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An Analysis of Alternatives to Verbal FM Radio Tactical Command and Control Communications

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Final report 6 June 1975

A thesis presented to the faculty of the U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
An Analysis of Alternatives to Verbal FM Radio Tactical Command and Control Communications

5. TYPE OF REPORT & PERIOD COVERED
Final report 6 Jun 75

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Beaver, John W., CPT, USA

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Student at the U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
US Army Command and General Staff College
ATTN: ATSW-DD
Fort Leavenworth, Kansas 66027

12. REPORT DATE
6 Jun 75

13. NUMBER OF PAGES
58

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Distribution limited to U.S. Government agencies only: Proprietary Information. Other requests for this document must be referred to U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES
Master of Military Art and Science (MMAS) Thesis prepared at CGSC in partial fulfillment of the Masters Program requirements, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
See reverse.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Three threats to the current tactical command and control communications system are identified and examined. These threats are overcrowding the frequency spectrum, electronic warfare, and the electromagnetic pulse effect. When these threats are considered in the light of the number of FM radios employed in the armor division for command and control communications, questions arise concerning the adequacy of the command and control system used in the division. Alternatives to verbal FM radio command and control communications do exist. The purpose of this research was to identify and evaluate those alternatives. This was accomplished by using a scenario for an armor battalion in the offense in a European conflict. The doctrinal alternatives--wire, messenger, sound, and visual--were wargamed against the required communications needlines. The number of messages required for battalion operations over a 24-hour period were derived from several current studies.

AN ANALYSIS OF ALTERNATIVES TO VERBAL FM RADIO TACTICAL COMMAND AND CONTROL COMMUNICATIONS

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements of the degree

MASTER OF MILITARY ART AND SCIENCE

by

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1975

ABSTRACT

Three threats to the current tactical command and control communications system are identified and examined. These threats are overcrowding the frequency spectrum, electronic warfare, and the electromagnetic pulse effect. When these threats are considered in the light of the number of FM radios employed in the armor division for command and control communications, questions arise concerning the adequacy of the command and control system used in the division. Alternatives to verbal FM radio command and control communications do exist. The purpose of this research was to identify and evaluate those alternatives. This was accomplished by using a scenario for an armor battalion in the offense in a European conflict. The doctrinal alternatives--wire, messenger, sound, and visual--were wargamed against the required communications needlines. The number of messages required for battalion operations over a 24-hour period were derived from several current studies.

Although a single replacement communication means does not exist for FM voice radio, armor battalion commanders need to accomplish several actions. The significant threat posed by the proliferation of electronic devices, the electronic warfare capability of the Soviets, and the possibility of nuclear warfare on the future battlefield make it

essential that commanders prepare their units to operate using the alternative means of communication. It is essential that tactical commanders train their units in decentralized operations, electronic counter-countermeasures, and integrate the alternative means of communication into training exercises. In the midst of battle is too late to train commanders and staffs in command control operations which do not include FM voice radio communication.

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CHAPTER I

INTRODUCTION

Rationale for Study

One of the most serious problems facing the commander of ground forces is his ability to control the forces in a maneuver to succeed in its mission and to take maximum advantage of the friendly and enemy situation. The nature of combat and the variations in terrain make it very difficult for the commander to achieve control, alter plans, and take advantage of a weakened enemy situation. In recent years the control problem has been greatly overcome by the use of tactical net radios which enable the commander to receive real time intelligence and react immediately. He can control forces which are spread over an area in excess of 30 kilometers in diameter with the net radios authorized his units. His movement is unhampered.

The zenith of command control by net radios was achieved in the Vietnam War. Radios were plentiful and even high level commanders were able to monitor and provide guidance to squad and platoon leaders engaged in combat with the enemy. The result was almost a sand table exercise. Commanders could look down from helicopters and control the tactical maneuvers. As a result of this type of operation in Vietnam and the lack of an electronic warfare threat from the enemy, the

technique for commanding troops hinged on verbal communications. Proper radio telephone procedures were not always adhered to and a breakdown in communications discipline resulted. Commanders and operations officers found that they relied upon verbal communications to conduct operations.

Events in the 1973 Mid-East War have indicated that the U.S. Army may not have the opportunity to operate as freely and openly in the future. The Soviet Army, a potential enemy, possesses a massive electronic warfare capability. Another problem facing the U.S. Army's command control system is the threat of nuclear war. The use of tactical and strategic nuclear weapons can seriously degrade the electronic equipment used for command and control.

The great number of electronic emitters on the battlefield crowd a limited frequency spectrum and pose a serious problem. Armies on the future battlefield may find that they have overloaded the frequency spectrum and cannot effectively operate their electronic devices.

Command and Control

Command and control is "an arrangement of personnel, facilities and the means for information acquisition, processing and dissemination employed by a commander in planning, directing, coordinating and controlling operations."[1] Too often, command and control is believed to be solely the communications used by the commander for information flow.

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[1]Department of the Army, Dictionary of Army Terms, AR 310-25 (1972), p. 127.

However, as AR 310-25 indicates, it is actually the sum total of things done by the commander and his staff in order to accomplish the mission.

Communications are an important facet of command and control since tactical forces have come to depend increasingly upon communications-electronic devices to enhance maneuverability and increase operational flexibility.[2] This research paper is concerned with the communications portion of command and control or the means of getting information to the commander and from the commander to his staff and subordinate units.

Command and Control Using Tactical Net Radio

The increasing role of communications-electronic devices (especially the tactical net radio) has overshadowed the use of alternate means. Commanders now control their units in training exercises primarily with voice commands over frequency modulated (FM) radio nets.

Major General Robert M. Shoemaker, in an address before the U.S. Army Command and General Staff College, stated that the best way to convey orders to his subordinate commanders in training and in combat is over FM radio. Not only does this provide speed, accuracy, and flexibility, but General Shoemaker believes the characteristics of the voice carry essential information.[3] Some communications data give voice

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[2]Department of the Army, Tactical Communications Doctrine, FM 24-1 (1968), p. 77.

[3]MG Robert M. Shoemaker, "Command and Control of a Division," address before USACGSC, 14 November 1974.

characteristics credit for more communications meaning than the words selected.

Current U.S. Army doctrine reinforces dependence upon voice radio communications for command and control. The principal means of communication within the division, brigade, and battalion is FM voice radio. The division is augmented with multi-channel communications, which is also FM radio.[4] In each case, the unit communication-electronic staff officer or section is tasked to provide alternative means in the event FM voice communications fail.

The intent of this research was to examine the alternative means available to the communications personnel and the commander to provide for the flow of information. The significant threat posed by the proliferation of electronic devices, the electronic warfare capability of the Soviets, and the possibility of nuclear warfare on the future battlefield make this necessary.

Threat I: Proliferation of Electronic Emitters

The great number of ground and air vehicles added to the Army in recent years has led to a massive number of FM radios in the Army's inventory. The Office of the Chief of Staff, U.S. Army, directed that a study be made of the great number of radios in the Army to determine if doctrinal authorizations were being followed and if the number could be reduced. The result was the publishing of the commonly-referred to

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[4]DA, FM 24-1, pp. 36-37.

SPANNER Final Report in 1974. It found that "tactical net radios, particularly FM radios, proliferate primarily because operators require no special training and the radios are effective in any environment." Further: "Results of the SPANNER TOE review have proven that hundreds of excess radios exist throughout a wide spectrum of TOEs."[5] It is obvious that the practice of "minimum essential" requirements is not being followed.

Even without the problem of unauthorized radios, a massive number of net radios exist in the Army. For example, an armored battalion has 149 FM radios and requires about 14 FM frequencies for operation under current doctrine. The armored division has 2,691 FM radios, 162 amplitude modulated (AM) radios, 59 very high frequency (VHF) multichannel radios, and 54 radars, a total of 2,966 electronic emitters.[6] This great reliance placed upon electronic devices (particularly FM radio) for command control communications has subjected the Army to a significant threat. Lieutenant Colonel Edwin B. Leaf, Jr., had this to say about the massive communications system that has evolved:

> Because only radio transmission is practical for modern Army long lines and tactical communications, our system already dangerously crowds the frequency pattern. Add to this enemy use of frequencies in wartime, the growing use of the system for non-communications purposes and it can be seen that . . . large portions of the system

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[5]Department of the Army, Office of the Chief of Staff, U.S. Army, Special Analysis of Net Radios: SPANNER Final Report (1974), pp. 1 & ii-5.

[6]Department of the Army, Armor Division, TOE 17-H (1970); and Department of the Army, Armor Battalion, TOE 17-035H (1970).

