NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

ASSESSING THE U.S. ARMY'S
COMBAT VEHICLE COMMAND AND CONTROL SYSTEM
AT THE BATTALION LEVEL

by

Gordon G.R. Slifer

March, 1992

Principal Advisor: Michael Sovereign

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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b. OFFICE SYMBOL *(If applicable)* 39	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS *(City, State, and ZIP Code)* Monterey, CA 93943-5000	7b. ADDRESS *(City, State, and ZIP Code)* Monterey, CA 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS Program Element No. / Project No / Task No. / Work Unit Accession Number

11. TITLE *(Include Security Classification)*
ASSESSING THE U.S. ARMY'S COMBAT VEHICLE COMMAND AND CONTROL SYSTEM AT THE BATTALION LEVEL

12. PERSONAL AUTHOR(S) Slifer, Gordon, G.R.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(year, month, day)*	15. PAGE COUNT
Master's Thesis	From To	March, 1992	74

16. SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17. COSATI CODES

FIELD	GROUP	SUBGROUP

18. SUBJECT TERMS *(continue on reverse if necessary and identify by block number)*
Command and Control, Combat Vehicle Command and Control System, CVC2, Combat Operations Process Model

19. ABSTRACT *(continue on reverse if necessary and identify by block number)*

The United States Army is presently conducting evaluations of the Combat Vehicle Command and Control (CVC2) system. The CVC2 system is being developed to assist battalion level commanders and below with their command and control functions. Current evaluations of the system have been focused at the platoon and company levels. This thesis proposes that the greatest benifit of the automated system will be to support battalion level command and control functions. This paper provides; a description of the CVC2 system and the functions it is designed to perform, a description of the process and system used by combat battalions to execute C2, identification of the information requirements of a commander, proposed measures of performance (MOP's), measures of effectiveness (MOE's) and measures of force effectiveness (MOFE's) to be used to evaluate the CVC2 system at battalion level. An evaluation methodology is proposed and areas of concern relating to the implementation of the system are discussed.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS REPORT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Michael Sovereign	22b. TELEPHONE *(Include Area code)* (408) 646-2428 22c. OFFICE SYMBOL OR/SM

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

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Assessing the U.S. Army's Combat Vehicle Command and Control System at the Battalion Level

by

Gordon G.R. Slifer
Captain, United States Army
B.S., United States Military Academy, 1983

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY
(COMMAND, CONTROL and COMMUNICATIONS)

from the

NAVAL POSTGRADUATE SCHOOL
March, 1992

Author: ______________________
Gordon G.R. Slifer

Approved by: ______________________
Michael Sovereign, Principal Advisor

____
William J. Caldwell, Associate Advisor

____
Carl R. Jones, Chairman, Command , Control and
Communications Academic Group

ABSTRACT

The United States Army is presently conducting evaluations of the Combat Vehicle Command and Control (CVC2) system. The CVC2 system is being developed to assist battalion level commanders and below with their command and control functions. Current evaluations of the system have been focused at the platoon and company levels. This thesis proposes that the greatest benefit of the automated system will be to support battalion level command and control functions. This paper provides; a description of the CVC2 system and the functions it is designed to perform, a description of the process and system used by combat battalions to execute C2, identification of the information requirements of a commander, proposed measures of performance (MOP's), measures of effectiveness (MOE's) and measures of force effectiveness (MOFE's) to be used to evaluate the CVC2 system at battalion level. An evaluation methodology is proposed and areas of concern relating to the implementation of the system are discussed.

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I. INTRODUCTION

A. PURPOSE

The U. S. Army has been using technology and electronic advancements to increase the ability of commanders to execute their command and control (C2) functions on the modern battlefield. While most of the attention has been focused on studying the command and control process at levels above combat divisions, the focus of this thesis is an analysis of the automated Combat Vehicle Command and Control (CVC2) system being developed to support command and control operations at the tactical level. Current evaluations of the CVC2 system are focused at the platoon and company user level. This thesis proposes that the emphasis should shift to evaluation of the system at the battalion user level. The study defines the combat operations process and the command and control system in which the CVC2 system will operate. The system and process descriptions provide the basis for the measures of performance (MOP's), measures of effectiveness (MOE's) and measures of force effectiveness (MOFE's) presented in this report. The measures proposed can be used to evaluate the CVC2 system at the battalion level.

B. SCOPE AND ORGANIZATION

This thesis is organized into six chapters. Chapter I provides an executive summary, describes the purpose and provides the reader with background information. Chapter II describes and discusses a proposed system, the Combat Vehicle Command and Control (CVC2) system. This developmental system is an effort by the Army to automate many of the communications functions and information management functions required of commanders at battalion level and lower. The discussion of this system provides a description of the system, its networks, and the key functions it is designed to execute. In the third chapter, the generic Combat Operations Process model,developed by Maj George Orr, USAF, is used to provide the framework for the command and control process used in a mechanized infantry battalion. The chapter continues with an analysis of the current command and control system used by infantry battalions. The chapter closes with a discussion of how specific parts of the C2 system operate to execute the functions described in the process model. The fourth chapter examines the information aspect of command and control. The first section of this chapter uses the Army's METT-T analysis technique to categorize the information needed by the commander to make planning decisions. The remaining sections focus on how information enters into the decision making process (inputs) and what the products of the process are (outputs). Chapter V discusses an experimental test design including discussion of design considerations and suitable measures of effectiveness (MOE's),measures of performance (MOP's), and measures of force effectiveness (MOFE's). The final chapter provides conclusions and recommendations concerning the application of the CVC2 system to the command and control system of armor or mechanized infantry battalions.

C. BACKGROUND

The U.S. involvement in Desert Shield/Desert Storm illustrates the continued need for highly trained and sophisticated armored forces. Recent events such as the break up of the Warsaw Pact and the break up of the Soviet Union have decreased the chances of a global conflict but increased the likelihood of regional conflict. With the United States as the only super power remaining it is not unlikely that we will become involved on these battlefields. The battlefield of today is rapidly becoming increasingly complex. The numbers and types of sensors that provide accurate, timely information about the enemy are increasing. The speed of armored vehicles and the range and lethality of their weapons systems is awesome. These sophisticated systems are also in the hands of potential enemy forces. This situation places an increased need for tactical level commanders to have systems that will enable them to maximize accurate, timely information available to them and their forces and minimize the time required to exchange information and orders. Regarding this issue a recent study, using the Army Command and Control Evaluation System (ACCES), stated the following:

> "Those who had the most accurate information (which was also the most current) were the most successful. Those who lacked current information, particularly about their own forces, had the slowest and most complex command and control processes." (Hayes,1990)

The desire to present the commander with the most pertinent information in the least amount of time is one of he fundamental problems faced by command and control systems. Time is a finite resource the command must carefully allocate. By reducing the amount of time required to gather information, develop courses of action, make a decision, and then issue orders, the commander can provide his subordinates a greater share of the time available. This will allow them to conduct their planning, combat preparation of men and equipment, conduct rehearsals of the plan, and allow more opportunity to rest prior to the conduct of the operation. The time saved in planning can be allocated to other important areas to increase the units chance of success. The CVC2 system discussed in this thesis provides functions that save time by automating many information exchange and storage tasks that are currently being done manually. Attempts to automate the tactical command and control system and thus speed up the planning process is one way in which time can be saved for use in other areas. The CVC2 system being tested by the U.S. Army will provide commanders of tactical units such a system. The CVC2 system is being developed as a joint effort by the U.S. Army Tank Automotive-Command (TACOM), U.S. industry and the German Ministry of Defense (IDR, Dec. 1990). This approach to the development is an effort to ensure interoperability between national forces. The effort for testing of the system in the U.S. rests with the U.S. Armor School at Ft. Knox, Ky. The focus of the testing has been at the platoon and company level utilizing the SIMNET system. The CVC2 system provides capabilities that are more fully utilized at the battalion level. An evaluation of the CVC2 system at the battalion level is necessary to determine how much the system aids the battalion commander and staff in executing command and control. The next chapter provides a description of the CVC2 system and the functions it is expected to perform.

II. THE COMBAT VEHICLE COMMAND AND CONTROL SYSTEM

A. INTRODUCTION

The Combat Vehicle Command and Control (CVC2) system being is being developed by the U.S. Army along with the German Army to aid tactical armor and mechanized infantry battalions in transmitting and managing the flow of information within their command and control system (IDR, Dec 1990).

The purpose of this chapter is to provide the reader with an understanding of the system. The chapter is divided into three sections. The first section describes the mission or purpose of the CVC2 system. The second section details the hardware of the system and the proposed fielding configuration of the system within a mechanized infantry battalion. The third section describes how the system will actually function. This description is presented by breaking the system down into its functional parts: Provide tactical situation displays, prepare digital messages, provide digital communications, process received digital messages, maintain tactical and logistical databases.

