs direct the activities of subordinate and supporting units and ensure they are consistent with the will and intent of the commander."[5]

As a practical matter for combat operations at division level this refers to the orders which are provided to subordinate units and situation reports which are fed from subordinates to the commander.[6] Command and control, the process which puts the two together, is defined as:

> "The exercise of authority and direction by a properly 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 planning, directing, coordinating and controlling forces in the accomplishment of the mission."[7]

Simply put, it is the process which permits the commander to turn potential combat power into actual effect against the enemy. Finally, the command and control system consists of:

> "The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to missions assigned."[8]

While the above terms constitute a doctrinal basis for the discussion of command and control, it is important to review the theoretical aspects of command and control of combat forces.

Without continuous direction, any force ceases to exist because command and control serves as the nervous system which causes the separate parts to work in concert. The necessary degree of control is largely a function of the size, complexity and differentiation of the organization. Historically, growth in the size of armies, additions of new and different types of units capable of fighting over greater distances with more powerful weapons and increasing specialization of subordinate organizations have expanded the scope of command and control requirements in units.[9] Structurally, command and control can be viewed in at least a couple of key approaches with respect to its contribution to the life of the unit.

As the directive function, command and control is possibly the critical element of an army's combat power. At its basic level it provides for the subsistence and maintenance of the unit and permits the direction of the force towards its fundamental goal -- the destruction of the enemy. For the purpose of this study, command and control will be considered from a systems approach. That is, what is the nature of the input, process, and output of a command and control system?[10]

An ideal command and control system has been described as one which provides inputs consisting of information which can be selectively acquired quickly and accurately. Such information is then processed in a manner which quickly confirms the reliability

and relevancy of the information, displays it for users in a clear and concise format, allows the user to visualize the information in a matrix for analysis which reflects reality (not preconceptions) and leads to the identification of objectives which are both desirable and obtainable. The output is a decision which is correct, but which permits deviation based on circumstances. This decision must be transmitted in unambiguous and concise orders. Execution is monitored to ensure compliance, but not in a manner which stifles the initiative necessary for subordinates to deal with the inevitable battlefield friction.[11]

Of course an ideal system does not exist. Commanders resolve differences based on their individual styles and within the context of the system they are operating. Armies at the lower levels (for a force the size of the U.S. Army, division is a lower level of command) cannot accept command and control systems based on commanders' personalities. Building a system for the entire force requires recognition and manipulation of the principal structural means of a command and control system.

The means of command and control systems have evolved over time to meet the needs of increasingly complex armies. The three categories of means identified by one author are organizations, procedures, and technical means of command and control. Organizations are entities such as general staffs and other organs which have developed to support the commanders control process. Procedures include actions such as standard reporting measures or the use of independent observers in the form of "directed telescopes." Technical means include tools like the

radio. Together they provide commanders the capability tc execute their missions. Increasingly, complex automated systems are blurring the lines between technical means and procedural or organizational means. The efficacy of automated systems at division depends on their applicability to the fast moving environment of mechanized AirLand Battle.[12]

Identifying specific needs requires a narrower and more precise analysis of the command and control requirements of the mechanized division. Brigadier Simpkin in his book, Human Factors in Mechanized Warfare, evaluated the demands of the these units and postulated five approaches to the command and control of mechanized forces. These methods have their roots in systems which have been developed and advocated by various armies over the last forty years.

Simpkin addresses the five systems of control -- "minimal, directive, mission type, forward command, and detailed orders tactics" -- in order of increasing degrees of centralization. Of the five, the system exercising the least control was the "minimal control of forces" following a breakthrough to operational depth as described by the Soviets following WWII. This system possessed no positive control over tactical forces other than a general understanding of the commander's intent. The next level was the "Directive Control" promulgated by the U.S. and Great Britain in the 1950's. This system depended on subordinate commanders being able to execute the higher commander's guidance without additional instructions in a nuclear environment. Still another system, with roots in the Wehrmacht

and purportedly practiced by the Bundeswehr today, is of "mission type" control. This method, popularly referred to as auftragstaktik, gives the subordinate his mission and constraints at the outset and then permits him to execute his task as he sees fit as long as he adheres to the guidelines. Closely related to the "mission control" is the concept of "Forward Command" in which the commander is constantly forward and where he may actually take control of the battle from subordinates at critical points on the battlefield. This technique was practiced extensively by German Panzertruppen during the Second World War. Finally, Simpkin identifies a method he calls "Detailed Orders Tactics" which he maintains is the mode currently practiced by the U.S. and Great Britain and coming into vogue in the Soviet army. This method dictates, where feasible, the greatest measure of control from the highest level possible. In his study the author evaluated each of these methods with respect to their effectiveness in the command and control of mechanized forces.[13]

Simpkin's analysis criticized the detailed order method. This system is described as being overly reliant on SOP's because of their rigidity and the tendancy of some to take them literally. Further, he questions the over-reliance on advanced electronics primarily due to their vulnerability. Moreover, he believes it demonstrates a lack of confidence in subordinate leaders to carry out their missions. This system, he argues, may be difficult to sustain in a nuclear or chemical environment super-imposed on a battlefield characterized by exceptional violence and high tempo.