> may become ineffective. . . . [O]verdependence on great volumes of electrically transmitted traffic may put in jeopardy the system of command that depends on it.[7]

The U.S. Army Combat Developments Command also expressed concern over the increased use of the frequency spectrum and the growing demand for communications-electronic equipment. It saw the frequency resources as limited and already seriously stressed.[8] The belief that problems dealing with the sharing of the frequency spectrum will plague the future battlefield is shared by Lieutenant Colonel Charles B. Ablett, USA. He stated: "Any modern major military force generates a radiated electronic field. When two such opposing forces meet, their radiated electronic fields interact accidently or intentionally."[9]

One of the more difficult problems facing the peacetime Army and the civilian users of the frequency spectrum is the coordination of that resource. Anyone who has been on a field training exercise in recent years realizes the difficulties in interference free operation of electronic devices. Add to this the utilization of the frequency spectrum by allies and by the enemy in time of war and a major force will be fortunate to operate electronic devices in the most marginal manner.

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[7]Edwin B. Leaf, "Are We Overcommunicating?: The Signal Explosion," Army, September 1973, pp. 17-19.

[8]U.S. Combat Developments Command, "Study of Communications Electronics--75" (Fort Belvoir, Va., 1969), p. O-2.

[9]Charles B. Ablett, "Electronic Warfare--A Modern Weapon System," Military Review, November 1966, p. 3.

Threat II: Electronic Warfare

In addition to the proliferation of electronic emitters and the resultant overutilization of the frequency spectrum, the threat of the enemy's use of electronic warfare against U.S. Army communications and non-communications devices is very real. Electronic warfare is the use of electronics by a military force to prevent the enemy from effectively using electromagnetic energy and the action taken to insure its own effective use of electromagnetic energy. Electronic warfare (EW) consists of electronic warfare support measures (ESM), electronic countermeasures (ECM), and electronic counter-countermeasures (ECCM).[10]

> Electronic warfare support measures involve actions taken to search for, intercept, locate, and immediately identify radiated electromagnetic energy for the purpose of immediate threat recognition and actions exploiting such radiations in support of military operations.[11]

The electronic warfare support measures are considered to be the passive aspect of electronic warfare. This is the area in which the enemy can construct an electronic order of battle and gain valuable intelligence about the operations of the units he is facing. It is this aspect of electronic warfare that poses a significant threat to the FM radio. The operator must assume that all the information that is being passed over the radio is being intercepted by the enemy.

An enemy can often identify an emitter type in near real time when

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[10] U.S. Army Command and General Staff College, Electronic Warfare, RB 32-20 (1974), p. 1-1.

[11] Ibid.

> direct intercept occurs. The tactical implications might be highly significant, especially if the enemy has time and facilities to establish the geographic location of the emitter by direction finding.[12]

If a communications station is located by direction finding, Soviet procedure is to fire artillery on the location. In the Soviet Army, "signal intercept is a primary means of target acquisition."[13]

Electronic countermeasures represent the offensive aspect of electronic warfare. This is the area in which disruptive techniques are employed against the enemy's electromagnetic emitters in order to reduce their effectiveness. This area includes jamming and deception.[14]

Electronic counter-countermeasures are those actions taken to prevent the enemy's use of electronic countermeasures or to limit their effect. These actions are generally defensive and include correct operator procedure, training, proper siting of equipment antennas, and the actions an operator takes when his radio receiver is jammed.[15]

To gain an insight into the role that Soviets feel electronic warfare will play in future conflict, it is of value to examine the statements of two Soviet military writers. Colonel M. Belov stated:

> Radio interception of signals and their interpretation occupy an important place in the system of electronic and radar reconnaissance. Therefore, special services are already created in peacetime. The employment of electronic and radar countermeasures means

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[12] DA, O/CSA, p. xii-40.

[13] U.S. Army Command and General Staff College, "Nuclear and Chemical Doctrine and Capabilities" (1975), p. i-5.

[14] USACGSC, RB 32-20, p. 1-1.

[15] USACGSC, RB 32-20, p. 1-1.

> is assessed as a factor which is able to influence decisively the outcome of a battle or an operation. According to some specialists, an enemy attack can be thwarted by these means even more reliably than by conventional weapons.[16]

Marshal Vasili D. Sokolovsky offered a good summary of the Soviet view of electronic warfare today. He stated:

> The widespread use of radio-electronic equipment in all fields poses a difficult problem concerning the battle in space. The problem is how best to prohibit or decrease the effectiveness of the enemy's radio-electronic systems and at the same time, how to ensure the successful use of one's own equipment. One of the main aims is to disrupt the enemy's control over his own troops and weapons by active radio interference and the destruction of his most important radio systems. This includes demolishing or interfering with the enemy's electronic equipment installed in aircraft or missiles: preventing the enemy's use of electronic equipment for aerial detection, navigation, bombing, and missile guidance; and disrupting the operation of the enemy's ground-based electronic apparatus used for commanding troops. This list alone shows the great extent to which electronic countermeasures, and protection from electronic countermeasures of the enemy can be used; it shows how serious their consequences can be. The development of electronics is, at the present time, as significant as the development of nuclear missiles which, incidentally, cannot be used without electronic equipment.[17]

Colonel Charles L. Bachtel and Major General Stewart C. Meyer are among many American military writers who have publicly expressed their views regarding electronic warfare. Colonel Bachtel wrote:

> Army air defense equipments are ill-equipped to handle anything like what the Soviet ECM/ECCM effort is capable of delivering--even on a half-hearted basis. Regrettably, the rest of the Army has little or nothing to show in the line of ECM/ECCM.[18]

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[16] Colonel M. Belov, "New Factors in the Development of Modern Armies," Soviet Military Review, February 1974, pp. 12-13.

[17] Ablett, pp. 10-11.

[18] Charles L. Bachtel, "The ECM-ECCM Syndrome," Signal, October 1973, p. 29.

General Meyer stated the following about the Army's role in electronic warfare:

> In past military operations, the Army's exposure to hostile electronic warfare or to hostile electromagnetically controlled weaponry has been relatively minimal. This has been true despite the fact that today's Army is employing far more sophisticated equipment and weaponry than at any time. The pervasiveness of electronic sensors and communications on the modern battlefield places a premium on the capability of the Army to protect its multi-billion dollar investment in sophisticated electronics equipment.[19]

As General Meyer pointed out, the U.S. Army's concern with electronic warfare has increased in recent years, especially during the months since the 1973 Mid-East War, where both belligerents made extensive use of electronic warfare. The Army Materiel Command's Research, Development, Testing and Evaluation budget for electronic warfare equipment also reached a new high in Fiscal Year 1974.[20]

General Meyer also speculated that the U.S. Army can ill-afford to field a tank, a highly sophisticated weapons system which costs in excess of one-half million dollars, without protection from electronic warfare.[21] Clyde D. Hardin, Director, U.S. Army Electronic Warfare Laboratory, pointed out that the United States is "behind the power curve" and that "the principal challenges are well known to most." He also pointed out that the recent Mid-East conflict has brought into "the

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[19] Stewart C. Meyer, "AMC Started the New Year with Renewed Emphasis on Electronic Warfare," Electronic Warfare, March-April 1974, p. 27.

[20] Ibid. [21] Ibid.

open press the extensive use of electronic warfare as a tactical weapon."[22]

As pointed out earlier by Colonel Bachtel, the U.S. Army has been poorly prepared to compete in an electronic warfare environment. The Soviet Union has taken a great lead in the employment of electronic warfare equipment and in the development of electronic warfare doctrine. The 1973 Mid-East War did much to emphasize the state of the art the Soviets possess and to awaken the U.S. Army to the need to develop its electronic warfare capability as evidenced by General Meyer's comments and the increased Army Materiel Command budget.

Threat III: Nuclear Warfare

Another threat to command and control communications, using FM voice radio, is the effects of nuclear warfare. A nuclear detonation produces radiated or induced electromagnetic fields. These fields can induce large surge currents on power, telephone, and other lines and metal conductors. This electromagnetic pulse (EMP) has most of its energy within the radio frequency spectrum. Another term for EMP is radio flash. The Compton-electron effect is a principal means of the generation of EMP. The initial gamma radiation, hard x-rays, are emitted from the exploding weapon with high energies and strike the molecules in the surrounding atmosphere. This causes electrons to be

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[22]Clyde D. Hardin, "The U.S. Army Electronic Warfare Laboratory: A View from Behind the Power Curve," Electronic Warfare, March-April 1974, pp. 33-37.

violently separated from the air molecules. These electrons, called Compton recoil electrons, move away from the explosion, leaving behind much slower moving and heavier positive ions. This relative displacement of positive and negative charges produces an intense electric field. Under the influence of the electric field, the large number of electrons present will be driven back, some via the ground, toward the burst point, and will produce high-level currents and magnetic fields.[23]

Basically, EMP creates a "power surge" in electronic equipment much the same as one gets when he starts a vehicle while the radio is turned on. Figure 1 provides a comparison of the relative electromagnetic power of typical electronic devices compared with EMP. Electronic devices need not be "on" to be affected by electromagnetic pulse. Transistors, which operate on micro-volts, are most susceptible to power surges and, therefore, the effects of electromagnetic pulse. All of the U.S. Army's tactical net radios are transistorized, whereas the Soviets use exclusively vacuum tube electronic devices. It is not known if the Soviet reliance upon vacuum tubes is the result of technological lag, the utilization of old radios, or due to foresight as to the effects of the electromagnetic pulse.

