COMMAND AND CONTROL SYSTEMS: OUTLOOKS FOR A DIGITIZED FUTURE

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History reveals that C2 systems evolve when three areas are evolved holistically: organizations, procedures, and communications.

The subject areas are the basis for a comparison of Force XXI with commercial and academic trends where increased information technology (IT) is involved.

In the first subject area: organizations, commercial firms have adapted to leverage technology by moving from hierarchies to flat and networked organizational structures. Force XXI proposes a "flattened" organization to achieve efficiencies through information technology.

In procedures, the Army and commercial organizations face similar challenges: micromanagement and information overload. In the Army, most C2 procedures stem from the Military Decision-Making Process. Commerce uses similar procedures to address the two challenges and achieve greater effectiveness.

In communications, commercial firms insist on interoperability, flexibility, upgrade-ability, and portability. Commonly used technologies such as the Internet and Microsoft Windows/Office usually drive the baseline of compatibility. Force XXI implements a number of systems which perform similar functions.

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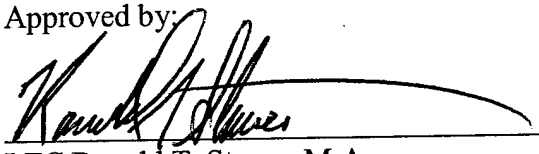

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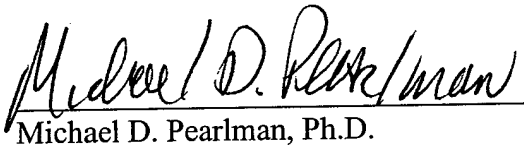

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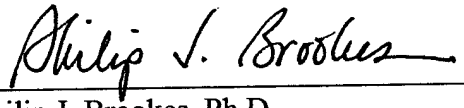

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ABSTRACT

COMMAND AND CONTROL SYSTEMS: OUTLOOKS FOR A DIGITIZED FUTURE, MAJ MICHAEL R. McCAFFERY, 239 pages.

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History reveals that C2 systems evolve when three areas are evolved holistically: organizations, procedures, and communications.

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I would also like to thank the faculty of Marine Corps University, who taught me how to think about command and control beyond the electrons.

TABLE OF CONTENTS

ABBREVIATIONS

AAR	After Action Review
ABCS	Army Battle Command Systems
ADC-M	Assistant Division Commander-Maneuver
ADC-S	Assistant Divistion Commander-Support
AFATDS	Advanced Fiele Artillery Tactical Data System
AM	Amplitude Modulation
AMDWS	Air and Missile Defense Work Station
AOE	Army of Excellence
ARFOR	Army Forces
ARI	Army Research Institute
ARL	Army Research Laboratory
ASAS	All-Source Analysis System
ATCCS	Army Tactical Command and Control System
ATO	Air Tasking Order
AWE	Army Warfighting Experiment
BFA	Battlefield Functional Area
BOS	Battlefield Operating System
BPV	Battlefield Planning and Visualization
C2	Command and Control
C3	Command, Control, and Communications

C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaisance
CA	Civil Affairs
CAS	Close Air Support
CCIR	Commander's Critical Information Requirements
CGSC	Command and General Staff College
CHS	Common Hardware Suite
CINC	Commander in Chief
CIO	Chief Information Officer
CNR	Combat Net Radio
COA	Course of Action
COP	Common Operational Picture
COTS	Commercial-Off-The-Shelf
CS	Combat Support
CSM	Command Sergeant Major
CSS	Combat Service Support
CSSCS	Combat Service Support Control System
DIVARTY	Division Artillery
DTLOMS	Doctrine, Training, Leadership, Organization, Material, and Soldier Systems
EEFI	Essential Elements of Friendly Information

FFIR	Friendly Force Information Requirements
FM	Field Manual
FXXI	Force XXI
FBCB2	Force XXI Battle Command Brigade and Below
FM	Frequency Modulation
FRAGO	Fragmentary Order
GCCS	Global Command and Control System
GCCS-A	Global Command and Control System-Army
GCSS-A	Global Command Support System-Army
GUI	Grahpic User Interface
IBCT	Interim Brigade Combat Team
INFOSYS	Information Systems
IPB	Intelligence Preparation of the Battlefield
IT	Information Technology
HQ	Headquarters
IMO	Information Management Officer
IO	Information Operations
JFLCC	Joint Forces Land Component Commander
JRTC	Joint Readiness Training Center
JSTARS	Joint Surveillance and Target Attack Radar Systems
JTF	Joint Task Force

JP	Joint Publication
JTRS	Joint Tactical Radio System
LAN	Local Area Network
LNO	Liaison Officer
MCDP	Marine Corps Doctrinal Publication
MCS	Maneuver Control System
MDMP	Military Decision Making Process
MI	Military Intelligence
MLRS	Multiple Launch Rocket System
MOOTW	Military Operations Other Than War
MSE	Mobile Subsciber Equipment
MTS	Military Telegraph Service
NCO	Noncommissioned Officer
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, Chemical
NTC	National Training Center
OODA	Observe-Orient-Decide-Direct
OPCON	Operational Control
OPORD	Operations Order
OPLAN	Operations Plan
PIR	Priority Intelligence Requirements
PPE	Plan-Prepare-Execute

RCP	Relevant Combat Picture
RI	Relevant Information
RMA	Revolution on Military Affairs
RSTA	Reconnaisance, Surveillance, and Target Acquisition
RWS	Remote Work Station
SASO	Stability and Support Operations
SOP	Standard Operating Procedure
TACON	Tactical Control
TCP/IP	Transmission Control Protocol/Internet Protocol
TTP	Tactics, Techniques, and Procedures
TOC	Tactical Operations Center
TOE	Table of Organization and Equipment
TRADOC	Training and Doctrine Command
UAV	Unmanned Aerial Vehicle
VTC	Video Teleconferencing
WARNORD	Warning Order
WIN-T	Warfighter Information Network-Tactical
XO	Executive Officer

ILLUSTRATIONS

TABLES

CHAPTER 1

INTRODUCTION

> Rather than focusing primarily on technological applications, the organizational and procedural dimensions of the C2 system must receive increased consideration. Implied in this is the fact that the human dimension must also receive commensurate emphasis.[1]
>
> Colonel M. J. Dumais, *When a Butterfly Flaps its Wings over the Battlefield*

The purpose of this study is to examine current Army ground combat command and control (C2) systems in light of historical precedents and related commercial initiatives. This study will encompass four main areas of research: the historical evolution of C2 systems, current U.S. Army and commercial organizational initiatives, current U.S. Army and commercial procedural initiatives, and current U.S. Army and commercial communication initiatives.

Proposed Research Question

Does digitization constitute an enhanced ground combat command and control system?

Secondary Questions

1. What are the historical precedents for advancements in C2 systems?

Tertiary Questions

a. What have been the major advances in command and control in history?

b. How has the introduction of different organizational models affected the advancement of command and control systems?

c. How has the introduction of different C2 procedures affected the advancement of command and control systems?

d. How has the introduction of different communications technology affected the advancement of command and control systems?

2. What is the current state and major movements of C2 organization change?

Tertiary Questions

a. What are the baseline organizational theories which explain how work environments are organized?

b. Given enhanced information technology, what major changes in organizational models are commercial corporations implementing in order to optimize command and control?

c. How do the organizational theories of the information age compare with Army re-organization efforts as stipulated in the designs of Force XXI Division?

d. What are the major implications for command and control of the Army's new organizational designs according to the ideas of the organizational theorists?

3. What is the current state and major movements of C2 procedural change?

Tertiary Questions

a. What are the main Army operational C2 procedures?

b. What major changes is the Army implementing to existing procedures to optimize command and control through the Force XXI initiative?

c. Given enhanced information technology, what major changes in information procedures are commercial corporations implementing in order to optimize command and control with increased information technology?

4. What is the current state and trajectory of C2 communications change?

Tertiary Questions

a. What are the new communications capabilities inherent in army digitization?

b. What are the new communications capabilities are commercial corporations implementing in order to optimize command and control?