B. THE MISSION OF THE CVC2 SYSTEM

The mission of the CVC2 system is to provide commanders of maneuver forces (from the individual vehicle to battalion command levels) accurate, timely information in order to make decisions, and assist him in preparing orders and supervising operation. The system must be responsive to vehicle mission requirements and effectively facilitate continuous planning, coordination, and assessment in every situation (CSIWG, 1990).

C. CVC2 SYSTEM DESCRIPTION

The CVC2 system is an automated command and control system which prepares, collects, organizes, displays and disseminates pertinent battlefield information to assist commanders in *maneuver-force command and control* at the battalion level and below (CSIWG,1990).

The system consists of the following:

-Vehicle embedded functions to perform command and control as well as communications network management within each of the combat vehicles of the battalion task force. These are termed CVC2 system nodes or simply nodes in this report.

-A distributed communications network for the combat vehicles in the battalion task force. This will involve augmenting the existing analog voice system with the digital CVC2 system. The CVC2 node will work through the Single Channel Ground/AIR (SINCGARS) radio.

-Communications network interfaces to non-combat vehicle assets within the battalion task force. These will provide an indirect interface with other command and control systems (e.g. the TOC S-2 interface provides a link into the Maneuver Control System (MCS)).

1. The CVC2 Communications Networks

As illustrated in Figure 2-1, the CVC2 system provides automated digital communications between combat vehicles at each echelon of command and between adjacent units.

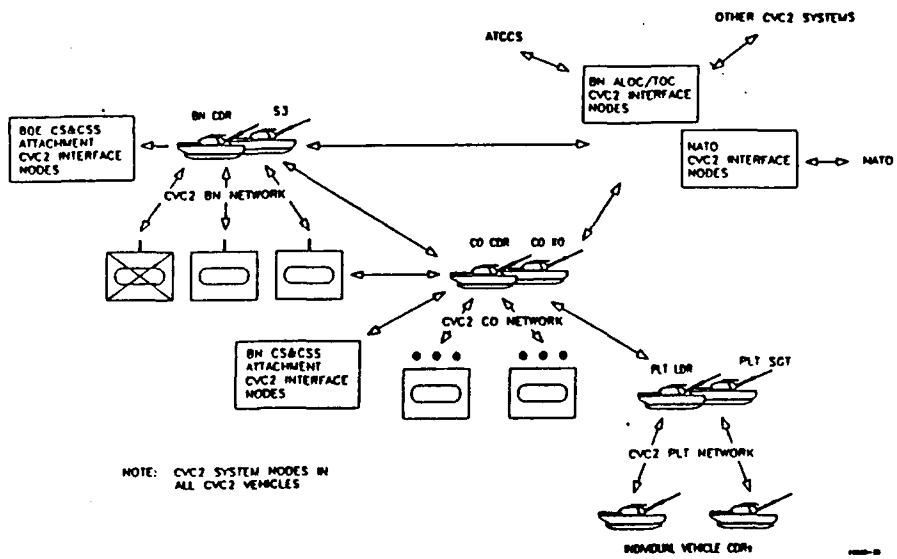

Figure 2-1. **CVC2 System Diagram** (CSIWG,1990)

The CVC2 system will operate on the voice combat radio networks established within a battalion. The primary networks using the CVC2 system will be the battalion, company, and platoon level Command networks. The digital communications will not interfere with the voice traffic carried on these networks. The CVC2 nodes of the system will be able to communicate with any other CVC2 node operating on the same network frequency. The network will typically be set up as depicted in Figure 2-2. The figure shows one battalion level command net, four company level command nets, and thirteen platoon level command nets.

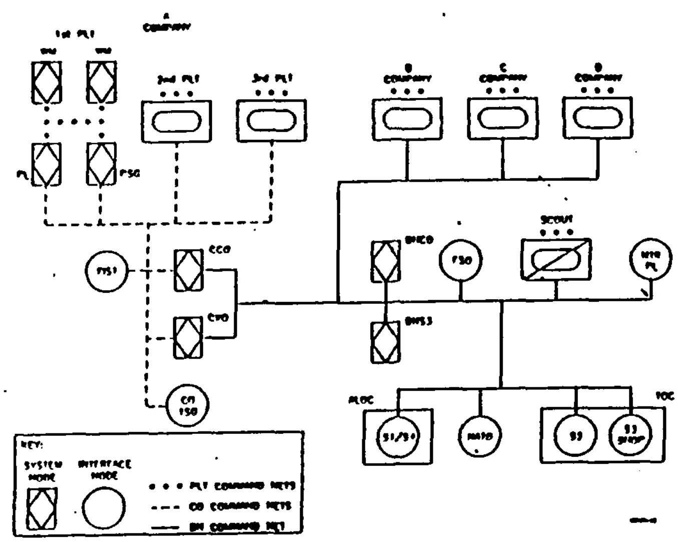

Figure 2-2. **Battalion CVC2 Networks** (CSIWG, 1990)

As with the current voice system no CVC2 network will be able to transmit digital messages to any other network without changing the network association of the CVC2 node.

2. The CVC2 Node

A CVC2 node is defined as the equipment located in a combat vehicle which connects the user with the CVC2 functions. The CVC2 node in the vehicle connects the user to the CVC2 network. The CVC2 node is made up of the following elements:

-computer-generated interactive display

-Processing elements

-Mass memory unit

-Position/navigation unit

-Combat network radios

Because the CVC2 system is being designed for a wide variety of vehicles and vehicle architectures, multiple hardware /software configurations of the CVC2 nodes are expected (CSIWG, 1990).

Another type of node in the system is the CVC2 interface node. These nodes contain equipment that will allow non-combat vehicles to interface with the CVC2 network. Through these CVC2 interface node the CVC2 system can indirectly interface with other command and control networks which the interfacing element also participates in. As show in Figure 2-1, the CVC2 system interfaces to CVC2 nodes located at the battalion Tactical Operations Center (TOC), and the Administration Logistics Center (ALOC). These CVC2 interface nodes connect the combat vehicle commanders to the battalion intelligence, operations, personnel and logistic staff. They also provide the interface of the CVC2 system to the Army Tactical Command and Control System (ATCCS) and the NATO command and control networks.

D. THE CVC2 NODE'S FUNCTIONAL PARTS

This section highlights the functional areas of the CVC2 node that will be used by personnel to effect digital message transmission. The focus is on describing the functional features that enable the commanders to execute better maneuver force command and control.

1. Tactical Situation Display

The CVC2 system provides the commander of each combat vehicle an interactive tactical situations display (TSD). Figure 2-3 provides an illustration of what the display looks like. The TSD presents the commander with a current and consistent picture of the battlefield situations.

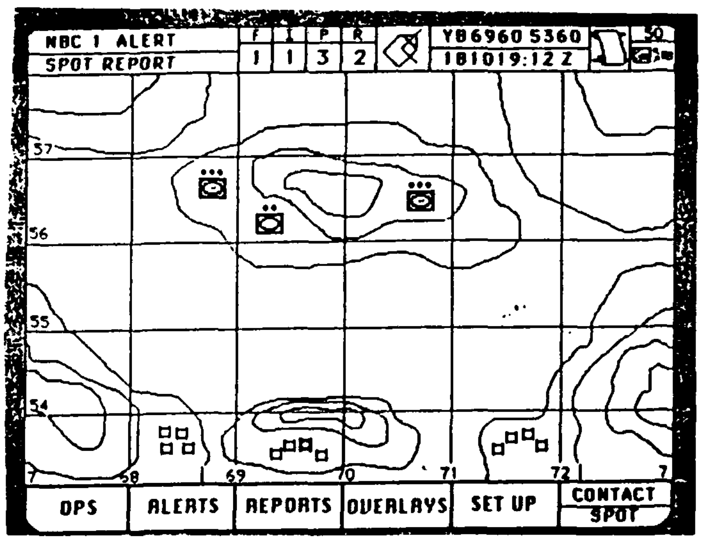

Figure 2-3. **Representative CVC2 Interactive Display**

(CSIWG, 1990)

The picture consists of an electronic map, an own vehicle position/orientation indicator, and planning/situation overlays which utilize information stored in the CVC2 system node's tactical/logistical information database. The TSD is a computer generated, color video display that is updated in real time (CSIWG, 1990). The content and format of the display is tailored to the CVC2 duty position of the user (i.e., Battalion Commander, Platoon Leader, Battalion Operations Officer).

a. Electronic map.