The relative effects and radiated areas of electromagnetic pulse on land systems are shown in Table 2. The "killing" range of electromagnetic pulse varies from hundreds of kilometers from a high altitude

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[23]Office of Civil Defense, "EMP Protection for Emergency Operating Centers" (Washington, 1971), pp. 1-7.

TABLE 1.--Electromagnetic Power Comparison

Power/Energy Source	Power Density (Watts Per Square Meter)
Typical Radio Receiver	10^{-3}
Typical Radio Transmitter	10^{2}
Directional Pulse Radar	10^{3}
Electromagnetic Pulse	10^{6}

Source: Edwin James Gaul, "Electromagnetic Pulse," Military Review, March 1975, p. 13.

TABLE 2.--Strength and Area Coverage of Electromagnetic Pulse on Land Systems

[NA = Not Applicable; Sq Km = Square Kilometers]

	Source Region		Radiated	
Type of Burst	Strength	Area (Sq Km)	Strength	Area (Sq Km)
Exoatmospheric	NA	NA	High	10^{6}
Air	NA	NA	NA	NA
Near-Surface	Low-High	10	Low	50
Surface	High	10	Low	50
Subsurface	High	1	NA	NA

Source: Edwin James Gaul, "Electromagnetic Pulse," Military Review, March 1975, p. 15.

burst to tens of kilometers from a surface burst. Therefore, damage or disruption of communications devices may occur where other nuclear weapons effects are not important. The important thing to command and control is that the tactical commander may lose his communications-electronic devices at a distance up to ten kilometers from a tactical nuclear burst.[24]

Edwin James Gaul pointed out that the "Army's increasing dependence on sophisticated command control and communications systems enhances the electromagnetic pulse threat proportionally." He concluded that "electromagnetic pulse is a critical effect because of the energy involved, the area of coverage, and the possibly large vulnerability radius of modern weapons."[25]

Problem Statement

When the three major threats of overcrowded frequency spectrum, enemy electronic warfare, and electromagnetic pulse effect are considered, questions arise concerning the adequacy of the voice dominated command and control communications system used in the armored battalion. Alternatives to verbal FM radio command control communications do exist. The purpose of this research was to identify and evaluate those alternatives. Therefore, the problem statement developed for the research

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[24]Edwin James Gaul, "Electromagnetic Pulse," Military Review, March 1975, pp. 12 & 18.

[25]Ibid.

effort reported in this study was: To examine the alternatives to verbal FM radio tactical command and control in an armor battalion in order to create an awareness of the capabilities of the battalion to function on the electronic battlefield.

CHAPTER II

METHODOLOGY

Scope

This chapter consists of methodology. An armor battalion was the basis for analysis of the doctrinal means of command control communications available to the commander. These means--FM radio, wire, messenger, visual, and sound--were examined in terms of employment, capabilities, and the requirements of the commander to communicate. Characteristics utilized for comparison were speed, reliability, distance, and security.

Instruments

The means were evaluated based upon the tactical scenario used in Communications Support Requirements (COMSR) for a tank battalion. The U.S. Army Combined Arms Center is conducting the COMSR Study in an attempt to establish estimated communications requirements for future combat. The scenario was developed to provide all the communications needlines that are anticipated for a tank battalion in the offensive in the European scenario (see Appendix A). An analysis of the tank battalion communications support needlines for the scenario may be seen in Appendix B.

Data as to the number and length of messages that are expected to be used by a tank battalion in combat are shown in Table 3. The data were derived from the COMSR Study and from MASSTER Test 119. The data from MASSTER Test 119 are for a maneuver battalion rather than an armor battalion, as in the COMSR data; however, they provide a comparison for the COMSR data. The two sets of COMSR data in Table 3 are used in this study. The initial COMSR data, COMSR I, were based in large part upon empirical data that were obtained during the Vietnam War; they therefore reflect the massive number of messages that were communicated between units during that conflict. The second set of COMSR data, COMSR II, was based upon input from the Combined Arms Center, the U.S. Army Armor School, and the U.S. Army Signal School and should more closely approximate the actual traffic in a European scenario.

Table 4 reflects the total number of messages a battalion transmits and receives during a 24-hour period. Although the COMSR Study is undergoing a revision, the number of total messages appears to have increased in the second study. Regardless of the apparent increase, it is evident that the battalion, using current doctrine, can be expected to send and receive a large number of messages during a 24-hour period. As may be seen in Table 4, the battalion can be expected to send and receive an average of 733 messages in a 24-hour period. The approximate average time for transmission of each message was 2 minutes, which means the battalion can expect to occupy 24-1/4 hours in transmission time. Even when this is spread out over the battalion's twelve radio nets, it

TABLE 3.--Number of Messages Originated in a 24-Hour Period by Command/Operations Elements*

Element	COMSR I	COMSR II	Test 119
Commander	116	64	. .
Operations	178	165	338

TABLE 4.--Total Messages for a 24-Hour Period*

Study	Originated	Received	Total
COMSR I	317	439	756
COMSR II	366	409	775
Test 119 (Operations Only) . .	338	331	669
Average:	340	393	733

*Sources:

Column 1: U.S. Army Combined Arms Center, Communications Support Requirements (COMSR) (Computer Sciences Corporation, 1973), pp. A-II-74-5 through A-II-74-12.

Column 2: Ibid., special undated printout of Tank Battalion.

Column 3: Modern Army Selected System Test, Evaluation and Review, Staff Organization and Procedures, Test 119 (1974), pp. 328-41.

is an immense amount of transmission time.

In analyzing the doctrinal communications means of the battalion, the number of messages and the time required for transmission established by the COMSR and MASSTER studies were used as a guideline for the measurement of the effectiveness and practicability of the various means.

The communication needlines of the tank battalion established by the COMSR Study (see Fig. 1) were used in this study to provide a guideline for the expected communications links in a future conflict. An analysis of these needlines and the justification as established by the COMSR Study may be seen in Appendix B. Figure 2 depicts the doctrinal net structure of the armor battalion. The COMSR needlines are an amplification of the doctrinal needs, applying the doctrine to the European scenario.

For the purpose of this study, it was necessary to determine the physical dimensions of the battlefield or area upon which a tank battalion will operate. Based upon the COMSR scenario and discussions with the European Scenario Committee in the Tactics Department of the U.S. Army Command and General Staff College and various Armor Officers in the student body, it was determined that the tank battalion in the scenario will occupy approximately six square kilometers of terrain. Based upon this assumption, the distances depicted in Figures 3 and 4 were used for the analysis of alternative means of communication.

Figure 5 depicts the analysis model which was used for the

1/20 Tank Battalion to:

Air Cavalry Troop, 7th Air Cavalry Squadron
Air Defense Artillery Battery
Armored Brigade
Attached Company A/4/20 Mechanized Infantry Battalion
Company A/1/20 Tank Battalion
Company B/1/20 Tank Battalion
Company D/1/20 Tank Battalion
Direct Support Medical Company
Division Alternate
Division Main
Division Support Command
Engineer Battalion
Forward Support Company
4/20 Mechanized Infantry Battalion
Maintenance Battalion
7th Administration Company
7th Armored Cavalry Squadron
7th Aviation Company
7th Medical Battalion
7th Supply and Transport Battalion
Supply and Services Company
2/7 Field Artillery Battalion (155mm Self-Propelled)

Source: U.S. Army Combined Arms Center, Communications Support Requirements (COMSR) (Computer Sciences Corporation, 1973), p. A-II74-2.

Fig. 1.--1/20 Tank Battalion Communication Needlines

	Bde A&L	Bde Comd	Bde Intel	Bn Comd	Bn A&L	Bn Hv Mort Plt	Bn Scout Plt	Arty Bn Comd/FD	Bn Survl	TAD(UHF)	Bde RATT	Div Air Req(AM)
Bn Cdr		✓		✓								
XO				✓	✓							
S1					✓							
S2			✓	✓					✓			
S3		✓		✓								
S4				✓	✓							
Bn S3 Air										✓		✓
HHC				✓	✓							
HHC XO					✓							
Scout Plt												
LDR				✓			✓					
SGT							✓					
SEC(2)							✓					
Hv Mort Plt												
Squad(4)						✓						
FDC				✓		✓		✓				
FO(3)						✓						
LDR				✓		✓						
FAC				✓						✓		
Bn LNO(2)				✓								
Commel Off				✓								
Survl Sec Sgt									✓			
Commo Plt				✓								
Gnd Survl Sec(6)									✓			
Spt Plt	✓				✓							
Co Maint Sec					✓							
AVLB Sec					✓							
Med Sec					✓							
Bn Surg					✓							
Bn Maint Off					✓							
Tnk Co(3)				✓	✓							
Bn Maint Plt(3)					✓							