Background and Context

Today, the Army is embarking on several multi-billion dollar initiatives which will alter the basic elements of the current ground force C2 system. At Fort Huachuca, Fort Gordon, and Fort Leavenworth the Army is moving forward to streamline and update the most basic tactical and operational procedures of the battlefield in a new set of warfighting communications systems, called the Army Battle Command System (ABCS). At Fort Hood the Army is implementing the digitization program to leverage the telecommunications revolution in a bid to enhance significantly the communications gear and capabilities which the Army brings to the modern battlefield.

History is full of examples of armies employing technical advances to gain an advantage in their overall C2 systems. This study will review the major advances in these systems to determine what major trends have enabled armies to maximize the utility of these technologies. This study will determine the C2 systems elements which are evolved to create a significant advance in C2.

This study will further investigate what advances in what the military calls command and control have been manifest in the civilian and academic circles during the past five years of the current technology revolution. The major commercial trends in

these areas which most closely align themselves with the in digitization effort are reviewed in this study.

Secondary Question Information

1. What are the historical precedents for advancements in C2 systems?

The study will track the evolution of C2 systems elements to identify trends and key aspects of historically successful command and control systems. The themes identified will validate the approach of analyzing the organizational, procedural, and communications aspects of command and control systems in general.

The body of thought and writing specifically about command and control systems theory has been limited. While the individual elements of C2 are discussed in detail in numerous studies and publications, a holistic approach including C2 elements is less common. This study will attempt to present a limited review of the organizational, procedural, and communications aspects of systems of C2.

A study of the evolution of C2 systems in terms of the individual elements will answer corollary questions. One of these is to identify the attributes of an effective and efficient C2 system in terms of these three subjects. Evidence may point to a C2 trend within a certain element of C2 such as a steady advance towards combined arms (organization), or decentralized execution (procedures), or mobile communications or, a holistic effect resulting in advances in a combination of these areas.

2. What is the current state and major movements of C2 organization change?

The organizational model for observation in the Army is the Force XXI Division. The organizational changes involved with the movement to the Force XXI organizational structure are numerous. This study will review the motivations and projected impacts of

these with special attention to the issues of span of control, unit differentiation, and decentralization of operational control in the Force XXI division.

Commercial firms have adapted their organizational structure to enhance operations in the information revolution. Flatter and more networked organizations have successfully been adopted by hundreds of commercial firms based on the availability of enhanced information technology. Civilian organizational theorists have outlined the basic parameters inherent in alternative organizational designs. This study will present a few of these major trends with their implications for their use in military organizational structures.

3. What is the current state and major movements of C2 procedural change?

The military decision-making process (MDMP) is the baseline Army procedure investigated for this study because more specific procedures of military command and control are varied by location, unit, and operational parameters. These often fall into the category of standard operating procedures or SOPs. The MDMP process and its associated C2 procedures also offer some criteria for identification of major trends from evaluation and grading at the Army's Combat Training Centers. The commercial C2 procedures (which have military counterparts) are part of a system of change in commercial sectors made possible by improved information technology. This paper reviews both commercial and military C2 procedures.

4. What is the current state and trajectory of C2 communications change?

The digital division or Force XXI is, at its heart, an upgrade of command and control communications capabilities of Army forces. The addition of systems to attempt to create a common operational picture (COP) at the tactical level of operations has been

mirrored by new systems at the operational and strategic levels designed and implemented for a similar purpose, namely to provide increased planning capacity and greater cognition in operations. Force XXI uses commonly available but more modern technology to enable enhanced situational awareness for the commander in the location of his forces, fire support situation, intelligence, air defense, and logistics at a minimum. These systems are reviewed in light of commercial trends in this area.

Commercial corporations are investing heavily in advanced communications technology. The systems for remote and mobile users in particular apply closely to the current military applications of advanced technology. The means and standard formats by which commercial firms move information to remote users have advanced exponentially. The major commercial strategies employed to inject advanced communications technologies are reviewed in this study.

Assumptions

1. That the evolution of C2 systems in war has been one of organizational, procedural, as well as technological change.

2. That the "personnel" element of a C2 system equates to how those people are organized and trained, and is thereby described by the organizational element of C2.

3. That the three aforementioned elements of a C2 system may enable the study of current Army and civilian C2 system initiatives.

Definitions

Command and Control

"Command and Control- [Joint Publication (JP) 1-02] The exercise of authority and direction by a properly designated commander over assigned and attached forces in

the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission."[2]

Command encompasses the legal authority and responsibility to make decisions and ensure they are carried out. The commander is also responsible for intangible attributes of the organization sometimes called command climate such as morale, cohesion, and trust. Control, in the NATO definition, is the process through which a commander, assisted by a staff, organizes, directs, and coordinates the activities of the forces allocated to him. In this way, control encompasses all the command functions which can be accomplished without the commander. Command retains its almost mystical aura, but control is the set of procedures, communications systems, and organization (to include the chain-of-command and the staff) which enable the commander's decision to be reached, then implemented on the battlefield. The delegation of control functions is not because commanders are less capable, it is the reduction of the commander's need to attend to mundane details on a complex battlefield. The staff acts as an extension of the commander with limited authority to reduce uncertainty and increase response time by collecting and processing information, dividing problems, and imposing order. The Canadian forces definition of a command and control system, called a Command, Control, and Information System focuses on the information processing nature of the system, "as integrated system comprised of doctrines, procedures, organizational structure, personnel, equipment, facilities, and communications which provide authorities at all levels with timely and adequate data to

plan, direct, and control their activities."[3] Yet the staff has a dual role. As a command support organization, it supports the commander in any way possible. As a specialized body of experts, it supports, controls, and coordinates subordinate and supporting units.

The elements of Command and Control consist of the five identified in the joint definition: organization, equipment, communication, facilities, and procedures arranged to enable military operations. This study substitutes organization for the element of personnel from the original C2 definition. This assumes that the "arrangement of personnel" as described in the joint definition could be more accurately described simply as organization. This is in agreement with current organizational theory definitions and thought, and, the researcher believes, more accurately describes the functions of this C2 systems element in the context of the evolution of C2 systems.

The equipment element described in the joint definition includes the life supporting and otherwise necessary gear that enables commanders to established and sustain a C2 system. The facilities element described in the joint definition includes all headquarters facilities used by the commander. While these nodes merit study subjects, the researcher believes that their impact on C2 systems evolution may be adequately reflected in the investigation of the more central elements of organization, procedures, and communications.

Force XXI

Force XXI is centered around five strategic characteristics: "doctrinal flexibility; strategic mobility; tailorability [sic] and modularity; joint, multinational, and interagency connectivity; and versatility in war and military operations other than war (MOOTW)."[4]

The implementation of the Force XXI initiative to date has been centered on providing digital connectivity through the Army Battle Command System (ABCS). While different agencies define the ABCS differently, this study uses the most common seven key systems for analysis. These include the All Source Analysis System (ASAS) for intelligence, Force XXI Battle Command for Battalion and Below (FBCB2) for tactical maneuver, Combat Service Support Command System (CSSCS) for logistics, Artillery For Army Tactical Data System (AFATDS) for fires, and the Air and Missile Digital Workstation System (AMDWS) for air defense, and the Maneuver Control System (MCS) for tactical-operational maneuver, and the Global Command and Control System-Army (GCCS-A) for operational level C2.

The underlying assumption driving Force XXI is that more complete, more accessible information, that is, a common operational picture, about friendly and enemy forces, presented visually via Army communications systems will enable battlefield dominance for the commander in all areas from logistics to maneuver. As such, Force XXI is primarily a C2: communications advance with significant organizational and procedural implications.

Force XXI has been critiqued and tested in monographs, theses, and rotations of units through the National Training Center (NTC) and the Joint Readiness Training Center (JRTC). These provide empirical information on the communications, procedural, and organizational changes promised by Force XXI. The object is to identify the C2 elements which would be significantly altered by Force XXI in this chapter.

C2 Organization

Organizational theorists have worked on the optimum size and shape, as well as the perfect inner relationships of an organization since the science was invented with the likes of Max Weber, Chester Barnard, and Frederick Winslow Taylor. The maximization of efficiency and effectiveness are the most common objects of the arrangement of operating divisions and personnel in an organization.