His ideal system combines the directed control concept of the 1950's and the forward command typified by the Panzer division commander of 1943. Not surprisingly this theoretical system straddles the spectrum. It permits the subordinate freedom of action, unconstrained by overly restrictive OPORDs or SOPs, yet permits the senior, and by definition more seasoned commander, the opportunity to intervene at critical junctures in the battle. The battlefield of extended frontages and uncertain electronic communications mandates a technique of command and control which gives significant latitude to the subordinate or for that matter the commander to change the concept to deal with the exigencies of the moment.[14]

HISTORICAL PERSPECTIVE

Since the advent of mechanized warfare in the Second World War, battle has become more dynamic at the division level. Operations conducted over frontages and depths far exceeding those of previous wars and at speeds considered impossible just a few years before required a commensurate degree of command and control. In the half century since the introduction of combat systems capable of blitzkrieg operations, armies have, with varying degrees of success, introduced new methods of command and control to conduct those operations. To gain perspective on where we are today, three historical examples of divisional command and control will be examined.

First to be considered is the U.S. division of 1944. Like most elements of the ten million man army built to defeat the Axis, the Table of Organization for division headquarters reflected a

best guess at the structure which had to be fielded to ensure this vast organization worked. As U.S. divisions were committed to combat the means of command and control -- organizational, procedural, and technical -- were tested and, where found wanting, were fixed either through adjustments to the tables of organization or through ad hoc arrangements by commanders in the field.

The organizational design for the division headquarters just prior to the war created an allowance of 28 officers and approximately 110 enlisted personnel for the armored division headquarters. By 1943 recognition of additional requirements resulted in the officer authorization growing to 42. A specific deficiency -- key to the ability of the division commander to fight his division but not officially corrected until the end of the war -- were the allocations for division G-3 and G-2 sections.

The 1942 TOE for the armored division G-3 section authorized just ten personnel, only four of which were officers. The G-2 had even fewer people with only two officers and three enlisted soldiers. Divisions in the field found this number inadequate. A 1945 General Board recommendation recognized the wartime deficiency by recommending the divisional G-3 section be upgraded to 26 personnel to including eight officers. Three of these officers were captains designated as liason officers indicating an acceptance of the need to conduct coordination with several units in the fluid operations of the WWII battlefield.[15]

Equipment support for the headquarters element of the armored division was provided by the division headquarters company. It consisted of a two light aircraft and a number of vehicles, including both quarter-ton trucks and half-tracks to move the command post and its personnel. As a matter of course, divisions enhanced the available equipment by modifying their equipment. These changes included constructing map boards, obtaining and installing additional radios and making containers to store accessory equipment. The available personnel and equipment were typically organized into two elements.[16]

Division commanders in WWII were expected to fight their divisions from the front. A post war survey indicated they spent approximately 25% of their time in their command posts with the remainder of their time spent forward with subordinate units. Surveyed commanders reported they spent their time at the front visiting troops and commanders in order to enhance morale, viewing battles in progress to ensure they had an appreciation for how things really were and controlling specific actions when necessary. The role of the personnel and equipment authorized by the division headquarters table of organization and equipment was support of the commander in his efforts.

Support of the commander was provided with the establishment of two headquarters in the field. The headquarters were organized into forward and rear echelons. The division command post, run by the chief of staff, located in the forward echelon, was normally two to five miles from the line of contact. Close proximity to the front line facilitated frontline visits by both the commander

and the staff. On some occasions, especially in the armor divisions, the commander went to the front with a forward command group consisting of his aide, the G-3 or assistant G-3, representatives from the division artillery and radio-telephone operators. Planning and coordination remained the responsibility of the command post.[17]

Within the CP, many divisions created what became known as the "war room." This was not a briefing area in the sense that this term is often applied today, but rather a tactical operations center normally consisting of a joint G-2/G-3 work area. Operations and intelligence personnel worked together to track and coordinate the battle. Maps and chart information were always available here to include information from the G-1 and the G-4. While its chief function was to control the division's actions, it sometimes also served as the site of the morning or evening update briefing. Moreover, it was often used as a "jump" tactical command post when the primary division CP was displacing over large distances.

The technical means of command and control available to the WWII division were limited to wire and radio. Primary communication to forward and rear CP's was wire, although armored divisions, engaged in fast paced mobile operations, often depended on radio. A key feature in the communications system of the division was the inclusion of the war room as a subscriber to the division wire net with the capability of "eavesdropping" on calls made over the division command wire net. In addition the war room monitored the radio nets. In each case the purpose was

to ensure the CP was fully aware of the events of the battle. In this way it became the primary source of integrated information within the division and the division commander's chief means of control to assist in his command of the battle.[18]

The operations of the 4th Armored Division in a ten day period in September 1944 provide a snapshot of one unit's ability to operate successfully while using the WWII command system. Following participation in the exploitation across France, MG "P" Wood's 4th Armored Division conducted yet another brilliant armor operation in its deep encirclement of Nancy. On 18 September 1944, the division was preparing to lead the XII Corps and Patton's Third Army on a drive to the Rhine. Unfortunately, a delay in the attack caused by a shift of the theater main effort to Montgomery's 21st Army Group permitted the Germans to marshal their reserves and to launch a counterattack.[19]

As the German counterattack kicked off, 4th Armored was spread over thirty miles. Combat Command Reserve, in the south near Luneville, met the initial attack and repelled it with stiff resistance. Unable to break through at Luneville, the Germans shifted their attack north to the vicinity of Arracourt where they ran into CCA. In a four-day battle this combined arms force, which had been preparing to move north to support the attack of CCB, fought a continuous series of meeting engagements which eventually broke the back of two panzer brigades. CCB, further to the north, saw its attack to the Rhine aborted. It too became engaged in the fighting, first against the supporting attack of

the First German Army and later with CCA in a tenacious defense of Arracourt against the Fifth Panzer Army. Throughout the fighting, MG Wood's division lived up to its well deserved reputation as one the best divisions on the western front.