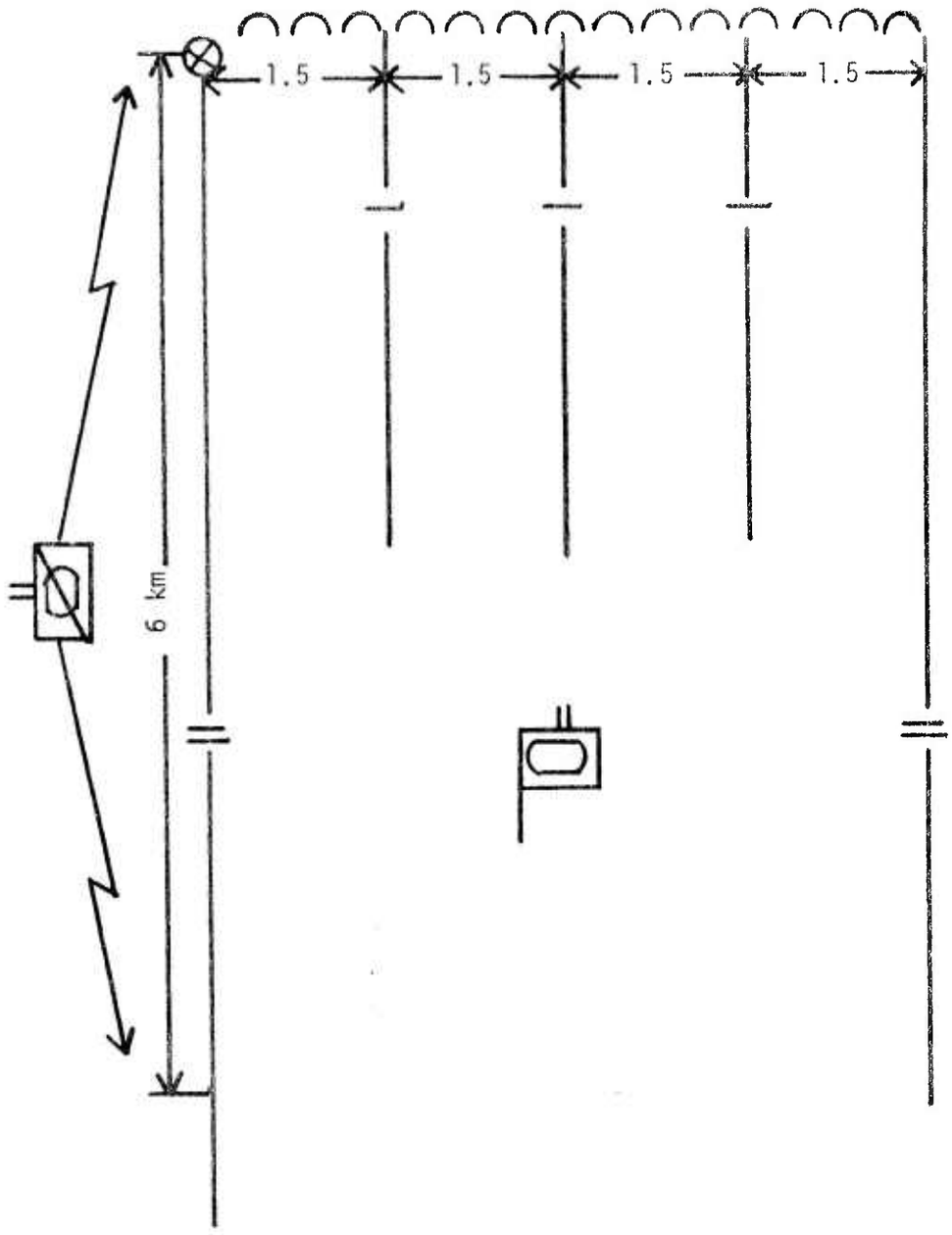
Source: Department of the Army, Tank Units: Platoon, Company and Battalion, FM 17-15 (1966), p. 19.

Fig. 2.--Doctrinal Net Structure of an Armor Battalion

Kilometers from Armor Battalion Command Post	To Supporting and Supported Units
6	A/4/20 Mechanized Infantry Battalion (Attached)
8	Air Cavalry Troop
6	Air Defense Artillery Battery
6	Armored Brigade
6	Company A/1/20 Armor Battalion
6	Company B/1/20 Armor Battalion
6	Company D/1/20 Armor Battalion
15	Division Main
15	Division Support Command
8	Division Tactical
6	Engineer Battalion
6	Forward Support Company
6	4/20 Mechanized Infantry Battalion
15	Maintenance Battalion
20	7th Administration Company
6	7th Armored Cavalry Regiment
15	7th Aviation Company
6	7th Medical Company
15	7th Supply and Transportation Battalion
6	Supply and Services Company
6	2/7 Field Artillery Battalion (Direct Support)

Source: Interviews with the European Scenario Committee of the Department of Tactics and Logistics and selected Armor Officers at the U.S. Army Command and General Staff College, School Year 1974-75.

Fig. 3.--Distances from Armor Battalion Command Post to Supporting and Supported Units



Source: Interviews with the European Scenario Committee of the Department of Tactics and Logistics and selected Armor Officers at the U.S. Army Command and General Staff College, School Year 1974-75.

Fig. 4.--Battalion Dimensions

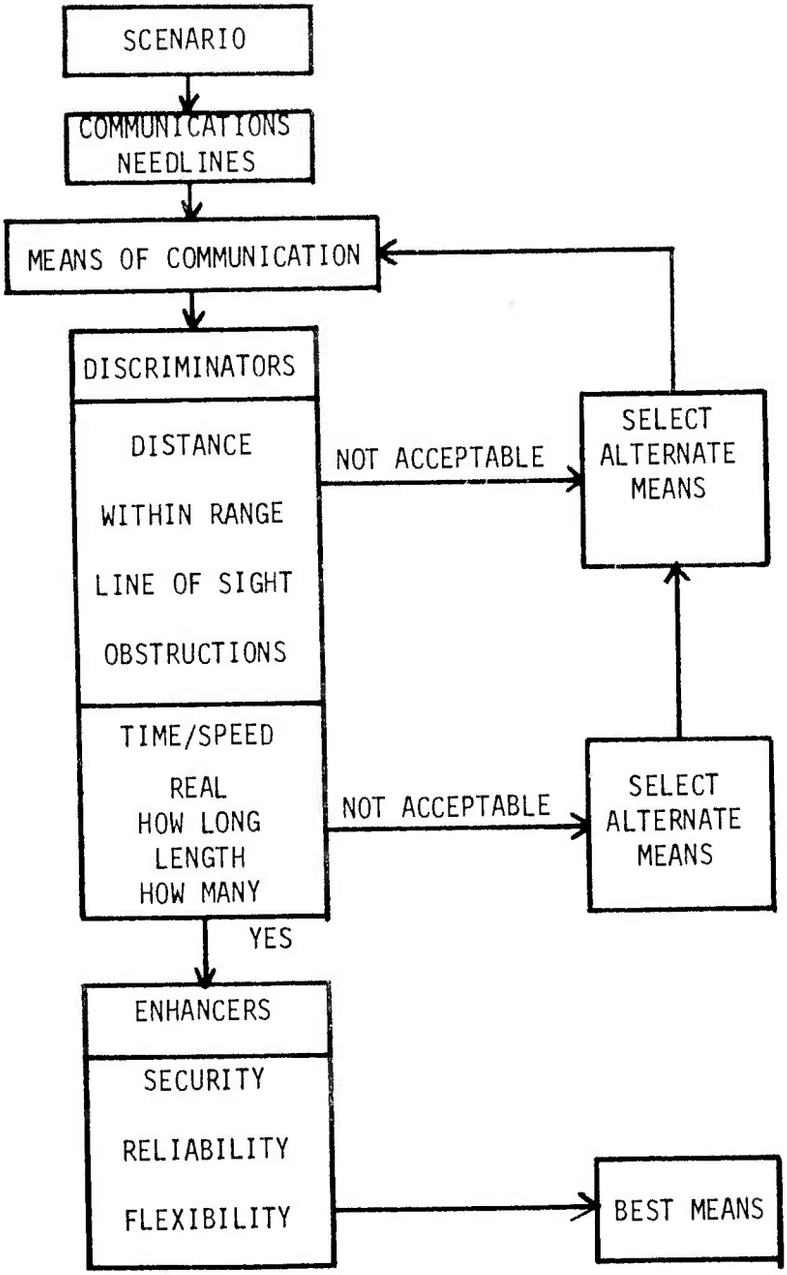


Fig. 5.--Analysis Model

comparison of the alternate means of communication. Based upon the scenario (Appendix A), the communication needlines were evaluated in the step-by-step method illustrated in the model. If a means of communication satisfied the discriminator block, it was considered an acceptable means of communication for the needline. The enhancer block was used to identify characteristics which improve the quality of the communication means above the acceptable level.

CHAPTER III

ARMOR BATTALION MEANS OF COMMUNICATION

Doctrine

Radio is the means of communication used most in armor units. Wire, messenger, visual and sound communication are supplemental means employed extensively under certain circumstances. The flexibility of radio communication affords the commander the ability to control and coordinate subordinate elements, yet does not restrict maneuver of these elements. Radio communication may be affected adversely by enemy jamming, unfavorable terrain, and weather. Armored leaders habitually operate their own voice radios to insure the direct and personal contact characteristics of armor command.[1]

The armor battalion is authorized the following radios:

Frequency Modulated, vehicular mounted, AN/VRC-46, 47 and 49
- Channels: 920
- Frequency Range: 30 to 75.95 MHZ
- Power Requirement: 22 to 30 volts direct current
- Power output: Low: 8 watts
  High: 35 watts
- Range: Low power approximately 8 kilometers
  High power approximately 41 kilometers

. . . . . .