The variables in C2 organizations include specialization, and decentralization, and span of control. Specialization is the degree to which subordinate elements are created based on special functions and capabilities rather than a generic, multi-functional unit. Decentralization refers to the distribution of authority and resources between executive and command echelons and their subordinate supervisors. Span of control is the number of subordinates per leader in a hierarchy.

C2 Procedures

C2 procedures are the rules and norms by which organizations exchange information and execute decisions. Information management, as a primary C2 procedure in warfare, deals with the movement, storage, processing, and distribution of information. Civilian theorists have proposed a body of advanced thought on information management, generally categorized under the term information and change theories. In this body of thought, organizations use various procedures to leverage information processing, transmission, storage, and presentation media to maximize the utility of that information and convert it to institutional knowledge.

The MDMP as the basis of military decision making at the tactical and operational levels has been continuously updated and added to from its inception by the

Army in the period just after World War II. Today, the MDMP consists of thirteen sequential tasks grouped in seven major steps from receipt of the mission to production of the operations order. The MDMP involves the collection, processing, and output of information in the context of this study. It is also the source of and framework for a number of C2 procedures is examined.

C2 Communications

Commercial communications are moving to more mobile, lighter platforms. Hand-held terminals are revolutionizing business of dispersed corporations as wireless communications are extending fixed plant capabilities to more dispersed, mobile locations. These communications systems are also providing a greater variety of media available to the user such as voice, electronic mail, web browsing, file transfer, and video. C2 communications includes these efforts and any other technologic means to enable the command functions of planning, coordinating, controlling, and commanding operations.

Limitations

The military notion of command and control is not as clearly understood as are fire support or logistics. As a result, the doctrine covering C2 is somewhat disparate. For instance, C2 is described differently in the Joint Staff and service publications. The Army equates C2 with "Battle Command" in FM 100-5. Also, the five elements of C2 as described joint doctrine are not mentioned in service publications.

A related issue is the evolution of command and control through time. The questions regarding how militaries have arrived at this stage of development in C2 systems are not directly answered by the history and the writings of historians. C2

systems, as defined in current military jargon, have not been subject to the intense study or investigation that maneuver, logistics, and fires have been. The contribution of the C2 system to victory or defeat on the battlefield is a subject which has been mentioned mostly in passing by theorists and generals.

Delimitations

The spectrum of C2 issues in modern military operations is necessarily wide. Due to time and space constraints it will not be possible to address the range of specific C2 for general war through humanitarian operations. Aerial and maritime warfare also offer insight into land-centric command and control and will be referred to, but these are offshoots of the land version. Therefore, this study will maintain a focus on tactical land combat.

In the tactical realm, the legal nature of command and control (as explained in JP 1-02) is less relevant than the strategic and operational levels of conflict. The "exercise of authority and direction by a properly designated commander" refers to in the joint definition of C2 will not be explored or examined in this study.

The subject of leadership itself is also a vast body of knowledge and experience. Since it is related to C2, this study will refer to specific examples to illuminate points herein. However, the related subject of leadership, which deals with intangible qualities and psychological issues, is beyond the scope of this study. It should be understood that the commander is the key node in any C2 system. Others have and continue to research how commanders make effective decisions. This study will not delve into this subject beyond the fact that military decisions must have specific inputs, follow certain established processes, and are transmitted as outputs in a C2 system.

As has already been stated, the historical evolution of C2 is addressed only on the margin of the body of military history. The likes of Martin Van Creveld have traced C2 back to the Roman Empire in his *Command in War*; however, this study does not have the luxury of his time, intellect, or resources. Therefore, only those major points relevant to the discussion of modern C2 will be discussed.

In the information age, there has been a marked increase in information on communications, military or otherwise. This study will not delve into the technical aspects of individual switches, radios, terminals, nodes or computing systems beyond general capabilities and limitations. To say that a communications system is capable of transmitting video efficiently, for instance, is sufficient for this study. The technical problems associated with transmitting that video over satellite links is often not.

Furthermore, this study will not deal with the actual detail of information content that moves through a C2 system beyond that directly relating to one or more of the elements of a C2 system. For instance, the relevant inputs may include priority intelligence requirements as these are procedural C2 factors and the process to ascertain the critical information itself may be pertinent. Likewise, the outputs include orders and reports sent organizational elements and to and from the commander and are relevant. Knowledge of the content, for example the actual intelligence, the tactical direction in orders, or report content is not necessary to understand the overall C2 system.

This study will also focus on the tactical and operational levels of war. Since command and control systems are exactly the means by which organizations concentrating on the strategic, operational, and tactical levels of war are coordinated, however the linkages (between these echelons) may be addressed where necessary.

Finally, the elements of a C2 system as defined in joint doctrine have at least two drawbacks for the purposes of this study. It is certain that the personnel element of a C2 system refers to organization and training yet this study assumes that the organizational aspect is paramount. The training issue will not be a central consideration when evaluating the C2 elements. Also, the element of "equipment" is limited in scope and impact. As such, it will not be evaluated to the same degree as the three defined elements of organization, procedures, and communications.

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[1]Colonel M. J. Dumais, "A Case for a Balanced Approach to Future Operational-Level Command and Control Systems: When a Butterfly Flaps Its Wings Over the Battlefield" (Toronto: Canadian Forces College, n.d.), available from http://www.cfcsc.dnd.ca/irc/amsc/amsc1/ 010.html; Internet; accessed 15 March 2001.

[2]The Department of Defense, Joint Publication 1-02, *Joint Military Terms and Definitions* (Washington, D.C: The Joint Staff, 1997).

[3]Captain (N) P. Guindon, "Command and Control Systems: A Challenge to the Leadership" (Toronto: Canadian Forces College, n.d.), available from http://www.cfcsc.dnd.ca/irc/amsc/amsc1/010.html; Internet; accessed 15 March 2001.

[4]Training and Doctrine Command (TRADOC) Pamphlet 5-525, *Force XXI Operations* (Fort Monroe, Virginia: TRADOC, 1994), 3-1.

CHAPTER 2

REVIEW OF LITERATURE

Command and Control Theory

Much has been written on the information age and explosion of knowledge. Less has been written on how this explosion relates to military command and control. Some of the more relevant works include *Dominant Battlespace Knowledge* by Stuart Johnson and Martin Libicki; *Combat Operations C3I: Fundamentals and Interactions* by Major George Orr; the Marine Corps' Marine Corps Doctrinal Publication (MCDP) 6: *Command and Control*; and the new Army manual FM 6-0 *Command and Control.* These works cover the military scope of C2 from theoretical, historical, and predictive viewpoints. The latest major volume of this type is Arquilla and Ronfeldt's *In Athena's Camp*, a compendium which applies the information revolution to military operations.

Command and Control History

General History

The evolution of military command and control has been documented in many forms, yet actual study of what is now described, as C2 over time is less prevalent. This may be because the Army's notion of C2 as a "Battlefield Operating System" or "Battlefield Functional Area" has evolved only over the last fifty years. A key source in this area is Martin Van Creveld's *Command in War*, where he traces the major advances of Napoleonic, Civil War, World War I, Arab-Israeli Wars, and Vietnam eras in C2. Ken Allard's *Command, Control and the Common Defense* ads an American perspective of the evolution of joint warfare C2.

Napoleonic Period

The Napoleonic revolution in command and control is outlined in general works in C2, such as Van Creveld's *Command in War* and Keegan's *The Mask of Command.* Paret's work *The Makers of Modern Strategy* and Addington's *The Patterns of War Since the Eighteenth Century* both add depth to a general outline of Napoleonic C2.

More specific references are harder to come by. One of the most useful works on the mechanics of Napoleon's system is S. J. Watson's work on Napoleon's Chief of Staff: *By Command of the Emperor: A Life of Marshal Berthier.* As the key player in the development and execution of Napoleon's command and control system, information on Berthier is essential to this study.

U.S. Civil War

The U.S. Civil War was a period of limited gains in C2 systems despite technical innovations. The technical advances of the telegraph and wig-wag are the focus of study for C2 systems in the American Civil War. *The Memoirs of U.S. Grant* shows us how operational C2 worked during the Civil War and how the technical innovations were incorporated. Grant is also a primary innovator in C2 procedures of his period with his mission type orders, commander's intent, and centralized command, decentralized execution. Edwin Fishel's *The Secret War for the Union* shows the tactical mechanics and procedures on both sides as well as a view of the limitations of these contemporary technical means of C2.