The 4th Armored Division was Wood's creation and it reflected his dynamic command style. He commanded from the front, normally using his Piper Cub to give him battlefield mobility. Typically he issued orders personally to his commanders at the front. He passed only objectives and the most limited of control measures. The CP's role was to prepare written orders to back up his oral instructions and to conduct coordination with Corps. The distances and tempo of this division's operations made decentralized operations a necessity. The available technical means of command and control were simply insufficient. Wire couldn't be used and the primitive radios of the day could not range the required distances.[20] As a result, the standard command system, effective for an infantry division, came up short in meeting an armored division's needs. Fortunately, the 1944 battlefield was generally only two dimensional and a system of command directly from the front was workable.

By 1973, the weapons of the Second World War had undergone significant improvements but these changes were evolutionary, rather than revolutionary. Both direct fire and indirect fire weapons had increased in range and size. The result was a more destructive and larger battlefield. As an example, tank effective ranges went from 500 to 1500 meters during the evolution from the Sherman to the M-60 tank. Complementing the improvement in

weapons capabilities was the refinement of the WWII technical means of command.

The communications means of choice available to the division commander in the early 1970's was the radio. The tenuous FM radio communications of 1944 France had given way to improvements in range and available frequencies. Reliable radio communications now permitted the commander to go forward and at the same time give him a reasonable expectation of contact with his rear and higher headquarters. Of course improved countermeasures were evolving which created vulnerabilities for the communications link and the commander himself.

Those vulnerabilities were no where clearer than in an operation conducted by the most successful practitioners of modern mobile warfare -- the Israeli Defense Force(IDF) -- in October 1973. The Israelis subscribed to a system of command referred to as "optional control." This system, depending on thorough planning, institutional discipline and innovation in execution, allows maximum independence to subordinate commanders, yet permits interference by the commander when he deems it necessary to support the intent. This command system served the IDF well in all of its wars, leading to operational success despite the problems caused by a very decentralized command structure. However, when faced with the disaster of the 1973 Yom Kippur surprise attack, elements of the Israeli system failed the IDF.[21]

The 6 October 1973 Egyptian attack across the Suez Canal into occupied Sinai achieved operational surprise. The Israelis quickly attempted to counter that surprise with an attack of their own on 8 October. The force chosen to execute the counterattack in the northern Sinai was MG "Bren" Adan's armor division made up primarily of reservists. Adan, a veteran of three earlier wars and recently retired as head of the IDF Armored Force, was intimately familiar with the requirements of mobile war. This battle is a useful vehicle for examining the difficulties of command and control in a fast moving armor environment.

Essentially the mission of Adan's division was to attack south along the eastern side of the Suez Canal to relieve several strongpoints which had been surrounded during the initial Egyptian penetration. On order, it was to cross the Suez Canal and conduct operations to cut the enemy off from their base. Adan's plan involved the employment of all three of his armor brigades (his mechanized infantry brigade had not yet closed on the rest of the division). The Natke Brigade was to attack south from the vicinity of Quantara. Gabi Brigade, located east of Natke, was to attack south moving parallel to the Natke. Aryeh Brigade, further to the east and still moving towards the battle area, was designated the reserve.

The Egyptians, deployed in force along the eastern bank of the Suez, had already demonstrated the deadliness of the wire guided anti-tank missile. As a result, Adan was further constrained in his operations in that he was instructed to close no further than

two miles to the bank of the Suez. This guidance -- ambiguous given the rest of the mission -- demonstrated the overall lack of clarity associated with the entire mission, a deficiency which among others doomed the operation from the outset.

The attack kicked off early on the morning of 8 October and almost immediately the plan was adjusted. Adan's right flank brigade came immediately into contact in the vicinity of Quatara. This resulted in the commitment of Aryeh's brigade to attack through another division on an axis perpendicular to the original plan of attack. Despite the initial change in orders, all elements enjoyed early success. By midmorning, however, the Gabi Brigade in the center had come into heavy contact. One of its tank battalions was ambushed late in the morning. In an attempt to counter this situation, the Natke Brigade was ordered to join with the Gabi Brigade in an attack against the Egyptian positions. This fight continued into the afternoon in an uncoordinated fashion and resulted in significant losses and a withdrawal. The Aryeh Brigade in the south experienced similar problems in a fight essentially isolated from the remainder of the division.[22]

As stated earlier, many factors went into this serious defeat of Adan's division. Not the least of the problems was the internal command and control system of this division. The IDF's means of command had been applied successfully in the past; however, in this reserve unit, command during the counterattack broke down. The primary culprit seems to have been the technical portion of the system.