The TSD generated electronic map image is a color representation of Defense Mapping Agency (DMA) topographic paper charts. The system uses CD-ROM maps provided by the DMA. This map is a background image on which military symbols can be overlaid. TSD controls allow the user to set map scale, scroll the map and map interpretation functions. This function also allows the user to determine point to point distances and the coordinates and elevation of designated points (CSIWG, 1990).

b. Position/Orientation readout.

The TSD will provide a distinct symbol to display the vehicle's current location in Military Grid Reference System (MGRS) accurate to eight digits and the current vehicle heading accurate to three degrees (CSIWG, 1990).

c. Graphic overlay display

The vehicle commander can selectively superimpose tactical planning and situation overlay graphics onto the electronic map. The overlay graphics consists of standard military symbols generated from the overlay database maintained by the tactical/logistical database function. The CVC2 user can call up any or all of the following overlay types (CSIWG, 1990):

1. Operations overlay
    a. Own current
    b. Own future
    c. Commander's current
    d. Commander's future
2. Friendly overlay
3. Enemy overlay
4. Obstacle overlay
5. Fire support overlay
6. Sector identification
7. Direct fire plan

The CVC2 system node will automatically update enabled overlays in real time. Changes to the information in the nodes tactical/logistical database due to the processing of received CVC2 messages will be reflected on the TSD within seconds (CSIWG, 1990).

d. On-call situation information

The CVC2 user can request amplifying information associated with a symbol on an overlay. On call information for particular symbols is described below (CSIWG, 1990).

1. Friendly unit symbols- The TSD will display a color coded graphic illustrating the status of a unit's ammunition,

vehicle, POL and personnel. On request the TSD will display ammunition, vehicle, POL or personnel reports from the selected units available from the tactical database.

2. Obstacle symbols- The TSD will display the full text of the CVC2 message which caused the inclusion of the symbol in the obstacle overlay.

3. Enemy unit symbols- The TSD will display the full text of the CVC2 message which caused the inclusion of the symbol in the enemy overlay.

2. Prepare Digital Message Function

In the normal mode of operations the CVC2 node allows the user the ability to generate digital messages (containing overlay symbols and/or formatted text/data) for transmission to other CVC2 nodes in the network. This is done by using a menu-driven interface in the user's control/display. The user will select the type of message he wants to generate. The CVC2 system node prompts him for the required information. Once the user has entered the information and requested the message be sent the CVC2 node will automatically send it to the designated receivers (CSIWG, 1990).

The following Figure (2-4) lists the messages in the CVC2 database and who can generate these messages.

CVC2 MESSAGE TYPE	CVC2 DUTY POSITIONS AUTHORIZED TO GENERATE MESSAGE
MOPP Status	CO CDR, PL
Air Alert	ALL
REDCON Alert Condition	BN CDR, CO CDR, PL
NBC Alert	ALL
Warning Order	BN CDR, CO CDR, PL
Operations Overlay	CO CDR, PL
FRAGO Order	BN CDR, CO CDR, PL
Enemy Overlay	NONE
Enemy Overlay Update	NONE
Obstacle Overlay	NONE
Obstacle Overlay Update	NONE
Fire Support Overlay	CO CDR
Fire Support Overlay Update	CO CDR
Direct Fire Plan	CO CDR, PL, PSG, WM
Sector Identification	CO CDR, PL
Call for Indirect Fire	CO CDR, CO XO, PL, PSG, WM
Call for CAS	BN CDR, CO CDR
Contact Report	ALL
Engagement Update	BN S3, CO CDR, CO XO, PL, PSG, WM
Spot report	ALL
Situation Report	BN CDR, BN S3, CO CDR, PL, PSG, WM
Bridge Report	CO CDR, PL
Minefield Laying Report	BN S3, CO CDR, PL
Obstacle Report	BN CDR, BN S3, CO CDR. PL, PSG, WM
Route Report	CO CDR, CO XO, PL, PSG, WM
Personnel Status/Request	ALL
Ammo Status/Request	ALL
POL Status/Request	ALL
Vehicle Status	ALL
NBC 1 Report	ALL
NBC 4 Report	BN CDR, BN S3, CO CDR, CO XO, PL, PSG
NBC 5 Report	NONE
Shell, Bomb, Mortar Report	ALL
Strikewarn	NONE
Position Update	ALL
Will Comply	ALL
Request (for Reports)	BN CDR, BN S3, CO CDR, CO XO, PL

Figure 2-4. CVC2 Message Table (CSIWG, 1990)

3. Provide Digital Communications Function

Messages will be transmitted over the SINCGARS radio. The user will have to initialize the combat radios of the CVC2 node for a particular network. The procedure is similar to that use to enter the MSE system and is transparent to the user. Once he is in the CVC2 network the user has many features available to him that exist in other military digital systems currently in use. Some features include; Priority tagging of the message (routine, priority, immediate, flash); message routing to single or multiple receivers; digital transmission of both text and overlay graphics; automatic message storage by message type and message queuing based on message priority. For messages that require the receiving unit to indicate they will comply (WILCO) with the message, the sending CVC2 node will maintain a list of which receiving CVC2 users have transmitted a responding WILCO message (CSIWG, 1990).

4. Process Received Digital Message Function

The processing performed by the CVC2 system node is dependent on the message type and the CVC2 duty positions of the receiving user. The following figure (2-5) provides a summary of this.

MESSAGE TYPE	CVC2 SYSTEM NODE RECIEVERS	AUTO/MAN REVIEW	SUPPORT FORWARD
MOPP Status	All	Auto	Yes
Air Alert	All	Auto	Yes
REDCON Alert Condition	All	Manual	Yes
NBC Alert	All	Auto	Yes
Warning Order	All except BN CDR	Manual	Yes
Operations Overlay	All	Manual	Yes
FRAGO Order	All except BN CDR	Manual	No
Enemy Overlay	All	Auto	Yes
Enemy Overlay Update	All	Auto	Yes
Obstacle Overlay	All	Auto	Yes
Obstacle Overlay Update	All	Auto	Yes
Fire Support Overlay	All except PSG and WM	Auto	Yes
Fire Support Overlay Update	All except PSG and WM	Auto	Yes
Direct Fire Plan	CO CDR, CO XO, PL	Manual	No
Sector Identification	CO XO, PL, PSG, WM	Auto	Yes
Call for Indirect Fire	CO CDR, CO XO, PL	Auto	Yes
Call for CAS	N/A	N/A	N/A
Contact Report	All	Auto	Yes
Engagement Update	All	Auto	Yes
Spot report	All except WM	Manual	Yes
Situation Report	All except WM	Manual	Yes
Bridge Report	CO CDR, CO XO, PL, PSG	Manual	Yes
Minefield Laying Report	All except PSG and WM	Manual	Yes
Obstacle Report	All	Manual	Yes
Route Report	All except PSG and Wm	Manual	Yes
Personnel Status/Request	CO CDR, CO XO, PL, PSG	Manual	No
Ammo Status/Request	CO CDR, CO XO, PL, PSG	Manual	No
POL Status/Request	CO CDR, CO XO, PL, PSG	Manual	No
Vehicle Status	CO CDR, CO XO, PL, PSG	Manual	No
NBC 1 Report	All	Manual	Yes
NBC 4 Report	CO CDR, CO XO, PL	Manual	Yes
NBC 5 Report	All	Auto	Yes
Shell, Bomb, Mortar Report	All	Manual	Yes
Strikewarn	All	Manual	Yes
Position Update	All	Auto	No
Will Comply	All	Manual	No
Request (for Reports)	All	Auto	No

Figure 2-5. Table of Message Receive Characteristics

(CSIWG, 1990)

The CVC2 node allows for flexibility in message processing. For automatically processed messages the CVC2 node will forward the message to the "maintain tactical/logistical database function" where any action required by the message is done automatically. Messages that require manual processing will be stored for retrieval and action by the user (CSIWG, 1990). If automatic forwarding is enabled the message will automatically be retransmitted by the node.

5. Maintain Tactical/Logistical Database

This function requires the CVC2 node to maintain a tactical/logistical information database derived from the received messages. These databases will organize and store received messages, maintain situation and planning overlays, and collect logistics data. The node will use new messages to update the appropriate databases automatically (CSIWG, 1990). For example, if a text message is received that contains information that can be displayed on an overlay the node will automatically generate the symbols and update the overlay as well as place the text message in the appropriate storage location.

E. SUMMARY

The CVC2 system as described above provides automation to arrange and display information about the battlefield environment including locations of obstacles and friendly and enemy forces. It will also be used to receive and display orders from echelons above, reports from echelons below, and coordination information from both echelons above and adjacent units. This automation will enable the integration and synchronization of critical maneuver combat support, combat service support and intelligence assets of maneuver battalions. The focus of the CVC2 system is to automate communication and situation displays to provide near-real-time response for the battalion command element, in order to speed the plans-orders-execution cycle.