Franco-Prussian War

Study of the C2 system which was successful in the Franco-Prussian War involves investigation of the Prussian and German development in two main areas: the

use of the telegraph and the German General Staff. Moltke, as the primary architect of both of the use of these systems during the period of the war, is the key figure of the period. As such, his work, *The Franco-German War of 1870-71*, as well as the collection of his actual orders issued during the war provided by Spenser Wilkinson in *Moltke's Military Correspondence 1870-1871* are critical primary sources.

Secondary works on the German General Staff include a monograph by a German Army officer attending the U.S. Army's Command and General Staff College (CGSC) by Oberst Millotat entitled "Understanding the Prussian-German General Staff System" and Walter Goerlitz's book *History of the German General Staff 1657-1945*. Both have proven very useful for understanding of Moltke's development and use of a comprehensive C2 system centered on the staffs of the major headquarters' during the war.

The most complete general work on the conflict itself is Michael Howard's *The Franco-Prussian War*. This book provides a stark contrast between the Prussian or North German Army C2 system, representing the new C2 paradigm, and that of the French representing legacy systems. This book illuminates why the German C2 system in general and the German General Staff system in particular were adopted by most industrialized nations of the period between the Franco-Prussian War and World War I.

World War I

World War I did not represent a major new leap ahead advance in C2 systems, but rather a more limited advance with both sides struggling to maximize the new technologies of C2, most particularly the telephone. The British system on the Western Front of 1916 and 1917 and the German C2 system are compared and contrasted in

Martin Samuels' *Command or Control? Command, Training, and Tactics in the British and German Armies, 1888-1918.*

World War II

The major C2 advance during the Second World War is represented by the use of the radio in combined arms operations. The best example of this system at work is presented in works recounting the German invasion of France in 1940, which was both wildly successful and too early to be affected by Hitler's interference in the German C2 system. Works on this topic and the developments leading to Blitzkrieg include Murray's *Military Innovation in the Interwar Period*, Guderian's *Panzer Leader* and Addington's *The Blitzkrieg Era and the German General Staff 1865-1941.*

Since the organization, procedures, and communications of blitzkrieg were successfully adopted in varying degrees by the allies later in the war, a study of the American tactical and operational C2 system of 1944 and 1945 is warranted. The U.S. Army's Center for Military History has this in their "Technical Services" series of a three-volume history of the Signal Corps during the war. Other sources which provide detailed information on the American development include the Combined Arms Command study *Towards Combined Arms Warfare: a Survey of 20th Century Tactics, Doctrine, and Organization* and Thomas Hughes' book *The Other Air War: Elwood "Pete" Quesada and American Tactical Air Power in World War II Europe.*

Command and Control Organization

Organizational theory is a small yet robust area of study centered in academic circles. It is the confluence of the subjects of sociology and management. Rick Mayer's

Organizational Theory reviews the works of Maslow, Taylor, Weber, Barnard, and Gulick which comprise the leading bodies of thought on the subject over the last century.

Current information on common military organizations is present in many service and joint publications. As many of these organizations vary greatly from doctrinal models, usually based on mission, lessons learned reports must be consulted for current datum.

Alternative military C2 organizations include those put forth in MacGregor's *Breaking the Phalanx*, as well as General Maxwell Taylor's attempt at Pentomic Division structures. The current Army Force XXI initiative also falls into this category as it relates to organizing for C2 and is documented in articles, briefings, and pamphlets from the U.S. Army's Training and Doctrine Command (TRADOC).

Command and Control Procedures

Current Army C2 procedures are outlined in doctrine dealing with the MDMP (FM 101-5), reporting procedures (various joint and service publications), and the draft FM 6-0 *Command and Control*. These procedural exercises of C2 are important to the study because they present all the various elements of C2 in action. They bring together the organization, its equipment and communications, the facilities, and the C2 information being transmitted and received. As such, they illuminate a model of the system as a whole at work.

Many theorists and thinkers within and without the Department of Defense have conjectured upon futuristic command and control procedures. Major George Orr's *Combat Operations C3I: Fundamentals and Interactions* is an excellent work on the overall execution of C2 as well as providing a good overview of the ideas of Colonel

John Boyd and his Observe, Orient, Decide, and Act (OODA) loop theory. Captain Frank Snyder in *Command and Control: the Literature and Commentaries* and Thomas Coakley in his *C3I: Issues of Command and Control* add additional in depth thought on military C2 procedures. Ideas on C2 procedures in the information age are outlined in Arquella and Ronfeldt's *In Athena's Camp* and, to a lesser degree, in Leonhard's *The Principles of War for the Information Age.*

Information management theory is a pertinent field of thought and practice which has been expanding in recent years. This subject deals with the nature of information, how it is stored, moved, used, and protected. Two fertile areas of current study dealing with information management focus on information overload and micromanagement. Davenport and Negroponte are two leading theorists in this field. They put forth their ideas in the works *Working Knowledge*, *Information Ecology*, and *Being Digital.*

How the Army currently conducts operations from a doctrinal perspective is included in the study because most of these procedures are not under consideration for review in light of digitization. Among the most important of these publications is FM 101-5, *Staff Organization and Operations* (Washington, D.C.: Department of the Army, 1997). To provide perspective and depth to this issue, the previous versions of this publication have also been reviewed and incorporated into this study. A review of how effective these C2 processes are is included with information provided by the Army Research Institute Study, "Assessing Battle Command Information Requirements and the Military Decision Making Process in a Concept Experiment Program."

Command and Control Communications

The communications systems in the Army are well documented in both military technical manuals and lessons learned reports and studies. Near term and future C2 communications structures and systems are documented in body of digitization publications as well as briefing and documents for the Warfighter Information Network-Tactical (WIN-T). Civilian communications systems are described in detail in many trade journals. The Internet also provides access to information about the latest communications systems available.

Military communications system capabilities and priorities in the "Revolution in Military Affairs" is the topic of many current works and articles. A book which has driven defense C2 communications systems development is Libecki's *Dominant Battlespace Knowledge*. Robert Bateman in his *Digital War: A View From the Front Lines* and Lt. Gen. Brown's *The U.S. Army in Transition II: Landpower in the Information Age* also address this topic.

Force XXI

The current literature on Force XXI is varied and fragmented. For instance, the literature fails to agree on what the basic communications systems, the ABCS is comprised of. Also, the jargon of digitization often fails to differentiate the objective capabilities from the currently operational ones. Regardless, this subject is presented in the capstone digitization TRADOC Pamphlet series 525, including 525-70 *Battlefield Visualization Concept* (Fort Monroe, VA: Headquarters, United States Army Training and Doctrine Command, 1995).

The performance of digitization is reviewed in primary sources which have appeared in service publications such as *Military Review.* Two of the most enlightening of these are Lieutenant Colonel James E. Harris III's "To Fight Digitized or Analog;" Colonel Stephen F. Garrett's "Evolving Information-Age Battle Staffs" and Major Anthony R. Garrett; "Information Superiority and the Future of Mission Orders."

A review of the performance of Army units in nondigitized operations is necessary to provide a baseline to highlight the changes and potential improvements of digitization. NTC after action reports and bulletins are used by this study to provide this perspective. Two of the primary sources are John Grossman's *Battalion-Level Command and Control at the National Training Center* and Bryan W. Hallmark and James C. Crowley's *Company Performance at the National Training Center: Battle Planning and Execution.* Both these studies include in depth studies of C2 systems used in current operations.

CHAPTER 3

METHODOLOGY

The methodology of this study has changed over time and with increased learning by the author. While a certain amount of this shift was anticipated, the degree of change overall has been unanticipated. The thrust or purpose of the research from the beginning has been to evaluate the holistic trends in Army C2 Systems evolution in the period of the information revolution. This overall object of this study has not changed.

Step 1: Identify Evolutionary Elements of Revolutionary C2 Systems

The method to go about the evaluation of C2 systems began with observations of the major trends in C2 systems evolution. This study concentrates on the keys to transformation of C2 systems during historical periods of military paradigm shift. These periods studied in detail were chosen for their remarkable innovation and advance of the military art.