Adan relied totally on FM communications in the fight. They were sporadic throughout. His headquarters consisted of three armored personnel carriers and two half tracks. In order to maintain radio communications with his higher headquarters, he was tied to an observation post located on a hill some distance from the battlefield.The result was his physical isolation from the fight. Radio communications to his subordinates were constantly disrupted to the extent that he lost all communication with his southern brigade for a period of time. Jamming efforts by the Egyptians were effective throughout the day. Moreover, Adan criticized his higher headquarters for breaking in on his command net and disrupting his communications during the fight. Finally, enemy artillery was on target, largely due to poor Israeli radio discipline. Adan's headquarters was hit and his commo track was destroyed during the afternoon. The net effect of these difficulties was that the battle from Adan's perspective was never synchronized.[23]

In his analysis of this battle, Martin Van Creveld says the Isrealis might have benefited from several technical innovations had they been available. For example, a position and azimuth determination system would have told Adan where his forces were in a confusing fight. In addition, sensors linked to computers would have eliminated uncertainty and aided the decision process. Finally, improved radio and other communications technology would have given Adan the means of control he so desperately needed.[24]

In the U.S. Army, the evolution of division-level command and control is illustrated by a piece written by MG Richard Prillaman who commanded a U.S. armor division in 1982. Prillaman's philosophy of tactical command for a division is based on five principles. He writes that any effective command organization must be relatively small. Further, he rejects the notion that control of the battle should be split between two CP's. Next, he stresses the need to limit the number of voices providing decision information to the commander. Continuing, he emphasizes his desire for unstructured command briefings which provide important data as opposed to command briefings providing "white wash." Finally, he focuses on the absolute requirement for oral orders given face to face.

This commander's focus was clearly on procedural means of command based on a well thought out concept of command. He addresses each of his principles in turn, but his emphasis is clearly on command and control as exercised by the leader. Unity of command is essential, he says, for:

> "Unity of command is a principle that should apply to tactical systems as well as organizational models. ... Furthermore, I am not willing to delegate to any subordinate the authority to make independent decisions about today's battle, because I am afraid the result would be inconsistant with what I want to do tommorrow."[25]

Given a philosophy of centralization, his desire for simplicity becomes clear.

He believes individuals have a limited capacity for information. Extraneous information is considered an anathema.

He says:

> "A general rule of thumb is that any information that does not call for a definite action or reaction...is not essential and should be eliminated."[26]

Information is gathered and analyzed by the staff and the fed to the commander as he determines requirements. The purpose of this support system is to allow the commander to fight from the front. For that reason he limited his command group to select individuals. Specifically, his G-3, major subordinate commanders and his chief of staff are identified as the players in his system of tactical control. A limited number of supporting players shields the commander from overwhelming distractions.

Under his concept, he moved to his forward units in a command personnel carrier. Representatives from the G-3 and the Fire Support Element (FSE) accompanied him for the issuance of orders. He views "face to face" transmission of orders essential because:

> "No matter how gifted the G-3, he cannot describe the nuances of the commander's concept in the formal, stylized process we use for issuing orders."[27]

Personal contact allows the senior commander to transmit not only the concept but also the all-important intent. Prillaman said it forced him as a division commander to think his scheme of maneuver through and ensure it could be accomplished.

MG Prillaman rejected much of the the emerging doctrine as being either too general or impractical. As described above he believed strongly in a system of command based on personal contact and communication. He goes so far as to state that his division does not need "high tech" command and control gear and that if he had it he would not use it.[28] His command style and

system are in many ways a throwback or at least an evolutionary descendent of "P" Wood.

The examples of three division command systems show a common thread. Each depended on forward command and control. The presence of the commander and staff with the lead elements permitted the commander to gather his information and to provide guidance which ensured accomplishment of his intent. Where circumstances of battle prevented the commander from being at critical points, he was dependent on evolving but often fragile communications links to gather decision information, convey instructions and supervise compliance. Whether these previous systems are sufficient or improvable for the future is the subject of the remainder of this paper.

CURRENT U.S. DOCTRINE FOR DIVISIONAL COMMAND AND CONTROL

Logarithmic technological advances coupled with the capabilities of modern industrial society have literally changed the face of battle. Automotive advances have provided vehicles greater range and tactical mobility, enhancing the tempo of the battlefield. Weapons improvements have increased ranges three times and overall destructiveness fifteen times since 1950. The emergence of electronics provides commanders with sensors and computer processors which greatly increase information acquisition and processing as well as improve the accuracy and effectiveness of weapons. Concomitant doctrinal and organizational changes have resulted in smaller and more numerous units and increased use of force multipliers by maneuver

commanders, each requiring a more sophisticated command and control system.[29]

In this environment, the division commander will fight on a non-linear battlefield. The strength of enemy forces ensures his ability to create penetrations through massing of maneuver forces --air and ground. In addition the commander must be prepared to employ conventional, chemical and nuclear fires while protecting his forces from those same weapons. Technical advances allow the commander to attack targets by fire or electronic means in depth. To win on this battlefield will require the division commander to look forward in both time and space. Massing at the critical time and place now means orchestrating forces in many places simultaneously. Controlling the initiative of this fight requires a command and control system which can handle more than one fight at a time.[30]

The U.S. Army's response to the command and control needs for the AirLand battle has been addressed in a number of its basic manuals. The description of the definition and functions of tactical command and control at the division closely correspond to the definitions presented earlier in the paper. The most recent draft of the new manual for division operations says the goal for division level command and control doctrine is to:

> "...have a process that is capable of acting more rapidly than the enemy, keeping him off balance by changing the situation so rapidly that his reactions are inappropriate and he remains at a disadvantage and thus can be defeated. This concept of warfare, rapidity of action, can only be obtained through a responsive command and control system that facilitates execution of the mission, provides for standard language and symbols, protects the force and motivates the soldier to fight.[31]

The aim is to have a system which conforms to the requirements of the modern battlefield.