Frequency Modulated, personnel carried and vehicular mounted, AN/PRC-77, AN/VRC-64, and AN/GRC-160
- Channels: 920
- Frequency Range: 30 to 75.95 MHZ
- Power output: 1.1 to 2 watts
- Range: 8 kilometers

. . . . . .

Amplitude Modulated, vehicular mounted, AN/GRC-106. A high frequency, single-sideband radio receiving-transmitting set. Voice and continuous wave (CW) operation.

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[1]Department of the Army, Armor Operations, FM 17-1 (1966), p. 130.

Range: ground wave up to 60 kilometers
skywave 600 to 2,400 kilometers

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Amplitude Modulated, vehicular mounted, AN/VSC-3, radio teletype. Same capabilities as the AN/GRC-106.[2]

The communications nets the armor battalion operates and is a member of are shown in Figure 2 (page 21). This includes nets to higher headquarters and to internal or subordinate nets. The artillery fire support officer and the tactical air controller provide their own communications equipment for entering external fire support nets.

Wire communication supplements radio and is used whenever practicable. The installation of wire is dependent on the situation and the time available. It is used mainly in defensive situations and in assembly areas.

Messengers are used to supplement radio and wire. Messenger communication is more secure and dependable generally than other means but lacks the speed inherent in radio or wire communication. Use of air messenger service will speed delivery time.

Visual communication is a means available to all units. Visual signals are transmitted by flags, lights, pyrotechnics, panels, arm and hand signals, and aircraft meneuvers. They are suitable for transmitting simple prearranged messages rapidly over short distances as well as for recognition and identification of friendly forces. Their use is restricted by distance, visibility, security and the nature of the signal.

Sound communication is typified by such devices as sirens, shots, horns, and alarms. The chief value of sound signals is to attract attention, transmit simple prearranged messages, and to spread alarms. Sound signals are satisfactory only for short distances, and their effectiveness is greatly reduced by battle noise.[3]

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[2]U.S. Army Southeastern Signal School, Signal Reference Data: Radio and Radar Communications Equipment (Fort Gordon, 1974), pp. 1-6, 1-13, 2-14, & 3-12.

[3]Department of the Army, p. 131.

Radio

When the doctrine of the armor battalion is examined, it is obvious that greatest reliance for a means of communication for command and control is placed on the radio. In the U.S. Army prior to 1935, the only means of controlling tanks was to assign objectives or other control measures and to use infantry-tank verbal communications. The Army began experimenting with radios in tanks about 1935. Platoons were equipped with receivers in each tank and the platoon leader had a receiver and transmitter which enabled him to provide information to the tank commander.

> For example, a tank platoon attached to an infantry battalion could in this manner be advised of the location of a particular hostile machine gun that was holding up the attack. Thus, the tank platoon commander could immediately move all or a part of his platoon against the reported resistance.[4]

It is also interesting to note that in 1935 instruction in tank employment, the following priorities were stated concerning control of tanks by commanders:[5]

1. By designated boundaries.

2. By designating assembly points where control is regained and new instructions are given.

3. By designating single missions with an assembly point for each.

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[4]Infantry School, Chief of Infantry, Tank Employment, ST No. 14 (Fort Benning: Army Field Printing Plant, 1935), p. 36.

[5]Ibid., p. 37.

4. By radio.

These priorities are just the opposite of those employed by current doctrine.

The increased reliance on radios for control of armored forces can easily be understood. Two examples of the reasons are especially noteworthy. First, the Germans defeated a far superior force of French tanks and attributed the fact to German mobility achieved through the effective use of command and control radios while the French were using flags to control their tanks.[6] Second, one tank commander in World War II explained that 50 per cent of the 20 officers killed in his battalion in 5 months of combat were killed when they "were forced to get out of their tanks in an attempt to communicate with infantry platoon leaders.[7]

Obviously the radio enables the commander to control his forces from the protection of the armored vehicle. This is a point which should be well heeded since some battles in the 1973 Mid-East War were "fought at 400 to 500 yards."[8]

As has already been pointed out, armor commanders have grown to

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[6]Frank E. Owens, "The Battle for France, May-June 1940: The Role of Command Control Communication" (student paper, U.S. Army Command and General Staff College, 1970).

[7]Army Service Forces, "Tank Operations in France" (Washington, 1945), pp. 1-2.

[8]"Israel Scores a Breakthrough," Newsweek, 29 October 1973), p. 41.

rely on radio for command and control communications due to its obvious merits. Radio allows the commander to effectively change the mission in order to exploit the situation, and it provides him great flexibility. The commander can talk in real time with his subordinate and higher headquarters to provide intelligence or guidance. He can physically be located anywhere in the 6-kilometer-square battlefield and control his forces. The ranges of the current radios used in the armor battalion allow him to communicate for distances up to 32 kilometers, which fully covers the distance to subordinate, supporting, and higher headquarters that the commander needs to talk with. All of the needlines established by the COMSR scenario and doctrine and the distances to those units, as shown in Figures 3 and 4 (pages 22 and 23), can be met by the FM radios in the armor battalion.

The great weakness of the FM radio for command control communication ironically lies in its strengths--the range, the ease of operation, and the fact that the commander can clearly explain his instructions. These weaknesses allow the Soviets, with their great number of electronic warfare devices, to have a significant target for electronic support measures and electronic countermeasures. The information the aggressor can acquire from monitoring 733 messages in a 24-hour period is phenomenal. Thus, if aggressor decided to take active measures and jam the transmissions, it is doubtful that a unit requiring 733 transmissions under normal conditions could operate effectively. With the armor battalion in the attack, it can be expected that the Soviets would

easily be within 32 kilometers, the range of tactical FM radios.

To effectively evade the Soviet electronic warfare threat, it would be necessary for the commander of the tank battalion in the scenario to impose strict radio listening silence on his units. The use of radios in control of the attack would have to be far below the 733 transmissions projected for this operation. It would be necessary for the number to be reduced to as few as possible. Not only would the number need be reduced, but other electronic counter-countermeasures would need to be strictly enforced. This includes proper siting of antennas, short transmissions, masking of electronic signature by terrain, and rapidly displacing transmitters once a message was sent.

If the Soviets should use an active response, the commander could expect jamming or artillery fire on his position very rapidly. One technique employed by the Soviets is to target transmitter positions they have located by direction finding techniques with artillery. Since an enemy with sophisticated electronics can probably identify an emitter type in near real time if he intercepts it directly, it is obvious that a commander who uses his radio must be prepared to displace rapidly. Even secure devices do not provide the protection from the electronic warfare threat that is needed. If the Soviets cannot gain intelligence from radio transmissions of a unit, they are left no choice but to take an active measure of jamming or artillery targeting of the transmitter location.

The threat of electromagnetic pulse, the proliferation of

electronic emitters, and the resultant overcrowding of the frequency spectrum have much the same effect on FM radio communications. Electromagnetic pulse could render all or a great part of a unit's radios inoperative, which would result in some 733 messages required for the operation of the battalion being sent by alternative means. The large number of messages is itself an indication of the frequency crowding and misuse. Both would result in complete reliance upon other means.

Instantaneous radio communication and the transmission of orders and instructions have strengthened unit control in armor units. The result has been greater maneuverability, flexibility, and response, but, as the Signal Corps Board stated in 1954, it has had its price. "it is not felt that armor can be effectively employed by relying solely on communications means other than radio."[9]

Alternatives to FM Voice Radio

The tank company and platoon can easily employ the visual and sound alternatives to radio communication for command and control. These units normally operate within line of sight of the company commander when on the offense. A tank or small group of tanks may be masked for short periods by terrain, smoke, or vegetation. If the situation is too hostile for the commander to employ visual means or if sound devices are masked by battle noice, the commander can still

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[9]Signal Corps Board, "Assessment of Radio Communications in Army Combat Operations," Case No. 664 (17 March 1954).

control his forces by personally moving to the area or tank which requires communication.

The real difficulty lies in the tank battalion commander receiving information from his battalion command post or his brigade command post and getting that information or orders to his subordinate units. Although the battalion commander will normally be located behind the last element of the lead unit, he may not always have visual contact with his companies and definitely will not have contact with his battalion command post. The battalion commander and his command group must always maintain communication with the command post in order to keep abreast of new developments and new or supplementary orders from higher headquarters. The visual and sound means of control do not provide the distance and flexibility required for this type of communication requirement.