The next chapter examines the combat process and the existing command and control system that the CVC2 system will be expected to support.

III. BATTALION COMMAND AND CONTROL

A. INTRODUCTION

To properly evaluate an automated command and control system it is necessary to understand the environment it will be operating in and the type and level of command it will be supporting. This chapter is divided into four parts. First, a model of the command and control process used in combat operations is presented and discussed. The second section identifies the current command and control system existing today in mechanized infantry battalions. The third section places the combat operations process model into the command and control system and shows how the system works to execute the different process functions. The final section is a chapter summary. These descriptions will familiarize the reader with the environment in which the proposed CVC2 system will operate.

B. THE COMMAND AND CONTROL PROCESS

This section presents a model of the process used to exercise command and control in combat operations. The use of a model allows us to make sense of what often seems to be an exercise in controlling chaos. The model framework allows for analysis of how the C2 system of the battalion operates in combat to enable the commander to effect command and control over his forces.

Defining and modeling the command and control process has been the subject of much research in the past few years. The following model of the combat operations process (Figure 3-1) was developed by Major George Orr and is a reworking of the concepts illustrated by Joel Lawson and Col. John Boyd (Orr, 1983).

Orr's model is intended to represent the combat operations process at any specified level of the military hierarchy.

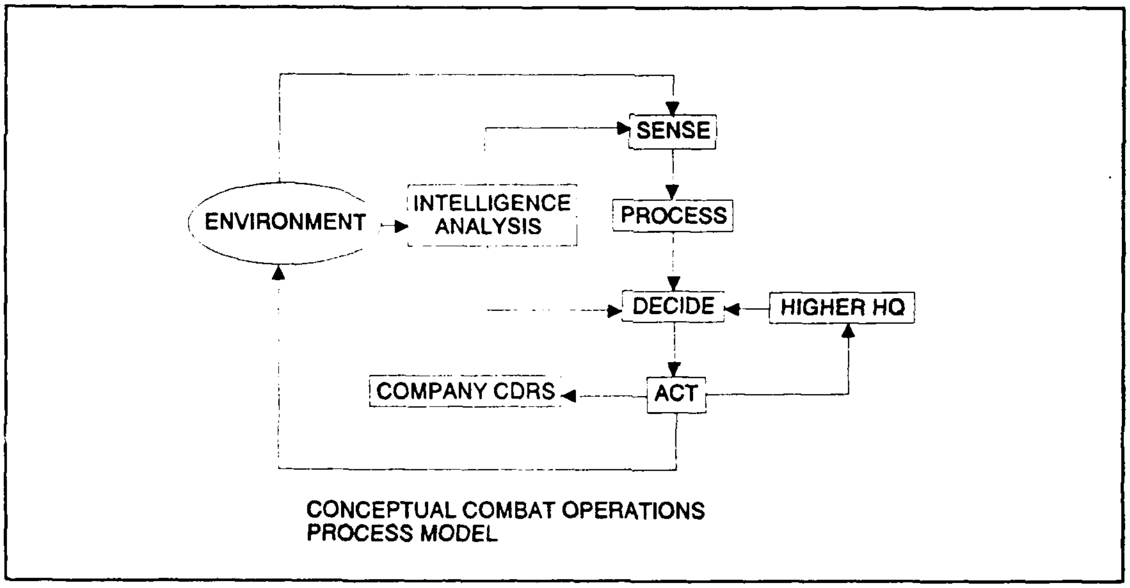

Figure 3-1. **Combat operations process model** (Orr,1983)

The model is composed of five basic functions: Sense, Intelligence Analysis, Process, Decide and Act. The following paragraphs provide a description of each of these functions.

The SENSE function corresponds to all data gathering activities (forward observers, battalion scouts, higher, adjacent, and lower unit intelligence reports). It is concerned with gathering data from the environment (Orr, 1983).

The PROCESS function involves all the processes and procedures used to deduce the occurrence of specific events or situations from the data gathered from the environment. It includes guidance and additional information yielded by the INTELLIGENCE/ANALYSIS function. This data is used to match patterns known to indicate specific situations or events. The PROCESS block also includes the task of displaying the results of the processing to the decision maker (Orr, 1983). Hence, raw data from sensors, intelligence and analysis reports as well as guidance, are transformed by the PROCESS function into the situation reports, status reports and courses of action reports required by the DECIDE function.

The INTELLIGENCE/ANALYSIS function requires the performance of two essential tasks. The first is the need to search for information concerning the organization, structure, capabilities and intentions of the enemy. This information provides the framework for assigning meaning to observed activities and situations. The second essential task is to predict changes in the current situation. These predictions are very important to the decision making process. The information and predictions developed in this block provide guidance to the SENSE function by telling where to look and what to look for. They guide the PROCESS function by helping to identify the patterns that indicate specific events and situations. They also impact on the DECIDE block by providing assessments and forecasts of the situation and the evaluation of probable consequences of proposed actions (Orr, 1990). The key aspects of INTELLIGENCE/ANALYSIS are completeness, accuracy, and timeliness. Major Orr notes that some of this function occurs during actual combat operations but much of the work is independent of the current situation.

The ACT function is the link between the system being controlled by the commander and the environment. It is the means used to influence changes in the environment that are determined to be desirable (Orr, 1990). The ACT function executes the outcome of the DECIDE function.

The DECIDE function requires the commander to consider the information provided by the INTELLIGENCE/ANALYSIS function and the PROCESS function as well as information from higher headquarters (Orr,1990). The commander must then select a course of action for his final plan. This aspect of the process involves problem solving skills often referred to as decision making. This is the most fundamental function performed and the one that has the most influence on the operational effectiveness of the unit (Metersky, 1986).

SUMMARY: The combat operations process model explained above, provides a conceptual framework to understanding what the functions of the command and control process are and how they are related. It must be remembered that the process is cyclic and in practice there are situations in which the operations within the function blocks are not fully executed. The critical parameters for the process are information accuracy within the process and the speed or timeliness of the process execution.

C. THE COMMAND AND CONTROL SYSTEM

The JCS define a C2 system as follows:

> The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces to accomplish assigned missions. (JCS Pub 1-02)

Though this definition does not explicitly address concepts such as information flow or C2 process, they are implicit and thus the definition will suffice for the purpose of this thesis. The JCS definition is intended to address a wide variety of military activities. This section refines the definition in order to better understand the C2 system as it exists in a mechanized infantry battalion.

The components of the subsystems identified (facilities, equipment, communications, procedures and personnel) differ between types of military organizations and the level of command they are supporting. For example, the subsystems that support the commander of XVIIIth Airborne Corps are different than those that support the commander of a mechanized infantry battalion.

What follows are the components of the five subsystems that a mechanized infantry battalion commander has at his disposal.

1. Facilities

The command and control facilities employed by the commander are the means that allow for the processing and transmission of information and orders necessary to have effective command and control. The primary facilities that exist in the battalion are the tactical operations center (TOC), the tactical command post (TAC), and the administrative/logistics center (ALOC) (FM 101-5, 1984). The TOC is the planning and monitoring headquarters where the battalion executive officer (XO) integrates the logistical and operational aspects of the operation. The TAC is the commander's mobile command post. It is not a permanent organization and is normally prescribed by SOP and modified as necessary. The TAC allows the commander to be in a position to see the battlefield and issue appropriate orders at critical times. The ALOC is located to the rear of the battalion operating area, often in the brigade support area.

It provides the commander with critical administrative and logistical information and support. Through these facilities, information is linked to the commander to preclude chaos on the battlefield.

2. Equipment

The equipment that the battalion commander has available to execute his command and control responsibilities are the current family of army radios, vehicles and limited computer support. At present the commander and his supporting staff have virtually no equipment to support command and control operations other than communications equipment.

3. Communications

The communications used by the commander to execute command and control of his combat and supporting forces are included here. There are three primary networks established within the battalion for combat operations. The first is the command net. This is the primary command and control net and is used to exchange operational messages (eg. SPOT REPORTS, FRAGO's, WARNING ORDERS). The command net links the battalion commander with his company commanders and the TOC.

Figure 3-2 depicts a typical battalion command network. Depicted are the primary users. Other personnel can monitor or speak on the network if the situation on the battlefield warrants their inclusion.