The system as described in U.S. doctrine is supposed to be capable of working in the same manner as the input-output model described in the theoretical discussion. The doctrine specifically says the command and control system must be able to support the c'ose, rear and deep, battle a recognition of the non-linear nature of modern mobile war. It emphasizes the need for speed in cycling information from acquisition to decision execution to ensure we can penetrate and get ahead of the enemy's decision cycle. Finally this doctrine emphasizes the need to screen and process information fed to the commander in order to ensure he receives the information critical to his decision making. Given these requirements, the doctrine describes the command and control system as command oriented. It is decentralized in a manner very similar to that described by Richard Simpkin.

The command oriented command and control system emphasizes four key elements. First, commanders at all levels have a duty and a desire to assume responsibility. Second, subordinate commanders must recognize their right and duty to work with freedom of action within the intent of their commander's mission order. Third, the system requires a high degree of trust between leader and led,and fourth, the emphasis on mission-accomplishment rather than method.[32]

Included in the command-oriented system is a focus on the importance of forward leadership by the commander. This is portrayed as the preferred mode of action for several reasons. By his presence forward, the commander is assured of receiving the most current information. Forward command also facilitates the siezing of opportunities which may only fleetingly present themselves. Further, the presence of the commander forward on the field of battle has always served as a builder of morale and confidence among the men actually doing the fighting. Facilitating this method of command is accomplished, according to doctrine, by small staffs who understand the commander's intent and who are able to translate it into coordinated actions.[33]

The system described above addresses the means and organizations which are employed to meet the command and control challenge. The technical means of command and control are addressed in the draft division operations manual in only a cursory fashion. The August 1987 draft of FM 100-15, Corps Operations, deals with this issue in somewhat more detail. Here is found a discussion of the Army Tactical Command and Control System (ATCCS) which encompasses the overall architecture for command of corps and below. This system exists today and emcompasses all in place equipment and facilities available for command and control at the tactical level. However, recognized deficiencies in the present system's ability to deal with the changing battlefield is leading to the development of improved systems.[34]

EMERGING TOOLS OF COMMAND AND CONTROL

Evaluations of the technical aspects of current tactical command and control reveal that information flow is effected largely through voice and message transmissions. Processing and correlation of information is accomplished within headquarters manually. In a more stable environment this system proved generally adequate, however, today the deficiencies are sometimes glaring. As mobility has increased, the lines of command and control have lengthened making them more vulnerable. Moreover, manual transcription of information and processing within headquarters lends itself to error. Mistakes are magnified as information requirements have grown. Further, routine traffic over nets which are difficult to discipline interferes with critical command and control actions. Finally, most systems have been oriented towards vertical information flow and command and control at the expense of ensuring functional operators at the same level are able to share information. The absence of horizontal flow severely detracts from the ability to coordinate the division's efforts on the battlefield and obtain the synergy necessary to win.[35]

Improvements in the ATCCS must occur if it is to overcome the shortcomings addressed above and better support the AirLand battle. Analyzing its needs, the U.S. Army identified the existence of five battlefield functional areas requiring continuous information flow horizontally and vertically. These functions -- Maneuver, Fire Support, Air Defense, Combat Service Support, and Intelligence/Electronic Warfare -- are those the

commander must exercise to fight his unit successfully. A concept called the Command Control and Subordinate Systems (CCS2) was developed to provide an integrated architecture capable of defining the automation and communication needs for the support of these systems on the AirLand battleground.

The Army wants the CCS2 framework to provide a system which can transmit accurate information when it's needed between commanders and their staffs, and the commanders and staffs of the functional units. To achieve this goal, the CCS2 has been structured vertically into three discrete subsystems. These are the Force Level Control System (FLCS), the Functional Control Systems and Subordinates Systems. These subsystems form a hierarchy under which subordinate systems feed a functional control system which feeds, in turn, the force level control system that has responsibility for integrating the inputs horizontally. Through this input/output system, key information will be gathered, decisions made and orders disemminated for execution. Each element in the system has a key role to play.[36]

The Force Level Control System or FLCS is the commander's portion of the structure. It consists of the commander, his staff, facilities and equipment (including communications and automation). Its chief responsibility is to provide the means of command and control for each echelon of command. This is accomplished by facilitating decisions concerning the employment of combat power, providing instructions to supporting and supported units and coordinating the efforts of all battlefield functional areas. The system is to be netted and distributed

allowing the commander to exercise command and control from any command post at any echelon within his unit. Hierarchal input is provided by the various functional control systems.

Supporting the FLCS are the functional control systems. These systems are the control elements of the individual battlefield functional areas, e.g. the Divarty commander and staff. The principle function of these systems is producing decisions for the employment of the combat power applicable to its battlefield functional area. Other functions include directing supporting and subordinate units and orchestrating the subsystems of the battlefield functional area. Specific services associated with each battlefield functional area also have been identified. As an example those associated with the maneuver functional area are:

> "Develop an integrated combined arms and services concept of operation for the AirLand force; develop C^3 Counter-Measures concept to assure the effectiveness of the C^2 capability of the force."[37]

The "subordinate systems" at the base of the CCS2 hierarchy are composed of the manual or automated systems which perform unique work within a battlefield functional area, e.g. counterbattery radars in the fire support functional area. Each of these systems has its set of personnel, procedures, and equipment which allows the structure to perform its specific function. At a minimum, these systems must perform basic tasks required to maintain its existance and to ensure basic mission accomplishment. These tasks include sustainment of subordinate system resources, security and protection of the resources and communications within the battlefield functional area network.