The key assumption of this study is that evolution in specific elements of what is currently considered a C2 system (personnel, equipment, facilities, communications, and procedures) produce effective change or evolution in C2 systems through history. The elements of equipment and facilities were quickly dismissed as extraneous to C2 systems evolution. The equipment element has a tenuous link to C2 systems in general as it refers to the support gear for the personnel and communications equipment of the actual C2 system and is thus twice removed from the action of C2. The element of "facilities" also was quickly removed as it is, in effect, the nexus of C2 communications systems and personnel. C2 facility can vary from a single commander with a radio or a futuristic,

multiscreen, command center. Furthermore, "personnel," as a C2 element, has a dual nature. The definition of a C2 system is the "arrangement of . . . personnel" in FM 6-0. The arrangement of personnel is the act of organizing. The other side of the personnel issue is leadership and command. The art of command has been the focus of countless studies, reports, memoirs, investigations, and books. This study does not have the capacity, nor the need to include the elements of leadership and command as they relate to command and control. So the result was that the elements of "organization" was substituted for "personnel" while "procedures" and "communications" were retained. The initial object was not to identify how these affected each other or which may have cause change in the others, but to simply identify the key elements themselves through analysis of history.

This process of narrowing down the three aspects of a C2 system did not finalize until about half of the available historical material had been digested by the author. In retrospect, these three revised elements of a command and control system fit the study well, are echoed by other C2 writers and students, and are supported by the historical evidence.

The method of choosing periods where the command and control system exhibited major change which impacted the nature of war was also an in depth process. Generally, the starting point was technical innovation such as the initial employment of the telegraph, telephone, radio, and computer in conflict. Next the author scanned history for the conflict in which nearly equal, modern powers engaged in a war which one side seemed to have a distinct advantage in a C2 system which involved use of these new devices. Some choices were easy to identify, such as Napoleon's command system, the

use of the radio in the German Blitzkrieg of 1940, and computerization during Desert Storm. Others were more subtle, such as the use of the Prussian General Staff in the Franco-Prussian War of 1870.

The exceptions which proved the rule are the conflicts in which either one side had a C2 system innovation and did not fully exploit it, or both sides had the innovation causing parity which has limited applicability to an investigation of C2 evolution. Examples of this are the use (or lack of use) of the telegraph in the Crimean War, or the use of the telephone during World War I.

Step 2: Identify Commercial and Academic Trends in the C2 Systems Elements

The current information revolution, fueled by digital communications technology, is changing many aspects of how people and organizations reach their goals and objectives. For this study, the primary focus in this area was to identify those trends which involve infusions of information technology and previously identified elements of C2 systems: organization, procedures, and communications.

The general trends in organizations and organizing are readily available in any management section of a good book store. Yet these owe their underpinnings and intellectual basis to the original organizational theorists who developed the science. Both are pertinent for this study, and both bodies of knowledge have been used to identify why and how organizations change with enhancements to information technology. This study has been successful at not only identifying the trends, but the theoretical and practical bases for these trends in the modern era. This provides transportability to the military realm, which exhibits some common management and organizing challenges with commercial firms. The study is careful, however, to point out the major differences and

reasons for these differences by which military organizations operate, such as the unpredictable environment of war.

Communications, the most visible aspect of C2 systems, was addressed last in order that the impact of organization and procedures might provide the reader with the context and issues surrounding advanced communications systems. This was also done to amplify the importance of organizational and procedural issues in the study.

Communications systems in modern commerce and government is a large topic with voluminous amounts of information over the past few years. Yet the trends for communications are emerging, and these are the areas of interest for this study. The technical details are often beyond the capability of the author to understand or relate, yet where necessary, these are included.

Step 3: Identify the Major C2 Systems Aspects of the Force XXI Program

The Army's attempt to deal with change in information technology has been encapsulated in Force XXI's subprogram of the Division XXI Experimental Force. As such the specifics of Division XXI are the objective criteria for comparison to commercial and academic trends in organization, procedures, and communications in the information revolution.

The observations of specific organizational models in this study provide a view of how military command and control systems are structured and weighted in organizations. This study of military organizations also investigates the key organizational issues of span of control, unit differentiation, and decentralization, since these issues are those which have dominated the construction of military organizations throughout history.

These organizational factors are also the variables in military organizations which are determined by the other elements of C2 systems, most notably communications.

Procedures is a generic term. For the military C2 system, procedures generally refer to how the unit is moved to action in advancement of the overall goals and objectives. The procedures involved center on how the functions of command are translated to and between echelons of a unit. For instance, orders format, process, and transmission are all relevant in this light.

Since this study is concerned with how well the digitization program enhances command and control, it is first necessary to review the organization, procedures, and communications systems involved in the digitization program. The major motivations, aspects, implications, and performance of units involved in the digitization program are identified and presented in the context of their relation to the overall command and control system. Where the digitization program does not alter the basic attributes of Army operations, this study presents the legacy version of how units conduct operations. The use of the Military Decision Making Process is a prominent case in point.

The flows of information are also relevant to procedures in modern business and academic organizations in pursuit of their goals. In the research, it quickly becomes apparent that information management procedures are keys to harnessing the information revolution. As such, major information management procedures which leverage IT systems were reviewed in this study.

There exist some conceptual guides to C2 procedures which will be also discussed such as Boyd's OODA loop, Lawson's model of command and control, and Orr's Conceptual Combat Operations Process Model. These models are useful because they

effectively break C2 procedures down to specific functions or steps with a defined purpose, relation, and optimum state for each step enumerated.

The definition of any system is something which has inputs, processes, and outputs. The most basic military process, that of mission analysis as stipulated by the Army's MDMP, is used in this study as a baseline for analysis and comparison for two reasons. First, it is perhaps the most central and common of the military processes which involve command and control functions. Secondly, there exists a large amount of empirical data from the Army's Combat Training Centers on the effectiveness and efficiency of this process as practiced in units over time.

The current emphasis on providing the commander the ability to visualize the battlefield and a common operational picture are also assessed in this study, as are alternative processes. These alternatives to processes such as the MDMP are gleaned primarily from academic and commercial concepts such as knowledge management systems and foreign military mission analysis processes.

Step 4: Relate and Study the C2 Systems Elements in Division XXI

While there are no quantitative studies involved in this investigation, the qualitative comparisons center on major trends and objective analysis which have revealed themselves in recent years. This is the basis for comparison of the specifics of the digitized force with commercial and academic thought in organization, procedures, and communications. In the end, this study attempts to arrive at an answer to the question of whether Division XXI is applying the lessons learned from commercial and academic study in the enhancement of its information systems.

CHAPTER 4

ANALYSIS

PART I. EVOLUTION OF C2 SYSTEMS

> Historical analysis suggests that to realize their full potential, revolutions in warfare must be incorporated within new processes and executed by new organizational structures as in the case of the development of the Blitzkrieg.[1]
>
> Colonel W. Semiamaw, Canadian Forces College

This study presents a review of how armies integrated the development of organizations, procedures, and communications to create a command and control system which was so successful that it changed warfare itself. In contrast to these successes this study also reviews the efforts of armies which had the latest technological improvements in communications but did not achieve competitive success, much less any lasting impact. The objective is to determine the major trends and common methods by which armies develop the organizations, procedures, and communications which provide input to the commander's decision and ensure his capability to put that decision into action.

Ancient Warfare: Messengers and Signals

Intricate and complex C2 systems are fairly recent developments. From ancient times to the period of the American Revolution, C2 was a straightforward issue because the limiting factors, the written word, line of sight distance, and the horse-mounted messenger, did not evolve. Commanders from Caesar to Washington collected intelligence through spies or local inhabitants; organized and deployed their forces of infantry, cavalry, and indirect fires; then sent messengers or a combination of visual and

acoustical signals to control the battle, hoping to strike at the decisive point with some thrust of forces, usually under their direct control.