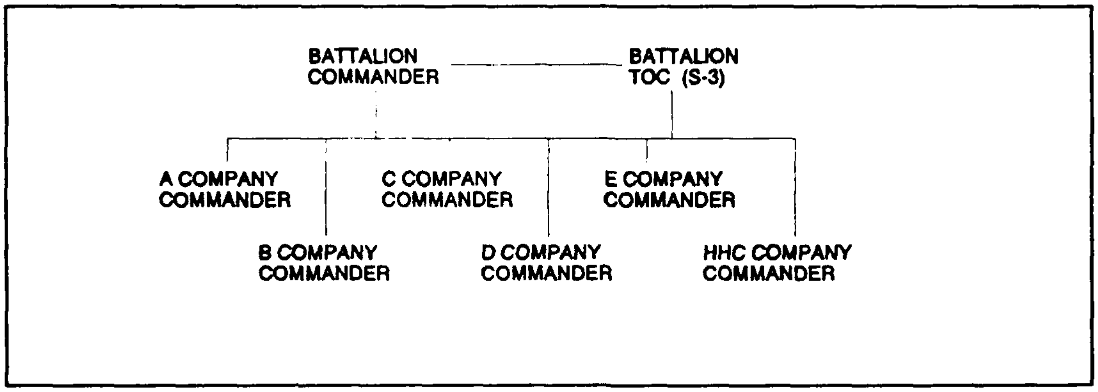

Figure 3-2. **Battalion Command Net - Primary Users**

The second network is the intelligence net. The intelligence net is established to provide a direct reporting link to the battalion S-2, the intelligence officer. This net is primarily used by the battalion scout platoon and other special reconnaissance elements operating under battalion control. The information gathered by these reconnaissance units is often time critical and can have a direct impact on the success or failure of a plan. This net allow the information to reach the staff planners with very little time delay.

The third network is the admin-log net. The primary purpose of this net is to service administrative and logistical communications traffic. Typical communications on this net include; casualty reports, fuel or ammunition requests and medical evacuation requests.

A typical admin-log network is diagramed in Figure 3-3.

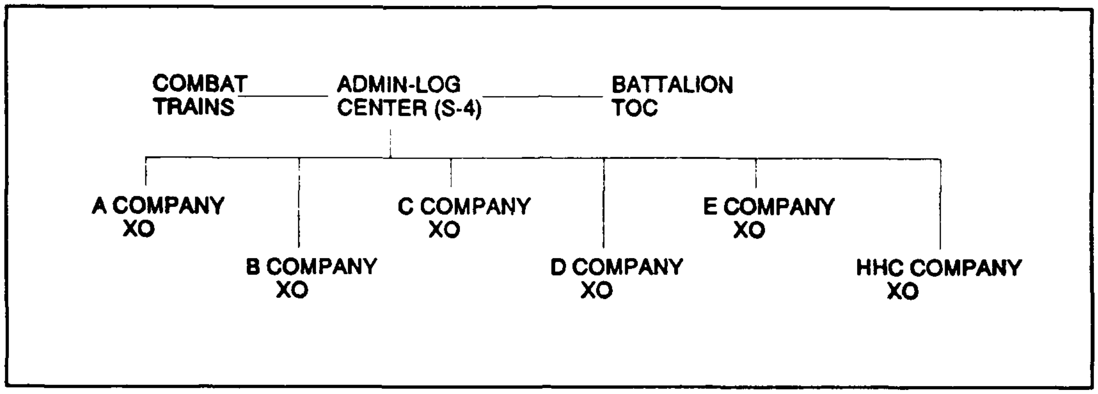

Figure 3-3. **Admin-Log Network - Primary Users**

The communications networks discussed above are voice systems. The current system does not permit the transfer of text or graphic message in these networks. The CVC2 system described earlier would add that dimension to the existing system. The transmission format and message structure of the current system are often prescribed by existing SOP's or regulations. This is also a feature of the proposed CVC2 system. Because of the location of the combat battalion with respect to the enemy, almost all of the communications traffic in these networks is transmitted with some type of electronic encryption devise altering the signal.

4. Procedures

The procedures used by the commander to execute his command and control functions are primarily outlined in SOP's and regulations. It is important to note that the procedures are subject to modification by the commander in order to fit his specific desires.

5. Personnel

The person with primary responsibility to exercise command and control within the system is the battalion commander. He is supported by the battalion staff. The staff is divided into functional areas which are familiar to most military officers and are described here only briefly. The S-1 (Adjutant) has staff responsibility for personnel and administration functions to include: maintenance of unit strength accounting; compiling personnel estimates and coordinating with the S-3 on assigning replacements; casualty reporting and awards. In combat he is the assistant officer in charge (OIC) of the ALOC (FM 101-5, 1984).

The S-2 (Intelligence Officer) has staff responsibility for integrating data collection from internal and external agencies. He is responsible for the intelligence preparation of the battlefield and the intelligence estimates. The S-2, in coordination with the S-3, is responsible for preparing and executing reconnaissance and surveillance plans, and he ensures the commander receives pertinent combat information about the enemy in a timely manner (FM 101-5, 1984).

The S-3 (Operations Officer) is the principle staff officer in the areas of operations, plans, organization, and training. His duties require close coordination with other staff officers. In addition to operational requirements, the S-3 exercises staff supervision of the TOC. He is responsible for coordinating all support assets (fire, electronic warfare, and obstacles). Finally, he is responsible for all aspects of the battalions combat orders (FM 101-5, 1984).

The S-4 (Logistics Officer) has staff responsibility for logistics (supply, transport, and maintenance services). He supervises all logistical elements in the battalion, both organic and nonorganic. He formulates logistical policy by planning, coordinating, and supervising the logistics resources. He is the officer in charge of the ALOC (FM 101-5, 1984).

Within their functional area the staff officers are required to continuously collect, collate, analyze and disseminate information gathered from all available resources. This information must be rapidly processed to provide the commander with data that is pertinent to his decision making responsibilities.

SUMMARY: The decomposition of the subsystems provides us with a better understanding of what comprises the command and control system the mechanized battalion commander has to support him in conducting combat operations.

D. RELATING THE SYSTEM TO THE PROCESS

The previous sections provided a description of the system the commander has available to enable him to command and control his combat forces and what functions the process of command and control involves. This section will detail how the battalion commander utilizes the elements of the C2 system to execute the command and control process functions.

The battalion organization can be viewed as being composed of three major entities: the commander and his staff, the combat support elements and the combat elements. These three groupings are representative of how the battalion is distributed on the battlefield.

The combat elements and the combat support elements are the elements which execute the ACT function of the command and control process. As the description of the ACT function stated, they provide the interface between the commander and the environment. The combat companies and specialty platoons (eg. mortars, scouts) are the means used to influence or force changes in the environment. Their actions are in response to orders issued by the commander as a result of the DECIDE function. These forces actions can be as simple as staying in a present position, to being as complicated as launching a night attack against fortified positions as part of a combined arms attack. The combat support elements act to provide the rations, equipment, ammunition and personnel to support the combat elements actions. Their activities could be providing additional ration supplies or getting replacement Bradley combat vehicles.

In the battalion the SENSE function is primarily executed by the battalion scout platoon, though combat companies also execute the SENSE function for special missions and almost continuously while in close proximity to the enemy. The scouts are considered "the eyes and the ears" of the battalion commander. They are used to collect information about the environment which will feed into the INTELLIGENCE/ANALYSIS function and the PROCESS function. The information gathered is dependent upon the future missions the battalion is expected to execute as well as how much information about the environment has already been collected. Typically information needs will focus on terrain to the battalion's front, location of key enemy positions, enemy movement and actions.

The battalion commander and the staff execute the INTELLIGENCE/ANALYSIS, PROCESS, and DECIDE functions. The description of the functions of the different staff cells shows that, though there are specialist in different areas, there is some overlap between the cells. Clearly, there is no one person who does all of the functions. The staff cells must operate in a coordinated and logical manner, providing each other information and data that they need in order to present the commander with as much complete and timely collective information as he needs to allow him to render the best decision possible.

The groups are connected by the communications system that was described earlier. The illustration below shows the battalion organization with the process related to each part and how they are connected by the communications network.