Information required by "subordinate systems" will be generated both internally and externally.[38]

The architecture described above is conceptual in nature. It reflects the Army's efforts to establish a doctrinal framework. The intent is to apply systems improvements to that structure. A number of specific functional systems are being developed which will permit the force level commander to integrate his command and control system vertically and horizontally. These systems are the Maneuver Control System (MCS), Advance Field Artillery Tactical Data System (AFATADS), All Source Analysis System (ASAS), Forward Area Air Defense Command Control and Intelligence System (FAAD C2I), and the Combat Service Support Control System (CSSCS). These systems all contain automation capability. Critical to overall force level control is the eventual compatibility of all the systems. Towards that end software and data base will be standardized to permit interoperability. This will facilitate the sharing of information at all force levels, permit decision makers to focus that information towards effective decisions and help ensure orders are desimminated to all affected parties. That is the promise, however; complete execution is still some time into the future.

We will focus on a single battlefield area control system -- the Maneuver Control System -- because it is first to be fielded and, more importantly, it focuses on the primary element of ground combat power. Moreover, the other systems will initially integrate into the Force Level Control System using MCS. Maneuver

Control System will be the commander's interface with automation in the tactical environment.[39]

The Maneuver Control System has its roots in command and control studies dating back into the 1950's. Observers noted existing command and control systems did not provide tactical commanders and staffs sufficient tools to transform information into orders. Not until the maturation of computer technology in the mid 1970's were combat developers able to realistically conceive of systems to meet that need. The short lived Tactical Operations System (TOS) proposed in the late 1970's was a first attempt at providing automated tactical data processing to tactical commanders. TOS was overcome by the accelerating rate of computer technology and in 1980 was replaced by the Maneuver Control System.[40]

The original MCS design was to be completely hardened for tactical use. Costs were prohibitive so a compromise position was adopted which combines military specification (MILSPEC) and non-developmental items (NDI) or "off the shelf" material. In addition software testing at two different locations led to another change. Tests in USAREUR focused on the development of a vertically oriented command and control system. Meanwhile the Army Development and Employment Agency was working towards a horizontally oriented system with the 9th Infantry Division (Motorized). A 1985 program review resulted in a decision to merge the two in order to achieve full benefit. Fielding of MCS is now on-going.

The system now being fielded is evolutionary, designed to place capability in the hands of the user today with planned enhancements already under development for the future. The baseline fielding consists of the issue of a limited number of Tactical Computer Terminals to the active component corps and divisions. Each division is now receiving nine Tactical Computer Terminals (TCT). Based on suggestions from VII Corps, the recommended basis of issue is four at division headquarters (to be spread among the division CP echelons) and one per maneuver brigade and the Divarty. In the near term, NDI terminals will be issued to expand the number of work stations within individual headquarters. Subsequent changes are programmed for the future.

Despite its current limitations, MCS has impressive hardware capabilities. Key characteristics include a memory storage capacity for creating a tactical database. This capacity varies, with two terminals per division containing an eight magabyte bubble memory; the remainder have floppy disk storage capacity. Each terminal also posseses a printer/plotter able to print eight to ten pages a minute. Another feature, impressive for the promise as opposed to its present utility, is a plasma display which can create decision graphics over a map sheet. Unfortunately, the current screen is only nine and one quarter inches square, and that is too small for effective use at brigade level and above. The terminal has a power converter enabling it to draw power from several possible sources, permitting its use in vehicles or buildings. In addition to these characteristics,

the TCT's are compatible with existing and developmental communications systems.[41]

The Maneuver Control System hardware -- TCT -- has been designed to work within the communications system. Each terminal has two communications ports and can transmit data over Area Common User Nets and FM nets. Normal transmission is digital burst; however, voice transmission is possible. The TCT's are also compatible with all communications security devices. As mobile subscriber equipment is fielded, it is envisioned it will be the primary means of communications for the system. It is important to note that MCS is not a communications system. It is an automated command and control system which works only as well as the quality of the communications system in being.

Operational capabilities are the heart of MCS. Its most obvious advantage over manual systems is the ability to store information in an accessible and organized manner. It handles standard reports which can be updated periodically, providing commanders and their staffs information they need to control the force. Devices, if authorized, also possess a query capability allowing operators to pull information from other terminals without having to bother personnel at the other end. Conference capability exists because commanders can designate multiple addressees. Orders and instructions can be quickly disseminated using this technique.

These capabilities provide important advantages over manual systems. When information is prepared manually and passed by voice there is potential for additional error at each step.

Information arriving in standard report formats on hardcopy gives the commander and his staff a readily usable product which can be understood by all. Digital transmissions will save time and help protect communications systems from enemy attack. Query capability allows key staff personnel access to dependable information without bothering their counterparts. An outstanding feature of the system is its distributive aspects. The commander can travel the battlefield visiting key subordinates and receive at their CP's the same quality information he could receive at his own main command post.[42]

Like any other system, MCS has liabilities. It requires extensive integration and "train up". As noted previously, if communications don't already work then an automated control system won't fix them. Mobile Subscriber Equipment promises to provide greater reliability in the future. A subtle factor which may result in difficulties is the absence of eavesdropping. In the past, when a transmission went out over the command net, other commanders and key operations personnel have been able to listen-in. This enabled them to maintain a feel for the battle at other locations. Silent systems such as MCS do not provide this advantage. Commanders can circumvent this drawback by having staff personnel provide info copies of key instructions to interested parties. Future developments should negate many of these disadvantages.