Relatively complex communications systems evolved with the advent of long defensive walls like the Great Wall of China and the walls of the Romans along the Rhine and in Britain. These linear fortifications fostered the development of specially trained long-distance signal soldiers along their ramparts communicating via visual signals such as fire, flags, or homing pigeons. A fixed set of field maneuvers, not tied to walls, was developed by Gustavus Adolphus in the seventeenth century. The number and intricacy of this set of maneuvers and the increased integration of combined arms complicated war as fighting forces became larger and more diversified. What began with infantry, archers, and cavalry evolved to include skirmishers, grenadiers, lancers, and hussars by the time of Frederick the Great. As the ability of the commander to exert continuous direct control of his more diversified and dispersed forces declined, systems of command and control evolved.

The Napoleonic Wars: Multiechelon Command and Control

The first major evolution in C2 systems was the result not of a technologic breakthrough, but an organizational one. The French revolution of 1792 allowed the new French army to reorganize based on an optimum structure rather than the ancient system of royal, political patronage. Napoleon's armies were the largest to be assembled since the time of Alexander the Great, requiring a C2 system based on new organizational frameworks and with new sets of procedures, creating a new paradigm in command and control.

Napoleonic Organization

As Napoleon's army was camped at Boulogne waiting to invade England between 1803 and 1805, he implemented his new army organization and drilled his army to work more effectively using it. The key aspect of the Napoleonic organization was that he enhanced the ability of his army to work well in separate pieces rather than to work well in a single body. The specific changes began with lowest formations, the traditional infantry regiment, and built a new multiecheloned, combined arms army. At the lowest echelon Napoleon used infantry regiments to create the *demiarmee* or army division with the addition of artillery and cavalry elements, allowing divisions to maneuver their three regiments tactically with organic fire support. The larger army corps, or *corps de armee,* was similarly outfitted with combined arms for independent operations. As the operational centerpiece of the Napoleonic system, the corps was unique in European armies of the early nineteenth century. It consisted of between two and five combined arms divisions of infantry and one cavalry division.[2] The innovative addition of full cavalry and artillery divisions to the corps completed this combined arms miniarmy and enabled the Napoleonic corps move, fight, and reinforce independently for up to twenty-four hours. Napoleonic corps was also logistically self sufficient, thereby freeing the main headquarters from a huge administrative burden. The corps could sustain itself because on campaign they moved to the main battle via parallel routes, determined by Napoleon himself to ensure that he could recombine his corps into a single army on a day's notice. Napoleon retained control of the army level artillery and cavalry thus enabling the flexible application of organic forces by commanders using their initiative at every echelon.

This new system was a significant change for European armies of the time and required new training programs to make the combined arms echelons cohesive on the battlefield. Training to this end was systematized by Napoleon who issued orders at the Boulogne camp that two days per week were to be dedicated to battalion or regiment, with two for divisional maneuver, and one to corps level training. Twice per month, Napoleon insisted on army-level maneuvers under his personal direction.[3] Never before had training in combined arms maneuver been standardized and delegated to so many semi-independent echelons within the framework of a single army. While this *Grand Armee* perfected and honed this system of independent yet coordinated echelons, the English Fleet under Nelson wrecked Napoleon's chances to embark for his invasion of Britain, leaving Napoleon to march off to score his greatest victories across Europe over the next eight years.

The system of self contained echelons allowed Napoleon to exercise a span of control up of up to eight corps simultaneously. Exceptions to this span include the invasion of Russia when twelve corps were constructed, and at Waterloo when Napoleon was short of experienced marshals. Significantly, both these instances of deviation from the basic Napoleonic organization were failures. In Russia, Napoleon lost control of several of his corps as his force melted away to desertion and logistical problems. At Waterloo two wing commanders, Ney and Grouchy, failed to execute under the new system when Napoleon's attention was diverted from direct supervision of their multi-corps wings.

Marshal Berthier, Napoleon's chief of staff, formalized the structure of the staffs during the campaign in Italy in 1795 when he developed of a standardized staff of three

major parts: a headquarters support section, a technical advisor section, and a body of aides de camp.[4] The support section moved and maintained the headquarters itself. The technical section consisted of topographical, artillery, engineer, and supply and transport officers to advise Napoleon and to plan and coordinate operations within their area of expertise. The aides de camp were a body of officers waiting to take command of subordinate units. While the staff structure was not rigidly mirrored at in every headquarters, Berthier ensured that its capabilities were replicated in every combined arms headquarters across the army. The three parts of the Army staff numbered in excess of four hundred officers, while the typical corps staff fluctuated between eighteen and twenty-four officers.[5]

Because Napoleonic corps were usually flung out to parallel routes of march, their independent movement, communications and intelligence had to be coordinated with adjacent corps and the army as a whole. The staffs at corps and division levels were required to provide liaison officers and messengers from their aides de camp to higher and adjacent units. This greatly improved the exchange of information between units and echelons as it provided a continued flow of updated information to commanders across the army. Due to the combined arms nature of the army and corps, artillery and cavalry staff officers, like the logistics and topographic engineers, had a small staff of their own of three or four officers. This created an information collection, processing and transmission system to assist commanders in planning and coordinating the operations of his unit, relieving him of attention to details of supporting functions.

Napoleonic Communications

Napoleonic communications were a critical element of his overall C2 system and the emperor paid a great deal of personal attention to this C2 systems element. Napoleonic tactical communications system relied on no new technological breakthroughs. Rather, communications with dispersed corps was normally conducted at the speed of a horse mounted aide at normally five to seven miles per hour and ten to fifteen miles per hour during battle. This limitation was the determinant factor in how far apart the corps could remain on the march, while remaining in contact with each other to lend support if necessary.[6]

The Army's aides de camp as messengers were multifunctional information gatherers and transmitters on Napoleonic staffs. These officers gathered intelligence, confirmed the receipt of a set of orders, assumed command of subordinate units, and reported on intangible items of interest such as morale, health, and loyalty. Napoleon and Berthier often personally quizzed messenger aides on any of these subjects upon arrival at headquarters.[7] The aide de camp as intelligence and ground truth asset commonly known as directed telescope was used extensively by Napoleon to ascertain what was happening at any part of his army, at any part of the battlefield, or regarding any ongoing activity through objective eyes.[8] These horse-mounted and specially trained aides extended the commander's field of vision beyond the information contained in standard reports and provided Napoleon with a way to add context and selective specificity to intelligence and status reports, allowing the emperor to develop a high degree of situational awareness.

Napoleon often paid close personal attention to this communications and intelligence system. To speed transmission and focus his vision, Napoleon himself sometimes prearranged army messenger services such as at the beginning of his Austerlitz campaign of 1805, "I recommend you [corps commander Marshal Soult] to make your aides de camp and adjoints [adjutants] ride their horses to death. Distribute them in relays upon the road to Weissenhorn, so that I may get your news as quickly as possible."[9]

On the strategic level, the French Grand Armee also utilized the first European long range, manual telegraph system. The system relied on tower based moving masts which could be arranged to convey 196 signals representing letters, numbers, and phrases. Claude Chappe developed and built a series of stations with revolutionary government support. This networked system grew to span the length of France by 1793, with intermittent extensions to Napoleon's headquarters in the field. This system's value was related by Jomini in his *Art of War*:

> Telegraphic signal [visual] are the most important of all. Napoleon owes his astonishing success at Ratisbon, in 1809, to the fact of his having established a telegraphic communications between the headquarters of the army and France. He was still in Paris when the Austrian Army crossed the Inn at Branau . . . Informed within twenty-four hours of what was happening seven hundred miles away, he threw himself into his carriage and a week later had gained two victories under the walls of Ratisbon.[10]

This strategic system also spurred a number of attempts at a mobile, tactical version using flags, but with limited effectiveness. The strategic, fixed Chappe telegraphic communications system was so effective that by 1809 a short message could be sent from Paris to any major city in France within five minutes in optimum weather. By 1815, the

system was copied by the Royal Navy and British Army, each fielding their own versions.[11]

At the tactical level, Napoleonic communications in close battle were indistinguishable from those of his predecessors. All commanders used traditional systems of voice commands and messengers as well as a standard system of drums, trumpets, and sometimes flares or fire pots in limited visibility to control the actual movement and employment of forces.

Napoleonic Procedures

The new independent echelons of command and the need to maintain a standard dispersion of one day's march between corps required Napoleon to develop new C2 procedures for maintaining effective command and control of his army. In particular, the emperor needed a standard method of concentrating forces at the decisive place and time, ready for battle. The resulting standard C2 procedures involved intelligence, information management, orders production, and initiative.