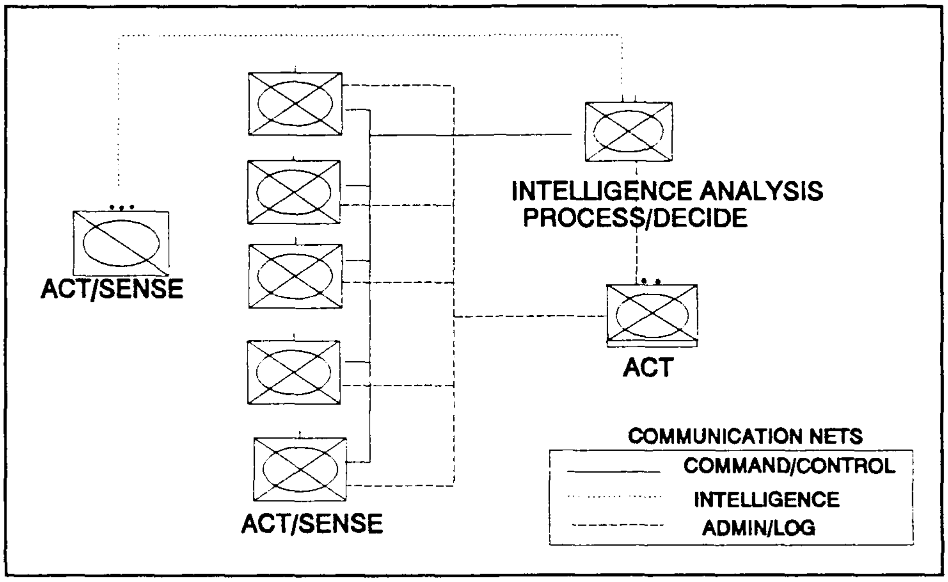

Figure 3-4. **Network Linking the Combat Model Process'**

E. SUMMARY

The system that the battalion commander has to execute command and control process is composed of many elements spread out on the battlefield. Each element is responsible for one or more of the process functions. An effective communications network is critical in linking the separated elements. Without a good communications network the C2 process functions will not be connected. A failure in this area will have a direct effect on the battalion's ability to conduct combat operations.

The following chapter examines the information requirements of the commander. This information will be used by the system described above to control and direct the activities of the battalion in combat.

IV. INFORMATION TO SUPPORT COMMAND AND CONTROL

A. INTRODUCTION

The previous sections have shown that the critical link between elements of the C2 system as well as the C2 process is communications. The communications networks described are the primary means in which information and intelligence is exchanged within the system. In order to assess a C2 system, the inputs and outputs of the system must be identified in relation to the information requirements of the commander. This is critical in automation in that a computer program can not be written or evaluated by a programmer if he has no knowledge of the inputs that will be provided to his routine or of the nature of the desired output (Turban,1990).

B. INFORMATION REQUIREMENTS OF THE COMMANDER

A useful starting point in determining what information is needed by the commander and the staff is to determine what factors all commanders and staff must consider when making tactical decisions. The Army's FM 100-5 Operations manual identifies these factors as being: mission, enemy, troop, terrain, and time available (METT-T). Applying the METT-T factors helps the commander isolate and address significant considerations that affect the missions.

By looking at these over-arching factors we are provided five areas in which the commander must have information. The sections which follow provide an explanation of what information is considered by the commander in each of the five areas.

1. Mission

The mission is received from higher headquarter and states what the subordinate must accomplish. It clearly establishes the intent or purpose of the commander ordering the mission and limitations imposed by the higher commander. The enemy, terrain and weather, troops available, and time factors are considered in terms of their impact on the mission. Thus, it is imperative that the mission be completely understood. Analysis of the mission is done primarily by the commander and the S-3. They determine the stated and implied tasks that their unit is being told to do (FM 100-5, 1986). Once these tasks are defined the remainder of the METT-T analysis can continue.

2. Enemy

The commander and the S-3 will now begin to bring the other staff elements into the analysis process. The S-2 will be required to present as much all available information to provide an intelligence picture of the enemy. The exact information wanted by the commander concerning the enemy is dependent upon the mission the unit is going to preform. For example, if the unit is going to conduct a breaching operation of the enemies' main line of defense the commander may want to know where the gaps in the mine fields and trench systems are. Or, how fast can the enemy react to the breach with mobile forces? If the mission were to conduct a delay operation he may want to know what forces are leading the enemy attack. Or, where the main and supporting attack efforts are to be expected in his sector. The list below provides the reader with an idea of what information is considered in an analysis of the enemy (FM 7-72,1987):

- Identification - Who is he? What size and type of unit is he?
- Location - Where is he? Where is he going?
- Disposition - How is he organized? What are his formations?
- Strength - Friendly versus enemy.
- Morale - Esprit, experience, state of training, regular or reserve forces?
- Capabilities - Electronic warfare, chemical or nuclear weapons types, airborne, attack helicopter or air assault forces?
- Composition - Armor, Infantry (mechanized, motorized or light), artillery, attack helicopters, combat support assets?
- Probable courses of action - What is his most likely mission or objective? How will he move his forces to obtain that objective?

The commander and staff, primarily the S-2 and S-3, will examine these enemy factors with regard to their impact upon friendly forces and the missions they have to execute. This will contribute to the decisions concerning future plans and operations the unit will conduct. Adequate information about the enemy allows for plans that will exploit enemy weaknesses and negate or reduce friendly weaknesses, counter enemy strengths and take advantage of friendly strengths.

3. Terrain and Weather

Primary responsibility for providing information in the area of terrain and weather again falls to the S-2. The commander expects him to be able to provide a terrain analysis of the area of operations. The S-2 uses maps and overlays, called templates, to illustrate his analysis. His terrain analysis involves an examination of the effect of terrain upon the following areas: observations and fields of fire, cover and concealment, obstacles, key terrain and avenues of approach (OCOKA). All of this information is related to both enemy and friendly forces. A brief explanation of each of these areas is provided below (FM 7-72, 1987).

a. Observation and fields of fire.

Observation applies to what can be seen; fields of fire determines what can be hit.

b. Cover and Concealment.

Cover is that which protects from fire. For mechanized forces something provides "cover" if it can stop enemy anti-armor weapon systems. Personnel are provided cover by anything that will stop small arms fire or artillery fragments. Concealment prevents observation of one force by the other force. Concealment may or may not provide cover at the same time. Dense foliage will often provide concealment without the benefit of cover.

c. Obstacles.

Obstacles that impede the movement of forces must be considered. The obstacles can be natural or man-made, enemy or friendly. The commander needs to know the location, extent and strength of obstacles so that they can be incorporated in the maneuver plan. For example, in operation Desert Storm the extensive Iraqi beach obstacles outside of Kuwait City forced General Schwartzkopf and his planners to not conduct an amphibious landing of U.S. Marine forces as part of the ground attack (Duffy, 1991).

d. Key Terrain.

Key terrain is any area that provides a marked advantage to the combatant who seizes or controls it. Examples of key terrain include such things as hill tops that would allow you to see behind the enemies front lines, the high ground on either side of a narrow valley enemy forces must move down in order to attack, the only bridge (that can support the weight of tanks) that crosses a major river.

e. Avenues of approach.

Avenues of approach are the major routes by which the enemy can travel to bring forces into the battalions area of operation. These routes are evaluated in terms of maneuver space available along the route, obstacles on the avenues of approach, and locations where the enemy could be disrupted or from which he could ambush or disrupt friendly forces. The S-2 terrain evaluation will assist in the determination of where the avenues of approach are located.

f. Weather.

Weather can affect men, equipment and terrain. Adverse weather can bring operations to a standstill. Information about future weather conditions is important to successful mechanized infantry operations. The S-2 will provide the commander with information concerning temperature, precipitation expected, sunrise and sunset times, and what phase the moon is in and the resultant percentage of illumination it will provide.

4. Troops available.

The commander must have information about his own troops that is similar to the information he would like about the enemy troops; location and disposition, state of maintenance and supply, personnel status, morale and state of training.

5. Time available.

This is critical to every phase of the conduct of an operation. All command and control systems must make efficient use of time. The importance of time allocation in preparing for operations is illustrated by the "one-third, two-third" rule for time allocation at the tactical level. The rule requires that the battalion headquarters should use no more than one-third of the time available for planning and the subordinate units should be given no less than two-thirds of the time for their preparations. Crucial time considerations include (FM 7-72, 1987):

- Available time for preparations and planning to include rehearsals to verify the plan.
- Movement times from assembly areas to sector positions, battle positions, or attack positions.
- Attack timings from the line of departure or line of contact to the objective or to intermediate phase lines.
- Delay times.
- Decision points and reaction times.

METT-T allows us to group relevant information for analysis in order to produce the best plan that will accomplish the mission. This short description of each element of METT-T illustrates the amount of information desired by the commander and the staff. The exact type and amount of information required to analyze each of the METT-T factors depends primarily upon the mission that has to be executed. The amount of information actually available for use in planning will depend on the resources available to gather the information, the amount of information already existing in some kind of database, and the amount of time the commander and his staff can wait for information before a plan must be developed. The level of detail of the METT-T analysis and mission planning will depend on how much time is available and the amount of information that is available during that time.

The next section describes how the METT-T analysis tool is use by the battalion commander and his staff within the functions of the Combat Operations Process model.