The battalion commander could employ the use of flags for command control communication in the battalion area. If the battlefield were not obscured by smoke, dust, or weather, it is possible, with the use of relays and binoculars, to extend the distance of flag communication to meet the requirements for intra-battalion communications. The length of messages would need to be short since they will be sent one alphabetic letter at a time or in short prearranged codes. This communication would not be secure in that it could be observed, and it would be subject to enemy suppression fires. Lights could be substituted for flags during darkness. This means of communication could best be

utilized during movement to contact.

Sound communication does not provide the distance or flexibility the battalion commander requires. Sound is effective for short distances only and is severely limited by combat noise. It is best used as a warning and for transmitting brief prearranged messages for short distances. Therefore, sound is best employed as a warning and within small units.

Pyrotechnics afford the battalion commander an opportunity to achieve a one-way communication with his subordinate elements. Light and smoke are the two useful effects pyrotechnic signals produce. The commander has access to hand-held, rocket type, ground signals and to mortar and artillery signals. These devices can provide communication if advance coordination is made. Various combinations can be used and can mean short, prearranged messages. The commander should be aware of some of the characteristics of pyrotechnics. He should

> know that the standard colors, red, white (or yellow), and green are the colors most easily identified under varying conditions of visibility; that atmospheric conditions may cause white signals to appear yellow, and that the two colors should be used synonymously; that certain conditions of humidity may cause a white pyrotechnic to be mistaken for green; and that a single meaning attached to a single type of pyrotechnic is always preferable to complicated combinations.[10]

Pyrotechnics, like the other visual means, are severely limited by atmospheric conditions, rain, night, distance, and simplicity. These

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[10]Frank L. Brown, Visual, Sound, and Tactual Communication (Washington: George Washington University, Human Resources Research Office, 1966), p. 6.

means have a valuable place in the area of communications in that they provide an excellent short, prearranged message for emergency communications. However, they do not provide the command control capability required for a battalion commander to rely upon them in combat.

The immediate reactions most commanders give to wire communications is that it is not flexible enough and that it cannot be installed rapidly. Current doctrine provides for the installation of wire for defensive operations but no longer includes this means once the offense begins. General George Patton had the following to say about the use of wire in the offense:

> In all attacks make the maximum use of wire lines and use every effort to keep it up with the advancing units. Radio, while theoretically efficient, is not as good as wire and should be considered as a secondary means of communication. On one occasion we actually launched a tank attack, by quite a large number of tanks, at the end of seventeen miles of wire.[11]

Although wire communications is considered more secure and the range can equal radio, the greatest disadvantage lies in the time required to install this means and the fact that it is very vulnerable to artillery and mortar fire. Wire is also subject to destruction by tracked and wheeled vehicles unless it is dug in or placed overhead. It is indeed unfortunate that wire communication doctrine and technology have not progressed since the Korean War. It seems incongruous that wire guided missiles can be controlled for distances greater than two

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[11]George Patton, "Helpful Hints for Hopeful Heroes" (Washington: Headquarters, Army Ground Forces, 1946), p. 9.

kilometers by tankers and infantrymen, but wire communications cannot support an armor attack that may progress at the rate of five kilometers per hour.

Wire is the best means of communication available to the battalion commander while his units are in a static position. It is reliable, and it provides excellent security. However, once on the move this excellent means falls victim to lack of speed of installation and the vulnerabilities of artillery and vehicle traffic. Perhaps a wire laying tank can be developed, a tank which will automatically lay and bury wire as it moves forward.

The battalion commander has one doctrinal means of communication remaining, the messenger. This is perhaps the best means available to the battalion commander; however, it also has limitations. The messenger can carry lengthy verbal or written messages, to include map overlays. He is restricted, however, by the time required to travel from the battalion commander to the subordinate unit or command post. It is estimated that a motor messenger can travel 6 kilometers within a 30-minute period, which means that in the scenario used for this study all subordinate units are within 15 minutes, the brigade command post is within 30 minutes, and the division tactical command post is within 30 minutes.

In an armor offensive situation the messenger would need to be mounted in either a tank or other armored vehicle. If the tactical situation permitted it, the most rapid means of messenger would be air

messenger or air drop of messages.

Included in the means of messenger is the personal presence of the battalion commander. The commander will normally follow the first unit, which will place him in the position to move about on the battlefield to control units with which he has lost communication. However, he may not have time to travel great distances to his command post. The senior commander has a responsibility to be present in subordinate units for control when communication is lost.

Emergency Means of Communication

The Armor School, in 1955, recognized the vulnerabilities of the doctrinal means of communication, especially under nuclear warfare conditions. It therefore conducted a study on emergency means of communication. The problem statement was: "To determine the feasibility and to establish methods for the use of rockets, artillery, and other devices as alternative means of emergency communications in armor units."[12]

The Armor School study determined the "105mm base ejecting smoke shell to be the most feasible to use."[13] The school determined that since the psychological warfare units used the base ejecting smoke shell for delivery of leaflets, the same shell should have an application to

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[12]Armor School, Emergency Means of Communication (Fort Knox, 1955), p. 1.

[13]Ibid., p. 2.

communications. The results of the tests conducted provided the following:[14]

1. Advantages

a. The use of artillery to transmit messages provides a means of communication which is not subjected to electronic countermeasures.

b. Enemy interference is possible only at the point of origin or receipt.

c. The 105mm base ejecting smoke shell is easily converted at battery level and provides acceptable accuracy. If more suitable components are not available, conversion of the shell can be made by using materials normally found in an artillery unit.

2. Disadvantages

a. When artillery delivery of messages is employed, the situation must be such that the requirement for communication outweighs the possibility of causing casualties among friendly troops. However, the probability of casualties resulting from these shell components can be reduced by the use of unit standard operating procedures which prescribe a location for messages to be delivered in relationship to the last known position of the unit command post. Also, a prescribed colored smoke shell could be fired at a safe range and a set time interval prior to message delivery as a warning signal.

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[14]Ibid., pp. 1-2.

b. Artillery delivery is only one-direction communication.

c. The headquarters sending the message must have access to the artillery unit.

d. The originator of the message cannot be sure that the message is received.

e. Messages may fall into enemy occupied areas.

f. There is a slight possibility that the messages may be scorched or burned when a cardboard tube is used in the center of the shell as a field expedient.

The technique of artillery fired messages has an application to the modern battlefield. It would be most useful in getting information to a unit that has been isolated on the battlefield or to a unit that is leading an exploitation. According to Field Manual 6-40, the 155mm artillery which supports the armor battalion has the capability of firing propaganda leaflets and therefore messages, using an HC smoke projectile with the filter and booster replaced by the leaflets.[15] Perhaps the most interesting conclusion of the cited Armor School study is that "no other devices, available to armored units, were considered to be adequate as a means of emergency communication."[16]

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[15]Department of the Army, Field Artillery: Cannon Gunnery, FM 6-40 (1974), p. 24-8.

[16]Armor School, p. 2.

CHAPTER IV

CONCLUSIONS

Findings

An acceptable alternative to FM radio for command control communications does not currently exist. Although several alternative means do exist, they could not adequately replace radio. Radio is the only means that provides the flexibility, the distance, and the rapidity required on the electronic battlefield.

The threats to this means of communication are very real, and any one of them is sufficient to severely limit the commander in controlling his forces. This writer believes that U.S. Army maneuver units are not prepared to operate in the environment of the three threats discussed in Chapter I. Too great a reliance is placed upon FM radio. Commanders need to take action now to train their units in operations without radio communications. The moment of combat is too late to practice command and control in the absence of voice radio communications.

What Can Be Done

Several things need to be accomplished to insure that units are controlled on the future battlefield. One of these is the practice of

decentralized execution. This requires the commander to conduct detailed planning and training. This is essential not only for the reasons discussed in this paper but also for operation on the nuclear battlefield.

To negate the effect of enemy electronic support measures, it will be necessary for units to conduct offensive operations with radio used only for emergency communications. This is not a new technique. It was used extensively in World War II, and the U.S. Navy relies upon radio silence for all submarine operations. If a radio transmission is made, the transmitter must be rapidly relocated to prevent location and targeting by the enemy. The time-tried rules and practices of electronic counter-countermeasures must be strictly practiced.

Radios in the armor battalion should be evaluated to see if the current series are overpowered and can be reduced in both number and output power in order to limit the electronic signature of the unit. The low power setting on the current radios is adequate to cover the entire battalion area of the model used in this study.

Armor commanders at all levels should make a concerted effort to develop training exercises which integrate alternative means of communication in lieu of radio. Just like gunnery, command control techniques must be practiced and skill levels must be maintained.

Developments Which May Help

One technique that might be of great value is the use of an

input/output device for tactical radios. This device would use the code burst technique of transmission. One that is currently being tested is the input/output device for the Tacfire System.

The code burst technique would provide for less time of transmission, thus making for more efficient use of the frequency spectrum. This technique also provides protection from enemy electronic support measures as it is not visible long enough for his detection. The input/output device would replace the current voice technique and should result in shorter messages.

These devices range from simple display panels consisting of lettered or numbered lighted buttons to miniature tape printers. The U.S. Army provided a simple device to some Vietnamese units which used the button technique. These button displays are also used by the U.S. Air Force for formation flying. This technique could be used for short messages or prearranged codes.