As noted earlier MCS and indeed the entire Force Level Control System is evolutionary in nature. Eventually, MCS will be netted with the other functional control systems. Software updates are

scheduled to be introduced at eighteen month intervals. The next generation of MCS hardware is due to begin fielding by FY90. MCS is also being linked to allied automated control devices and other automated data transmission devices.[43]

MCS will be given an interface with the Enhanced Position Location Reporting System (EPLRS) which is an automated digital network providing the location of friendly units equipped with the PLRS device. This linkage will allow MCS to provide control measure data in real time down to company level. Eventually this interface may greatly enhance the synchronization of combat power as the commander is able to pinpoint the location of his units across the battlefield. The commander of the division which tested EPLRS stated that when it was withdrawn his division suffered a real deficiency.[44]

The Army has made a concerted effort to think through the process of tactical command and control. The Army Tactical Command and Control System with its subordinate elements are the result of this effort. This endeavor has committed the Army to automate in a large way with Maneuver Control System being a significant piece of the total architecture. Automation is a new technology which has been applied only marginally in the past at the tactical level. How it will work and what its contribution will be is still somewhat conjectural. However, some practical experience does exist and some of it will be examined in order to establish a basis for judgement.

CONTEMPORARY ANALYSIS

Since the initial work with the Tactical Operating System, the

precurser to the Maneuver Control System, the U.S. Army has been engaged in testing efforts with battlefield automation. At the same time other nations within NATO have engaged in similar efforts. These efforts provide the base of experience upon which judgements have been made for continuing developments in automation and more generally for assessing the overall efficacy of automated command and control at the division level. To gain some insight into the practicality of this concept, I will examine two cases. The first is from the U.S. Army. The other reviews efforts to provide automated command and control in the British Army.

In 1982 the Third Infantry Division was selected as a test bed for MCS hardware. This testing, a part of the developmental effort, complemented the *modernization effort* then occuring in that division. The increased capabilities made possible by the fielding of the M1 tank and the promise of other systems helped foster an attitude among the division's leadership that it was on the leading edge of the effort to adopt the AirLand Battle at the tactical level. As a result, when given the opportunity to test the Tactical Control Terminals, the division aggressively embraced the concept.

The commander of Third Infantry Division at that time, MG Fred Mahaffey, restructured his command and control system to make effective use of the MCS capability. General Mahaffey and his staff went through a comprehensive review of the requirements of their command and control system. They followed up with a concerted effort to restructure the system to ensure actions

could meet capability. The payoff for his "Marne" Command and Control system came during REFORGER 1982.[45]

Recognizing the need to exploit the new dimension of combat capabilities inherent in the modernized systems, General Mahaffey analyzed the battlefield on which he would have to fight. The battleground he describes is that of the AirLand Battle. After assessing his own new capabilities, he saw a battle of greatly increased tempo fought over increasing space at the division level. He also saw a more complex battle resulting from the echelonment of enemy forces and the deep strike capability of his adversaries. This environment forced him to be prepared to fight several battles in depth simultaneously. Victory could only come from the capability to react faster than his enemy. Specifically, Mahaffey saw a need to orchestrate the fight by positioning or repositioning combat power rapidly. Synchronization of his combat power was only possible if he could find and target the enemy through good intelligence and communicate his assessments and orders quickly to ensure their defeat. Moreover, in order to make sound decisions, he believed he needed a feel for the battlefield which could only be acquired away from the main command post. The conclusion was the division's command and control system must be structured to support this new view of battle.

The "Marne" Division restructured its command and control system through changes to its existing equipment and procedures and by incorporating the Maneuver Control System technology. Eventual success in the system was due to the synergistic effects of all actions; however, MCS played a significant role. MCS

assets in the division consisted of TCT and TCS (a more capable version of the TCT discarded due to costs) terminals down to maneuver battalion level. The capability was further expanded through the use of additional microcomputers linked to the system through a CORVUS disk. This capability in some respects exceeds what will be fielded in the next few years. The means of communication was through FM secure. With this equipment, the Third Infantry Division was able to do a number of interesting operational tasks.

MCS use focused on the timely transfer of organized information. This facilitated command and control by providing a better product as an input to decision making. An outstanding example of the use MCS as a commanders tool was the "Blue Rocket" report. This was a standardized report containing decision specific information from all staff sections. Normally, time critical issues requiring quick decisions were the focus of these reports. Preparation of the reports was supervised by the Chief of Staff in reaction to a battlefield crises or more often to an opportunity. Meanwhile, the CG could go forward to make a personal assessment of the situation. Upon completion of the report (essentially a estimate of the situation with recommended solution), it would be forwarded to the CP of the subordinate commander. The CG already would have arrived at the subordinate's CP and together they were able to discuss it. An advantage was gained due to a superior estimate and recommendation, but also because the CG was able to impart his intent face to face. In addition coordination of supporting arms was enhanced due to

superior information management. This system was employed with great success during REFORGER 1982 when Third Infantry Division was able to execute 22 battalion or brigade level counterattacks against the red force while suffering only two against itself.[46]

The U.S. Army has not worked in a vacuum in the development of tactical automation. The British version of MCS--"Wavell"--was fielded in the British Army of the Rhine for testing purposes in January 1986. This system represents their "first cut" at an automated command and control system and is regarded as a device to acclimate their personnel automation. The goal is to use it to determine characteristics for their ultimate system. The system resembles MCS in many respects; however, there are some significant differences.