Intelligence acquisition, processing, use, and distribution were important issues for the conduct of Napoleon's campaigns because the emperor often composed open ended plans, to ensure maximum flexibility of action. The formal intelligence infrastructure of the army was well developed and highly efficient. In Paris the Ministry of Foreign Affairs collected reports from legations and spies abroad which were consolidated into books and sent to the emperor in the field.[12] In the field the chief of staff was the primary director of the commander's intelligence effort. As the army moved, Berthier automatically dispatched aides de camp specially trained to conduct reconnaissance and gather local intelligence from lords, citizens, and prisoners. Usually,

the emperor himself would also made personal reconnaissance forays prior to major battles to look over terrain and interrogate locals.

Berthier also kept abreast of the intelligence effort at subordinate echelons and he often took it upon himself to gather and distribute intelligence throughout the army. He usually worked through subordinate chiefs of staff but as a Marshall himself he could and did scold the corps commanders for their lack of attention to the ongoing intelligence effort. For example, during the Jena campaign, he was constantly pestering the Marshals such as Soult, "Do send me more frequent reports; in a war of combination like this we can arrive at satisfactory results only by frequent communications amongst ourselves-let this be your first care" and to Lannes, "What is most important at this juncture is to send news three times daily to the emperor about yourself and the enemy."[13]

The more mundane information flow throughout the army was also honed by Berthier in the creation of a regular reporting system. The information flow began each morning with the regiments compiling and forwarding to division a daily report on friendly and enemy activities. Divisions added to these reports and forwarded them to corps. Each day, each corps was required to send a digest containing the latest pertinent information on the unit and the enemy to the army headquarters by sundown. Napoleon's orders were given to these staff officers to take back the next morning. This daily report, the *etat de situation,* included a standard list of information items on friendly and enemy activities.[14] Every five days a summary report of more in-depth information was compiled for the emperor. Every fifteen days another standard report, the *grand etat de situation* was compiled by Berthier's staff and copies sent to Napoleon as well as the War Ministry in Paris.[15]

The Napoleonic chief of staff was the one responsible for the drafting and transmission of orders. The orders for a specific engagement were usually sent in two or three sets of main orders, with fragmentary orders sent at any time before, during, or after the battle. This first order was drafted by Berthier and established the overall campaign plan. The key to this warning order was Berthier's ability to grasp his commander's overall concept and express them in a way which ensured compliance and enable parallel planning but did not circumscribe flexibility. "Give your orders so that they cannot be disobeyed,"[16] Napoleon cautioned Berthier. The commander in chief himself drafted the second set of orders, usually in the middle of the night just after the final planning conference. This second, or commander's order contained Napoleon's intent, the scheme of maneuver, and special instructions to each corps commander. The final order, the "sunrise" order, was the result of work between a scribe and the chief of staff. The format usually consisted of the overall enemy and friendly situations, additional directions to corps commanders, and special instructions for the more technical arms of cavalry and artillery.

When the situation permitted and a large battle was imminent, Napoleon brought his marshals to him at a central place to review his instructions and to brief (and quiz) them personally on the details and objectives of his plan.[17] This ensured complete understanding of the intent and objectives in subordinate commanders, and reassured Napoleon of this understanding. During the battle itself, Napoleon observed, received reports, considered, and then issued orders via his aides de camp to all parts of the battlefield. At times Napoleon directed units two or three echelons removed from army level as he did at Borodino when he issued orders directly to regiments in the center.[18]

Typical Napoleonic orders, like the one below prior to the battle of Jena, were personalized for each subordinate corps commander and began the parallel planning process:

> The Chief of Staff [Berthier] is at this moment writing out your orders which you will receive during the day . . . I think it fit to make you acquainted with my plans in order that this knowledge may guide you in coming events.

Since this order was Napoleon's command communications, it shared his visualization of the coming battle and enabled parallel planning at corps level. It also left the coordinating information concerning movement, intelligence, and specialized, unit information for the artillery and cavalry to the chief of staff's final order.

The commander's order provided as much detail as was necessary to communicate Napoleon's visualization of the campaign. Generally, it began with a review of friendly situation and the most current scheme of maneuver:

> I have occupied, armed, and victualled the strongpoints of Wurzburg, Forcheim, and Kronach, and I intend to launch my whole army into Saxony along three axes. You [Soult] are to lead my right, having half a day's journey behind you the corps of Marshal Ney, and at a day's journey in the rear 10,000 Bavarians- which makes more than 50,000 men. At the head of my center is Marshal Bernadotte followed by the corps of Marshal Davout, the greater part of the cavalry reserve and my Guard-which makes more than 70,000 men: he will debouch by Kronach, Lobenstein, and Schleiz. The V Corps [Lannes] is at the head of my left, followed by the corps of Marshal Augerau: it will debouch by Coburg, Grafenthal, and Saalfeld. That makes more than 40,000 men.

These orders contained a commander's intent which maximized Napoleon's and the corps commander's flexibility simultaneously:

> The very day you arrive at Hof, all these will be occupying positions parallel. I myself shall make a point of keeping up with the center.
>
> You will appreciate that, with the enormous superiority of numbers concentrated in such a small area, it is my wish not to leave anything to chance, but to attack the enemy wherever he chooses to make a stand with double his strength.

Command and signal issues were included by Napoleon's personal direction:

> On arrival at Hof your first thought must be to establish communications between Lobenstein, Ebersdorf, and Schleiz [lateral communications to other corps].

Also included were any observations on the most important enemy intelligence:

> According to information I received today, it appears that if the enemy is moving at all he is moving towards my left, since the greater part of his forces appeared to be at Erfurt (*notes mine*).[19]

Berthier's final order normally included instructions for fires, reconnaissance, and engineers while logistics was normally coordinated by the individual corps. The final order also updated, echoed, or added to command issues such as the location and use of the reserve, or Napoleon's intent such as, "The important thing today is to deploy on the plain subsequent dispositions will be made in accordance with the enemy's maneuvers and the forces he reveals, in order to drive him from positions which he occupies and which are necessary for our own deployment."[20]

The overall orders system was not as rigid as to require a comprehensive plan and order before operations. Indeed, tactical flexibility was more important than perfect orders, sent on time. Another source of flexibility was mission type orders which allowed subordinate corps commanders to act within latitude of the emperor's overall intent for the operation, as long as they followed his direction and were usually able to react to subsequent orders from higher. The orders issued by Berthier provided the who, what, where, and when of a modern mission statement, but the why was usually provided by Napoleon in his personal order. The how, if provided at all, usually focused on the combining of the effects of the army's and corps' artillery and cavalry arms.[21]

Berthier as chief of staff had a critical part to play in all aspects of Napoleonic C2. Berthier himself often issued fragmentary orders once the battle was joined, based on the emperor's continuous observations and comments. The fact that the authority to issue orders rested with the chief of staff ensured that orders would be issued as quickly as possible. Since Berthier had participated in his general's war gaming, written the previous orders, and oversaw the intelligence effort he shared a high degree of his commander's visualization. This allowed him to ensure subsequent orders were coordinated with the army's dispositions as a whole and Napoleon's intent.[22] In this way, Berthier combined many of the modern staff functions into his own position at army level.

At headquarters the rhythm of orders preparation followed a regular schedule based on the emperor's habits. If Napoleon arrived in the afternoon or evening, Berthier greeted him with the latest friendly and enemy situation from incoming dispatches. If the two of them had been conducting reconnaissance that day together, they returned to the headquarters and cloistered themselves starting about 10pm in Napoleon's tent after a shared meal. Berthier received continuous updates from staff representatives of the topographic engineer, cavalry, artillery, and intelligence sections, which he distilled and passed to the emperor. An hour or so later, with two recording secretaries present, Napoleon huddled over his operations map with the topographic engineer. After thirty minutes or so Napoleon asked for the latest intelligence and dictated his orders based on the situation.[23] These dispatches and orders were ready for transmission via the corps aides at first light.