Miniature tape printers are current state-of-the-art items and have definite possibilities for tactical use. These devices provide a "hard copy," and the fact that the messages must be written should result in shorter length messages.

The current field wire used in the armor battalion is not satisfactory for use in offensive combat. An effort should be made to develop a wire that can be laid and buried as a tank moves forward. This would be a simple plow device with a wire that is cheaper, less bulky, and non-recoverable. There is a definite need for research and

development in the area of tactical wire.

Visual and sound means are almost totally ruled out in the scenario used for this study. In this type of offense the offensive and defensive forces would make maximum use of suppression. This would be in the form of electronic, visual or smoke, and intense weapons suppression from antitank and artillery positions. Even messenger travel will be difficult in such a situation.

Several new techniques may enhance the use of visual communications on the battlefield. With the addition of laser rangefinders to the armor inventory, a new area of visual communications may open. The capability exists for modulation of a laser beam with voice transmission. If the tank rangefinder were modified to provide this type of communication, it would expand the current command control frequency spectrum and would provide secure line-of-sight communication. This type of communication would be virtually free from electronic support measures and electronic countermeasures. It would, however, be limited since it is line of sight. This means that any obstruction, terrain, vegetation, and heavy smoke would degrade or destroy the circuit.

The U.S. Navy is currently conducting research with light emitting diodes, and this could provide a valuable visual communications means to the armor commander. Light emitting diodes are best known for their use in the miniature calculator field. They are used for the digital output display. The Navy is using these diodes in a binocular arrangement for message display. Although this is a line-of-sight

system, it could be a very valuable means of communication. When a commander can maintain visual contact with his unit commanders, this would provide secure communications. A serious problem is that a rather stable platform would be required.

Shortfall of Study

The ideal method of analyzing the alternatives would be the construction of a test involving a scenario which could be played by an armor battalion using one means of communication. In this manner each communications means could be evaluated by comparing the success of each battalion's accomplishment of its mission in such tangible areas as reaching objectives at given times, changing missions in the midst of movement, and the commander's control over his forces.

This ideal method was not feasible for this project; therefore, the methodology involved mentally wargaming each means of communication in the tactical scenario to see what the strengths and weaknesses of each means would be.

Practical Example of 1973 Mid-East War

Lieutenant Colonel Mahmoud Hammad Salem, an Armor Officer in the Jordanian Army, provided the example below of an electronic warfare situation in the 1973 Mid-East War.

While serving as a tank battalion commander in the war, Colonel Salem's battalion command net was jammed as he moved his unit to contact. He immediately began using an alternate radio set and net,

allowing the operators on the jammed net to attempt to continue operations so as not to disclose the operation of a new net. In addition, messengers in armored scout vehicles were used to supplement the radio net. Colonel Salem felt that the darkness of the battlefield, due to dust and smoke, completely ruled out the use of visual signals and that the battle noise would not permit the use of sound communication. He felt that the situation did not permit the use of wire.[1]

Tactical Commander

It is imperative that the tactical commander understand and appreciate the shortcomings of the command control communications system. Communications for command control will play an important role in any conflict, and it is essential that communications assets be evaluated, understood, and used just as any other element of combat power.

When the U.S. Army is engaged in combat, it is too late to teach commanders how to control forces without FM radio. They must prepare now for the possible need to control units without radio in future conflicts.

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[1]Interview with Lieutenant Colonel Mahmoud Hammad Salem, Jordanian Army, 15 March 1975.

APPENDIXES

APPENDIX A

UNIT SCENARIO FOR 1/20 TANK BATTALION, TOE 17-036

[Extract from: U.S. Army Combined Arms Center, Communications Support Requirements (COMSR) (Computer Science Corporation, 1973), p. A-II-74-1]

Conducts assault river crossing, secures crossing sites, establishes and expands bridgeheads to facilitate crossing of other elements. Continues attack to secure first division objective, Rhine-Main Airfield. 4/20 Mechanized Battalion on the right conducts supporting attack to secure critical terrain features and highway intersections.

Company C is detached to 4/20 Mechanized Infantry Battalion, beginning H-6 hours. Company A, 4/20 Mechanized Infantry Battalion is attached to 1/20 Tank Battalion beginning H-6 hours. Other battalion cross-reinforcements include an attached combat engineer platoon, a forward air control party, and a forward observer team. Direct support artillery support is provided by 2/7 Field Artillery Battalion (155 self propelled), reinforcing fires available on request from division and corps artillery general support units. Coordinates flank security with 7th Armored Cavalry Squadron operating under division control on the north. Battalion will attempt to secure existing bridges and ferries intact or in easily repairable condition. General bridge support (construction or repair) is available in sector upon request to brigade.

Priority of crossing initially to amphibious vehicles in the swimming mode. Tanks and other vehicles use existing bridges and rafts and ferries operated by engineer support. Tanks provide direct fires for amphibious vehicles in support of crossings. Battalion field trains located with brigade trains under control of brigade S-4. Field trains will support attack with priority on ammunition resupply prior to crossing. All tanks cross with full load to maximum extent possible. Attacking elements will approach crossings under cover of preparatory fires beginning H-30 minutes. Immediate close air support available on a call through TACP. Limited airlift support available on request to brigade. Aerial fires during crossing available by coordination with Air Cavalry Troop, 7th Armored Cavalry Squadron.

APPENDIX B

ANALYSIS OF COMMUNICATIONS SUPPORT REQUIREMENTS SCENARIO FOR 1/20 TANK BATTALION

[Extract from: U.S. Army Combined Arms Center, Communications Support Requirements (COMSR) (Computer Science Corporation, 1973), pp. A-II-74-3 & A-II-74-4]

The 1/20 Tank Battalion is assigned to the 7th Armored Division and has the mission of making the main attack to secure a key brigade objective. The scenario initially depicts the division in an area defense along a major river line. The battalion attack involves an assault river crossing, a penetration of enemy defensive positions, and rapid exploitation to gain control of a vital airfield in the enemy rear.

The envisioned deployment generated all the traditional doctrinal needlines of a typical armored unit. In addition, requirements for communication with armored cavalry elements on the flank and with supporting air cavalry elements have been generated. The normal cross-reinforcement of a tank battalion by detachment of one company to a mechanized infantry battalion and attachment of one mechanized infantry company from another battalion has been effected in the scenario. The presence of direct support elements such as an engineer platoon, a tactical air control party, and artillery liaison officer and others has also been recognized. The origination of traffic by such elements has

been included in tank battalion requirements to insure accurate estimates of traffic volumes flowing over the internal or external communication facilities.

Access mode requirements reflect the highly mobile nature of armor operations. Provision has been also made for the battalion commander and selected staff members to operate from an airborne command post as required. In the voice mode, the battalion headquarters requires links to its higher headquarters and to organic and attached companies and detachments. Communication requirements to adjacent supporting units have also been included. Adjacent units are the 7th Armored Cavalry Squadron and the 4/20 Mechanized Infantry Battalion. Direct support artillery is provided by the 2/7 Field Artillery Battalion. Logistical, maintenance, medical, and engineer support is provided by divisional units directly to battalion, and these communication needlines have been included. Needlines to division headquarters provide for personnel and administration functions not normally handled through brigade headquarters.

Record traffic estimates consist largely of radioteletype messages and reports required on a daily basis. These reports include status of ammunition, vehicles, major items of equipment, and personnel.

Intra-unit voice communications requirements are primarily vehicular-to-vehicular in a tank battalion. The need for less frequent communications over an organic wire system, however, must also be recognized.

BIBLIOGRAPHY

BIBLIOGRAPHY

Government Documents

Armor School. Emergency Means of Communication. Fort Knox, 1955.

Armored Command. Signal-Communications in an Armored Division. Fort Knox, 1943-1944.

Army Ground Forces. European Theater of Operations. Use of Combat Loudspeaker in Armored Breakthrough. Immediate Report 85. 1945.

Army Service Forces. "Tank Operations in France." Washington, 1945.

Department of the Army. Dictionary of United States Army Terms. AR 310-25. 1972.

_____. Field Artillery: Cannon Gunnery. FM 6-40. 1974.

_____. Armor Operations. FM 17-1. 1966.

_____. Tank Units: Platoon, Company and Battalion. FM 17-15. 1966.

_____. Visual Signals. FM 21-60. 1966.

_____. Tactical Communications Doctrine. FM 24-1. 1968.

_____. The Division. FM 61-100. 1968.

_____. Armor Division. TOE 17-H. 1970.

_____. Armor Battalion. TOE 17-035H. 1970.

_____. Office of the Chief of Military History. Report on the Commitment of the 36 Volks-Grenadier Division in Lorraine from 12 November 1944 to 27 December 1944. 1945.

_____. Office of the Chief of Staff, U.S. Army. Special Analysis of Net Radios: SPANNER Final Report. 1974.

European Command. Historical Division. Small Unit Tactics: Tactics of Individual Arms. 1951-1952.