C. RELATING METT-T TO THE C2 PROCESS MODEL

Orr's model, described earlier, shows higher headquarters providing input into the Decide Function (Figure 3-1). This is often in the form of a mission. The commander and staff conduct a METT-T analysis of the mission and determine, among other things, what information they still need. The information requirements are then sent to the companies and scout platoon who attempt to collect the information desired, the ACT and SENSE functions. The S-2 may be tasked to provide weather analysis and the S-4 is asked to develop a logistics plan that will support the new mission, the INTELLIGENCE ANALYSIS and the PROCESS functions. As the required information comes into the S-2 and the S-3 it is evaluated (the INTELLIGENCE ANALYSIS function), organized and placed into the plan, the PROCESS function. The process is iterated until available time is used up or the proposed courses of action are complete. The commander then executes his responsibilities, the DECIDE function, in selecting a course of action that will become the final plan.

D. INFORMATION INPUTS

To meet the information requirements of the commander many sources can be asked to provide data. Within the battalion the sources are the combat and combat support elements described previously. These sources use a number of pre-established standard report formats to transmit the information through the C2 system. The standard reports fall into one of two categories, tactical or logistical. The reports provide different types of METT-T information depending on the type of report. For example, a tactical report called a Spot Report will provide information concerning an enemy unit. It will provide such information as size, activity, location, uniform, time spotted, expected course of action. A logistical report such as a Personnel Status Report will provide such information as number of personnel on hand, number of personnel lost since the last report, number of new personnel since the last report, and number and type of duty positions still needing to be filled. Currently the Army is continuing to standardize reports, service wide, to increase interoperability between different units. However, units may still have reports that are unique and fulfill special requirements of different commanders.

E. INFORMATION OUTPUTS

The output of the INTELLIGENCE ANALYSIS, PROCESS and DECIDE functions are the plans and orders issued to lower echelons as missions. These missions are issued in one of three formats: Warning Orders, Operations Orders (OPORD) or Fragmentary Orders (FRAGO) (ARTEP 7-20-MTP, 1988). These each have service wide standardized formats. They are transmitted to subordinate units either by voice communications, courier or personal face to face meetings. Because of the complex nature and detail of the OPORD it is often communicated by gathering the company commanders, staff and other concerned personnel at a single location (usually the battalion TOC). Our present system does not have the capability to transmit overlays or graphics over radios. Graphics always must be physically transported by a person. This type of system has obvious short-comings that can be solved if a communications system that supported text and graphic message traffic were employed. Company commanders may not be called away from their units as often or as long for meetings, graphics could be rapidly disseminated through out the battalion, and the leadership of the battalion would not be gathered together and exposed to a single enemy indirect fire attack.

F. SUMMARY

Army doctrine and the current practice in the field utilize METT-T analysis to sort information and determine information requirements. To gather and store information the present system uses message record forms, journals, maps with acetate overlays that are updated by hand, and the memory of the staff personnel (FM 101-5). The entire information transmission process, the INTELLIGENCE ANALYSIS function, and the PROCESS function are all manual. Automation, which has been successfully applied to other command and control system (e.g. TAC-FIRE), has not yet been introduced in the mechanized infantry battalion. The current system of standardized reports for both the input and output of information can be made more efficient by automation. The CVC2 system applies automation to the process of information transfer and storage described in this section. The system should decrease the amount of time and effort needed to present information to commanders within the battalion C2 system. It is important to remember that, though the CVC2 system is not a decision making tool, decisions will be made based on the information it contains in its databases. This fact highlights the importance of identifying and having solutions to potential problem areas such as: validating information the user chooses to store in his CVC2 node database, uniformity of information within different users database, and what types of procedures are used to ensure the uniformity and accuracy of information databases within the system. These areas are addressed in the evaluation of the CVC2 system conducted in the next chapter.

To this point, the system processes and the information flow the CVC2 system has been designed to support have been described. Next, Chapter V defines the areas that the CVC2 system can be expected to have an impact on and proposes measures of performance (MOP's), measures of effectiveness (MOE's), and measures of force effectiveness (MOFE's) that should be applied to determine the qualitative value of the CVC2 system.

V. CVC2 ASSESSMENT

A. INTRODUCTION

The purpose of this chapter is to outline a methodology for assessing the value of the CVC2 system. Current evaluations of the system are being conducted at the tank platoon and company level. Though this tactical level of testing is important, it should not be used as the sole or primary measure of the value of the system. The previous chapters' description of the environment that the CVC2 system will be operating in indicates that the greatest value of the system may be better realized at the battalion level. It is at this level that the functions of the CVC2 system could receive maximum usage, particularly in the preparation of plans and orders. This chapter outlines the methodology of a battalion level assessment plan in the following sections. The first section provides the introduction. The second section after stating the CVC2 functions, proposes measures of performance (MOP's) to measure the CVC2 and competing systems' ability to execute those functions. The third section identifies measures of effectiveness (MOE's) that can be used to judge the performance of the battalion C2 system. The MOE's evaluate command and control products (eg. estimates, plans, orders) generated at the battalion command level. This method of assessing the value of the CVC2 system focuses on relating its functions to command and control products generated by its use. Research supports the concept that effectiveness can be described by relating a specific C2 process (communicating, decision-making) to the products (plans, decisions) (Olmstead, et al). Like the MOP's, the results obtained using the CVC2 system are compared to the results obtained by using the present system. The fourth section proposes measures of force effectiveness (MOFE's) that may be useful in evaluating a units success using the CVC2 system. The fifth section discusses the testing of the CVC2 system in the SIMNET test environment. The final section provides a summary of this chapter.

B. CVC2 SYSTEM FUNCTIONS AND RELEVANT MOP's

The mission of the CVC2 system states that it will provide commanders of maneuver forces accurate, timely information to allow them to make decisions and assist them in preparing orders. The system does this through the following functions:

- Provides a tactical situation display
- Prepares digital messages
- Provides digital communications
- Process received digital messages
- Maintain tactical and logistical databases

The assessment of these functions can be done by applying measures of performance (MOP's) that will allow the evaluator to compare performance of the CVC2 system in these areas with the current system. The following MOP's are suggested:

1. **Accuracy of Tactical Situation Display**

This MOP considers the technical aspect of the systems ability to transform a text message to a symbol and transfer that symbol to the appropriate overlay. It is anticipated that the CVC2 system will perform this task better than the current manual overlay system.

2. **Accuracy and timeliness of overlay updating**

This measure evaluates the systems ability to present timely and accurate overlays for the user. Items to look for include; information missing that was contained in a text message received by that CVC2 node; duplicate unit icons - were old unit icons removed when the overlay was updated because of newer information.

3. **Accuracy of tactical database**

This MOP measures the relative correctness of the tactical database with respect to the message received at that CVC2 node.

4. **Accuracy of logistical database**

This MOP is similar to the previous MOP but considers the logistical database.

5. Improvement in message traffic exchange

This MOP provides an indication of the differing capacities of the CVC2 and non-CVC2 architectures. It is based on the average amount of time required to send messages. The messages are sorted by type (eg. FRAGO, SPOT REPORT, SHELL REPORT) and the time is averaged within each of those categories.

6. Improved resistance to electronic jamming and direction finding

This MOP compares the number of successful jamming and direction finding efforts occurring in a scenario with the unit using a CVC2 system and a unit not using a CVC2 system.

The MOP's described above examine the technical aspects of the CVC2 system's performance. Evaluation of the technical performance characteristics is important but does not necessarily provide information on how much of an improvement is provided to the command and control system of the battalion. To gain further insight on the systems value, the evaluation must relate the technical functions of the system with the people using them. For battalion level evaluation the functions will be used by staff personnel to assist them in the preparation of their reports,estimates and orders. The next section considers this aspect of the evaluation by discussing measures of effectiveness (MOE's) that will relate the functions of the CVC2 system to the staff products.

C. CVC2 RELATED PRODUCTS AND MOE's

By comparing the accuracy, timeliness and completeness of command and control products created by people using the CVC2 system with the same products created by people using the current system an understanding of the value of the CVC2 system can be assessed. To evaluate how well the CVC2 system performs its mission the following measures of effectiveness should be used:

1. Improvement in battlefield situational awareness

This MOE allows users to state if they felt better informed with the CVC2 system or with the current system.

2. Improved S-2 Intelligence picture

This MOE compares the accuracy, timeliness and completeness of the S-2 intelligence estimates, Order of Battle templates, and Enemy Situation briefings for operations orders for operations conducted using the CVC2 system with ones conducted using the current system.

3. Improvement in the S-4 logistics picture

This MOE compares the accuracy, timeliness and completeness of the S-4's Equipment status charts, parts requisitions, ammunition status and distribution plans for operations conducted using the CVC2 system with operations using the current system.

4. Improved Operations Orders

This MOE compares the accuracy, timeliness and completeness of operations orders prepared by units using the CVC2 system with those prepared by units not using the system.