Among the differences is the total reliance on "Ptarmigan", the British counterpart to mobile subscriber equipment. Wavell has no FM transmission capability but this is not considered a disadvantage given their confidence in Ptarmigan. Apparently the data bases have a limitation which requires they be completely updated after every move. The British have gotten around that by using an algorithm to divide information into discrete packets and they then provide only the information required for the processor in question. Generally, the effort is considered a success.[47]

MG Ramsbotham, commander of the British 3rd Armored Division, believes distributed and automated command and control equipment has revolutionized the way he commands and controls his division. Ptarmigan provides him mobile communications anywhere on the

battlefield. The Wavell system has in Ramsbotham's view permitted his staff officers to think and plan as opposed to acting as scribes. He believes the greatest value of Wavell comes in planning and preparation where the commander can set the terms of the battle before it ever starts.[48]

These experiences with germinal automated command and control systems reflect a common result. Each division commander used the system to synchronize his combat power to fight the battle his way. Structured information, capable of being transmitted to the place where it was needed on the battlefield, allowed them and their staffs time to think about the decisions and then make them with greater certainty. Automated command and control freed them from the headquarters and permitted them to command forward with the troops.

CONCLUSION

This paper began by asking what the effect of automation would be on command and control at the division. The intent was to establish if automation was good or bad. To accomplish that goal, I reviewed the theoretical basis for command and control especially as it applies to modern mobile warfare. The theoretical constructs were applied to three modern historical examples and were found to be valid. Then I posed the question, has battle changed? The answer is yes.

Technology has improved capabilities to such an extent that a new dimension has been added to the battlefield. That change, expressed doctrinally as AirLand Battle, includes more than simply the aspect of air -- the vertical dimension. In a larger

sense, it speaks to the added dimensions of time and space: the requirement to fight many places at once. AirLand Battle is an operational and tactical doctrine. Tactical units must execute to a high standard, if they are achieve the fruits of operational planning.

The capability to act was the goal that General Mahaffey sought in restructuring his command and control systems. The Army has also recognized this need in its conception of the Army Tactical Command and Control System. Systematic evaluation of command and control requirements based on current and future need led to the establishment of the Command, Control and Subordinate Systems architecture. Automation of battlefield information and the inclusion of some automated decision support tools are key ingredients for fighting the tactical AirLand Battle. Only through speeding our processes will we be able to out-think and out-fight our most dangerous potential adversaries. Automation is not the only answer, as commanders such as General Mahaffey and certainly General Prillaman would argue, but, if properly developed it can be a very important edge.

Before reviewing methods of ensuring the success of automation in the Army, I will address a few of the criticisms of automation. A common complaint is that automated systems are unreliable and too often it's necessary to fall back on manual systems. This is unfortunately true "today"; however, unlike our predecessors who made the same valid observations of the tank in the early 1920's, we need to take the long view. The Army's evolutionary approach to automation, if it can be sustained, is

the right approach. Another issue arises from critics such as General Prillaman, who emphasized that command is a personal business requiring limited players who can get the intent across and accomplish the mission. This may have been true in "P" Wood's time, but the plethora of battlefield weaponry and combat systems today makes this nearly impossible. Finally, we hear commanders complain of information overload and their fear of being tied to a headquarters. Generals Mahaffey and Ramsbotham show us the opposite is true. Automation freed them to go forward and provided their staffs the means to support the commander with their thoughts.

With respect to the Army's methods for incorporating automation into tactical command and control systems, it should be noted many things are already being done well. There remains room for improvement in the process. Two key areas deserve discussion. The first addresses the decisionmaking process for selecting systems. The second addresses the process of integration. Improvements in each process would enhance the adoption of tactical automation.

A good start has been made for determining automation requirements; however, some deficiencies remain. There do not seem to be sufficient focus and integration across the spectrum of development efforts. As technology continues to expand, we may regret early commitments to some systems. Some--maybe, much--of this cost is the inevitable price of learning. Further, as we watch real program dollars decrease in the near term, tough decisions will have to be made. Those decisions ought to be made

prior to imposition of cuts. Test results and comments invariably report automation's primary benefit is as a planning tool. If its chief benefit lies in this realm, then development effort in the short term should focus there. Systems related to execution may be postponable or, as MG Ramsbotham suggests, the horizontal linkage among the battlefield control systems may be expendable.[49] The concept is good, but we need to continue to approach the whole system in an evolutionary manner.

The second area of concern lies with integration of automation in the force. A major difficulty is acceptance in the field. Often resistance results from unfulfilled expectations. Combat developers should not promise more than they deliver (don't sell the future), and what is delivered should perform to a given standard. Command emphasis is another key. The Army needs to have commanders on board or the equipment will not be used. A corollary of this principle is that the field needs to believe developers are listening to their needs. Finally, the Army school house needs to quickly incorporate tactical automation into its instruction with a corresponding increase in training personnel to act as field operators as opposed to school room tacticians. In these ways we can assimilate automation a more effective rate.

Martin Van Creveld argues the advances in command have invariably resulted not from technology but rather from advances in training, doctrine and organization.[50] That is mostly true, but for the first time we now have a technology which can help us do our thinking. Handled correctly, it will help us win our wars.

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