_____. _____. Foreign Military Studies Branch. Small Unit Tactics--Tactics of Individual Arms. 1951.

Infantry School. Chief of Infantry. Tank Employment. ST No. 14. Fort Benning: Army Field Printing Plant, 1935.

Modern Army Selected System Test, Evaluation and Review. Staff Organization and Procedures. Test 119. 1974.

Office of Civil Defense. "EMP Protection for Emergency Operating Centers." Washington, 1971.

_____. "EMP Protective Systems." Washington, 1971.

767th Tank Battalion. Report of Flintlock Operation, Kwajalein Atoll. 1944.

Signal Corps Board. "Assessment of Radio Communications in Army Combat Operations." Case No. 664. 17 March 1954.

U.S. Army Armor School. United States Army History and Role of Armor. Fort Knox, 1974.

U.S. Army Combat Developments Command. Dynamics of Fire and Maneuver (FIRMA III). Fort Belvoir, 1969.

_____ "Study of Communications Electronics--75." Fort Belvoir, Va., 1969.

_____. Soviet Block Communications-Electronics Threat to the Army in the Field, 1965-1980 (U). Fort Belvoir, 1965.

_____. The Evolution of Military Unit Control, 500BC to 1965AD. Prepared by Combat Operations Research Group. Fort Belvoir, 1965.

U.S. Army Combat Developments Command Communications-Electronics Agency. The Commel Model. Prepared by URS Systems Corporation, Midwest Systems Center. Kansas City, 1969.

U.S. Army Combat Developments Command Intelligence and Control Systems Group. Command Post Program Study. Final Study. Vol. I. Fort Belvoir, 1973.

U.S. Army Combined Arms Center. Communications Support Requirements (COMSR). Computer Sciences Corporation, 1973.

U.S. Army Command and General Staff College. "Nuclear and Chemical Doctrine and Capabilities." 1975.

_____. Electronic Warfare. RB 32-20. 1974.

_____. "Soviet Command and Control." Appendix 3 to Advance Sheet M1220-1. 1974.

_____. Mobile Command Post Vehicles. 1958.

U.S. Army Infantry School. Communication Lessons Learned in Vietnam. Fort Benning, 1966.

U.S. Army Materiel Systems Analysis Agency. Changes in the Armor Threat (U). 1973.

U.S. Army Mobility Equipment Research and Development Center. Military Significance of High-Altitude Burst Produced Nuclear EMP to the Seventh Army (U). Fort Belvoir, 1968.

_____. Survey of Reported EMP Damage (U). Fort Belvoir, 1968.

U.S. Army Mobility Research and Development Center. Nuclear Electromagnetic Pulse Effects on Army Materiel (U). Fort Belvoir, 1970.

U.S. Army Signal Propagation Agency. Effects of High Altitude Nuclear Detonation on High Frequency Communications (U). 1959.

U.S. Army Southeastern Signal School. Signal Reference Data: Radio and Radar Communications Equipment. Fort Gordon, 1974.

U.S. Marine Corps. General Operating Requirement: Tactical Information Exchange System. Washington, 1967.

WDMISCMA. Tactical Employment of Equipment in Desert Fighting. Cairo, 1942.

Reports

Brown, Frank L. Visual, Sound, and Tactual Communication. Wasnington: George Washington University, Human Resources Research Office, 1966.

Critical Combat Performances, Knowledges, and Skills Required of the Infantry Rifle Platoon Leader. Radio Communication Study. Washington: George Washington University, 1966.

ECCM Concepts for Armored and Mechanized Operations (1970-1975) (U). Sylvania Electric Products, 1965.

Electronmagnetic Vulnerability of 1970-1975: U.S. Army and Soviet Army Units to SIGINT and Electronic Warfare (U). Electronic Defense Laboratories, 1969.

Foreign Science and Technology Center. Combat with Electronic Devices, Czechoslovakia (U). Charlottesville, 1971.

_____. An Analysis of Selected Elements of Soviet Ground Forces Command and Control Communications (U). Charlottesville, 1971.

Mobile Command and Control System (Secure Survivable Command Control System (U). Bunder-Ramo Corporation, 1964.

Operations Research/Long Range Planning Department. Ground Combat-Communications Simulation System. Prepared for U.S. Army Combat Developments Command Communications-Electronics Agency. Fort Washington, Pa.: Philco Corporation, 1965.

Patton, George. "Helpful Hints for Hopeful Heroes." Washington: Headquarters, Army Ground Forces, 1946.

Books

Biryukov, G., and G. Melniko. Antitank Warfare. Moscow: Progress Publishers, 1972.

Guderian, Heinz. Panzer Leader. New York: Dutton, 1952.

Infantry in Battle. Washington: Infantry Journal, 1939.

Articles and Periodicals

Ablett, Charles B. "Electronic Warfare--A Modern Weapon System." Military Review, November 1966, pp. 3-11.

Almquist, E. H. "Army EW: A Top Priority Program." Electronic Warfare, January-February 1974, p. 51.

Bachtel, Charles L. "The ECM-ECCM Syndrome." Signal, October 1973, pp. 25-29.

Ball, Robert. "Rethinking the Defense of Europe." Fortune, February 1973, pp. 62-63.

Belov, A. I. "Signal Troops in the Soviet Armed Forces." Soviet Military Review, November 1973, pp. 2-4.

Belov, M. "New Factors in the Development of Modern Armies." Soviet Military Review, February 1974, pp. 10-13.

"Britain Adapts to Conventional Threat. Electronic Warfare, February 1973, pp. 41-46.

Carey, Arthur T. "How Important Is the Commander?" Armor, July-August 1965.

Fubini, Eugene E. "We Must Improve Control of Tactical Forces." Armed Forces Management, July 1965, pp. 52-56.

Gaul, Edwin James. "Electromagnetic Pulse." Military Review, March 1975, pp. 12-18.

Godding, George A. "Army Electronic Warfare--The EW Offensive Takes On New Dimensions." Electronic Warfare, January-February 1974, p. 54.

Hardin, Clyde D. "The U.S. Army Electronic Warfare Laboratory: A View from Behind the Power Curve." Electronic Warfare, March-April 1974, pp. 33-37.

Hargreaves, Reginald. "The Mechanics of Communication." Military Review, December 1965, pp. 87-95.

"Israel Scores a Breakthrough." Newsweek, 29 October 1973, pp. 39-48.

"Israel Seen As Special Relationship--(Close Ties with U.S. Industry and a High National EW Capability Seen As Key to Survivability)." Electronic Warfare, January-February 1974, p. 33.

Latta, William B. "Comments of MG William B. Latta, U.S.A. (Ret.) at Arizona Chapter, Armed Forces Communications Electronics Association." Signal, September 1973, p. 53.

Leaf, Edwin B. "Are We Overcommunicating?: The Signal Explosion." Army, September 1973, pp. 17-19.

Meyer, Stewart C. "MAC Started the New Year with Renewed Emphasis on Electronic Warfare." Electronic Warfare, March-April 1974, pp. 27-29.

Oney, Jerry T. "Tactical Data Communications." Signal, September 1974, pp. 12-14.

Petukhov, D. "Types and Means of Communications." Soviet Military Review, November 1973, pp. 5-8.

_____. "Signal Communications in the War Years." Soviet Military Review, September 1973, pp. 40-41+.

Rienzi, Thomas M. "Steps To Provide Adequate Command Control Communications for the 1980's." Signal, September 1973, pp. 9-10.

Runyon, Floyd L. "The Army Electronic Warfare Master Plan." Electronic Warfare, January-February 1974, pp. 52-53+.

Shehan, Robert R. "Electronic Warfare Equipment Sales (To NATO Nations) Procedures Outlined." Defense Management Journal, October 1973, pp. 32-34.

Shiflet, K. E. "Maneuverable Communications." Army, September 1965, pp. 53-57.

Turner, Fredrick C. "Professional Reading for the Soviet Armor Reader." Armor, January-February 1969, pp. 4-13.

Wagner, Joe. "Frustrations of a Vietnamese Commander: Viet Cong and Too Many Commanders." Armed Forces Management, July 1965, pp. 41-50.

"West German EW: Europe's Most Advanced." Electronic Warfare, February 1973, pp. 48-49.

"What Does the Commander Need?" Armed Forces Management, July 1965, pp. 79-85.

Yale, Wesley W. "Command and Control in the Grande Armee." Armor, September-October 1969, pp. 2-6.

"Yom Kippur Fighting Underscores EW Importance." Electronic Warfare, January-February 1974, pp. 24-29.

Other Sources

European Scenario Committee, Department of Tactics and Logistics, U.S. Army Command and General Staff College. Interviews. School Year 1974-75.

Owens, Frank E. "The Battle for France, May-June 1940: The Role of Command Control Communication." Student paper, U.S. Army Command and General Staff College, 1970.

Salem, Mahmoud Hammad, LTC, Jordanian Army. Interview. 15 March 1975.

Selected Armor Officers, U.S. Army Command and General Staff College. Interviews. School Year 1974-75.

Shoemaker, Robert M. "Command and Control of a Division." Address before the U.S. Army Command and General Staff College, 14 November 1974.