5. Improved accuracy of overlays provided to subordinates

The MOE compares the overlays provided by battalion to company level using the CVC2 system with those sent without benefit of the system.

6. Improved personnel accountability

The intent of this MOE is to compare the accuracy of the personnel status of the battalion on a periodic basis during an operation. Like the other MOE's the unit should conduct similar exercises one with the CVC2 system and one without.

The MOE's described above will allow an evaluator to determine the value of the CVC2 system to improving plans and orders developed by the battalion. The next section provides evaluation measures that will allow the evaluator to assess the value of the CVC2 system toward improving the outcome of combat operations.

D. UNIT SUCCESS MEASURES - MOFEs

The measures of force effectiveness can provide useful information for an evaluation of the system. Research has indicated that the performance of a C2 system is not a direct predictor of the units' mission success (Crumley, 1988). This research observed that often other factors unrelated to the plan or order contributed to the battle outcome. This has made it difficult to determine if the improved C2 system resulted in an improvement in unit performance. The test situation must be the same in order to determine if the C2 system's "better" plan or order contributed to improved mission success. The following scenario will illustrate the point:

A unit is issued an attack plan and prepares to execute it. Just prior to the launching of the attack a platoon becomes lost and can not participate in the attack. The attack is conducted by the rest of the unit and fails to achieve the objective. Now, an evaluation of the same unit is conducted again. This time the unit is using the CVC2 system. A similar attack plan is prepared, nobody gets lost, the attack is conducted successfully. The evaluator is now faced with a difficult, if not impossible, task of determining how much of the units success was a result of the C2 system and how much was a result of no tanks getting lost. Using MOFEs to measure the value of a C2 system can only be done if factors external to the C2 system are kept under control from test to test. Conducting C2 assessments in a computer controlled situation, such as the Army's SIMNET, can afford evaluators the use of MOFEs to reach valid conclusions. With this in mind, the following MOFEs are suggested to evaluate a units' success:

1. Percentage of enemy armored vehicles destroyed.
2. Percentage of friendly armored vehicles destroyed.
3. Number of fratricide incidents.
4. Time required to complete mission objectives.
5. Time required for the unit to conduct follow on operations.

With the proper control of variables MOFE's can provide evaluators with valid information on how much a new command and control system will improve a unit's results in combat operations.

E. ASSESSMENT PROCEDURE

Using the MOP's, MOE's and MOFE's outlined above, an assessment of the CVC2 system compared with the current system can be done. For the evaluation of the CVC2 system at the battalion level I propose using the Army's SIMNET system to conduct the testing rather than using units in a force on force situation in a field training exercise (FTX). Putting units into the SIMNET environment for the conduct of evaluations at the platoon and company level has shown it to be a good testing devise. The SIMNET system can be configured to support a battalion size evaluation. The computer can be programmed to automatically capture much of the desired data. This will allow for accurate comparison of the factors evaluated within the MOP's and some of the MOE's. The computerized system will also allow for more rigid control of scenario variables. This will allow for effective and valid comparison of the measures proposed, especially the MOFE's. The computerized system will provide a meaningful comparison of the results of scenarios run with and without the CVC2 system supporting the unit. The use of the computerized environment has not only allowed for better data capture and replication it is normally less expensive than a field exercise. Figure 5-1 indicates the measures that can be evaluated in the SIMNET environment and those the can be measured in the FTX environment. Much of the data related to MOE's and MOP's is gathered through the use of observers and questionares in both environments. SIMNET does allow better tracking and evaluation of message flow by using time-tagging of meassages. Following the SIMNET testing of the CVC2 system and analysis of the results the evaluators will be able to assess the value of the CVC2 system to tactical users.

ASSESSMENT MEASURES	SIMNET ENVIRONMENT	FIELD TRAINING EXERCISE
MEASURES OF PERFORMANCE		
Accuracy of tactical display		X
Accuracy and timeliness of overlay updating	X	X
Accuracy of tactical database		X
Accuracy of logistical database		X
Improvement in message traffic exchange	X	X
Improved resistance to jamming and direction finding		X
MEASURES OF EFFECTIVENESS		
Improvement in battlefield situational awareness	X	X
Improved S-2 intelligence picture	X	X
Improved S-4 logistics picture	X	X
Improved operations orders	X	X
Improved accuracy of overlays provided to subordinates	X	X
Improved personnel accountability	X	X
MEASURES OF FORCE EFFECTIVENESS		
Percentage of enemy armored vehicles destroyed	X	
Percentage of friendly armored vehicles destroyed	X	
Number of fratricide incidents	X	
Time required to complete mission objectives	X	
Time required for the unit to conduct follow on operations	X	

Figure 5-1. Measurement Environments

F. SUMMARY

The current focus on evaluating the CVC2 system at the platoon and company level falls short of identifying the value of the CVC2 system toward enhancing the accuracy and timeliness of information provided a commander. The MOP's and MOE's described in this chapter focus the assessment effort at the battalion level where most of the pre-battle information processing and sorting is actually done. The command and control products generated at this level form the basis for maneuver plans and orders that the battalion, companies and platoons will execute. It is also at this level where the cognitive abilities of people will become challenged first. For example, if you lost a vehicle and three crew members at platoon level the platoon leader often does not have difficulty remembering the pertinent information related to that. However, the battalion S-4 must be able to remember that loss as well as all other equipment losses suffered by the battalion and he must get the replacement equipment ordered and delivered to the correct unit. The S-1 must be able to provide the same service with respect to replacement personnel. For these reasons and others like it I suggest that the greatest benefit of the automated CVC2 system is at the battalion level.

In the next chapter I provide some observations concerning the implementation of the CVC2 system. Because of the lack of empirical data of the CVC2 operation at the battalion level, I base my observations on my operational experience of serving in infantry battalions for five years. During that time I was a primary staff officer, S-4, as well as a company commander. I was able to use the current system for planning and conducting operations and, along with my peers, noticed where improvements to the current C2 system could be effected.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. GENERAL OBSERVATIONS

The measures proposed in the preceding chapter are a start toward realizing an effective evaluation of the value of the proposed CVC2 system. The descriptions, in Chapters III and IV, of the battalion system and the command and control process that operates within that system, illustrate the increasing complexity of exercising tactical command and control. The battalion commander must be able to monitor and control his forces in an increasingly fast paced environment. The CVC2 system attempts to assist the commander in doing this. The use of automation to support tactical operations has been done with varying degrees of success by other US military services (eg. the US Air Forces' JTIDS system and the Navy's JOTS system). Like those systems, the CVC2 system is important in that it is attempting to speed the dissemination of information to tactical users. Unlike those systems, the greatest value of the system does not seem to be directly related to increasing an individual tank's ability to engage and destroy a target, rather, the value is that it allows access to timely, more accurate information which a commander and his staff can use to speed the plans and orders process. The time saved here can be reallocated toward conducting rehearsals, allowing subordinate units more planning/preparation time or even increasing the tempo of combat operations. This will in turn allow the individual tank or fighting vehicle to perform better on the battlefield.

B. CONCLUSIONS/ISSUES

The CVC2 system appears to be a system that will improve an area of combat operations through the use of automation. During the research for this thesis the author found some issues that are potential problem areas that must be addressed to successfully incorporate the CVC2 system into the existing structure. The first area of concern is the suitability of the current staff structure to incorporate the CVC2 system. The concern is that the primary staff officers will allow database management to become their primary focus. As discussed earlier, they need to perform analysis of information and use it to develop plans. However, the databases in the CVC2 system only provide information to allow the analysis. Responsibility for the updating and accuracy of the database must be specified in the fielding plan.

The second area of concern is the establishment and enforcement of standard reporting formats. The US Army must continue to stress the need for standardization in this area if it wants to develop users who will not feel the system is "hostile" or "too much trouble to learn".

A third area of concern is the need to continue to focus on development of a system that is interoperable with other services and countries. The CVC2 system has been developed as a joint effort with Germany. From my research it does not appear that the USMC has plans to assist in the development or fielding of the CVC2 system. It is important to remember that with smaller tactical forces in each service the services will operate together more and more in future conflicts. The communications and information systems they use must be compatible through design and not because of "work around" solutions.

C. RECOMMENDATIONS

The CVC2 system should be tested at the battalion level as a tool that will improve the commander's and his staff's ability to access accurate, timely information for planning and controlling the movement and employment of the battalion in combat. Once the testing is completed in the SIMNET environment units should deploy with the system to the National Training Center and employ the systems against an enemy in the field. These results should validate the earlier SIMNET results and evaluate MOE's and MOP's that could not be evaluated with SIMNET. In these times of reduced defense budgets, attempts should be made to interest the USMC in the program as early as possible. The need to provide interoperable systems for the future battlefields is a critical one.

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