The *Grand Armee's* degree of operational decentralization was balanced by Napoleon's use of a number of C2 measures. Napoleon had differing levels of implicit trust in his different commanders. He limited their latitude through the frequency and amount of detail in his orders to each individual commander. Napoleon also kept subordinates whose ability was in question near his own location where he could oversee operations. At Jena Napoleon deferred to Soult's request for an alteration of the plan without question. To Bernadotte and Davout at Jena he gave no orders at all during the critical periods of the battle, leaving them to their own devices. On the other hand, less trusted subordinates regularly received more specific orders than the other marshals and Napoleon's often visited these subordinates on reconnaissance trips to discuss troop disposition and operations.

Semi independent combined arms corps, controlled by mission type orders and commander's intent, using a standard staff with regulated procedures for coordinated operations represented a paradigm shift in C2 systems which changed warfare forever. It may have taken the genius of Napoleon to put all the pieces together on the battlefield for the first time, yet it is proof of the value of these new methods in organizing and controlling that they were adopted by many European powers of the early nineteenth century and some survive to this day.

Rise of the Telegraph: Crimea and U.S. Civil War

The invention of the electric telegraph in the 1823 might have signaled a new age in C2 systems in war in the middle of the nineteenth century. Yet this technologic breakthrough took over thirty years to be widely implemented in army operations.

The Crimea

The allied British and French Governments laid the first long distance electric military telegraph line during the Crimean War in 1852 to better monitor and coordinate their stagnated invasion in Russia. The line extended from the political capitols of London and Paris to the allied lines outside the besieged city of Sevastapol in Crimea. The British and French army commanders; however, remained suspicious of the new system, since they regarded it as a tool for politicians to impinge traditional prerogatives of field commanders and they resisted its use from the beginning.

As war itself dragged on with no decision, this new strategic link had impacts which were peripheral to the tactical conduct of the war. For instance, journalist reports of the abysmal conditions in Crimea spurred Florence Nightingale to found the Red Cross to enhance the sanitary conditions of the troops. Secondly, French Emperor Louis Napoleon, monitoring the slow progress of the war, used the implement to coordinate the exit of the French armies from the allied coalition, forcing the British to sue for peace not long after the fall of Sevastopol.

The U.S. Civil War

The U.S. Civil War was the first major industrial-age war of the nineteenth century, yet the armies of the Union and Confederacy encountered uneven success in the application of new C2 technologies and ideas made possible through science and industry. In organization and procedures the armies of the Civil War did not differ greatly from those of the Napoleonic age. At the outset of the war the generals organized with standard Napoleonic divisions, corps, and armies. Staffs were generally less capable than the Napoleonic versions because they lacked practical experience in the nuances of

intelligence and information management. These staffs were also consumed with the provisioning of their forces. Procedurally, Napoleonic tactics, as related by Jomini, were taught at West Point from the 1820s onwards. In the industrialized age, the battlefield had become more lethal, a fact which it took two long years of fighting for the combatants to recognize. Yet as the enthusiasm for the offense, massed frontal assaults, and decisive battles faded, the synchronization of combined arms improved through better communications.

In communications, the telegraph as a tactical and operational C2 means was adopted and employed widely for the first time. At the outbreak of the war, telegraph lines already crisscrossed the country along the major railroad lines and canals. This enabled commanders and political leaders to coordinate the movements of their armies in both the eastern and western theaters on a daily basis. For example, General R.E. Lee and President Jefferson Davis were kept abreast of developments in the western theater via the telegraph, enabling them to repeatedly shift troops and supplies from one theater to the other using the railroads.

The Union Army; however, lead the way in the technologic advancement of the communications element of their army's C2 system. A master organizer and planner, General George McClellan used the new Army Signal Corps and Military Telegraph Service (MTS) to coordinate his strategic and tactical movements as early as 1862 during the Peninsula campaign. While the MTS kept him in contact with the President and War Department in Washington via electric telegraph lines while the Signal Corps kept McClellan in touch with the Navy and his subordinate corps commanders via flag and

torch telegraphy. Yet, these innovations couldn't overcome the Union commander's crippling reliance on wildly pessimistic intelligence, leading to timid execution.

Union General "Fighting Joe" Hooker, in his Chancellorsville operation was the first Army commander to attempt to integrate the use of these new communications systems in his tactical plan to split his force and envelop the Confederate Army. For this first tactical use of long-range technologic communications in battle, Hooker had two types of electric telegraph systems, two aerial balloons, and two types of visual telegraphy at his disposal. Despite this redundancy there were at least three extended outages of communications between the wings of Hooker's army at the outset of the operation. The overly cautious and uncoordinated movement of the wings; poor intelligence; and, most importantly, Hooker's failure to enable any subordinate initiative action allowed Lee to brilliantly fight and defeat one wing at a time. Operational paralysis and over centralized control again led to a Union defeat despite technological superiority in communications.[24]

In the western theater of operations, U.S. Grant came to realize the capabilities and limitations of long-range command and control via the new communications systems. During his tenure as theater commander, he relied extensively on telegraph lines and railroads to coordinate and control his forces in victory after victory. As the new General in Chief of all Union Armies in 1864 he attempted to use the telegraph for much the same purpose but on a larger scale. Upon taking command, Grant sent his five subordinate commanders located in New Orleans, Fort Monroe, West Virginia, Tennessee, and Northern Virginia orders containing his overall intent for a coordinated campaign and individual key objectives in each theater. This message, mostly transmitted via the

telegraph, was designed to provide subordinates maximum leeway within Grant's overall plan to apply simultaneous pressure on the Confederate armies at dispersed points.[25]

> It is my design, if the enemy keep quiet and allow me the initiative in the spring campaign, to work all parts of the army together, and somewhat towards a common center. . . . I do not propose to lay down for you a plan of campaign, but simply lay down the work it is desirable to have done and leave you free to execute it in your own way.[26]

Grant's method of command and control involved providing his intent and overall scheme of maneuver without micromanaging the operations of his subordinates.

Grant's assessment of his subordinates' ability to act with initiative was overoptimistic and the plan was doomed. Three of his subordinate Generals, namely Sigel, Butler, and Banks proved difficult to spur to action partially because they were political appointees, commanding relatively isolated armies. The other commander, Meade, was collocated with Grant where all issues of importance were addressed in face-to-face meetings. General Sherman alone successfully coordinated and executed his campaign as stipulated by Grant in his telegraphic orders.

Despite the failure of the Union to successfully use the telegraph for the coordination of their campaign, the device proved useful in the direction of tactical movements of armies in the eastern theater of 1864. Under Grant's direction, Meade's Union Army of the Potomac in Virginia and Sheridan's Cavalry Corps both used the telegraph to coordinate and control movements and maneuvers of corps and divisions, thereby succeeding where Hooker had failed. In single engagements, the telegraph and flag telegraphy caused a closing of the distance between the commander and his subordinates with near instantaneous communications, especially in the tactical defense. This closing of distances on the battlefield enabled Grant (and Lee, who had similar, if

less capable communications), to extend his linear front line to an unprecedented ten miles from flank to flank. In this way, the technology contributed to the ascent of the tactical defense in war, culminating in the trench warfare of Petersburg and later still on the western front in World War I.

Grant recounted how his tactical communications were automatically established in his *Personal Memoirs*:

> There was a wagon, supplied with a telegraph operator, battery, and telegraph instruments for each division, corps, each army, and one for headquarters. . . . Thus, in a few minutes longer than the time it took a mule to walk the length of its coil, telegraphic communication would be effected between all the headquarters of the army.[27]

Intelligence gathering and distribution also transformed by the telegraph, as information was transmitted over great distances within minutes. While McClellan's and Burnside's unfortunate reliance on the Pinkerton Agency was detrimental in that it spread erroneous information, Hooker's and Grant's new Bureau of Military Information used the telegraph to share accurate intelligence across the Army from 1863 onwards.

Like the Confederacy, Union armies also made use of information from local inhabitant and cavalry information transmitted via telegraph. In the Pennsylvania campaign of 1863, Lee moved through Union states with neither the benefit of his cavalry eyes nor local support and information, both of which he made use of while campaigning in his native Virginia. Common citizens and Union scouts alike throughout Pennsylvania regularly telegraphed word of the movements of Lee's army to Washington and Hooker's (later Meade's) Army, enabling the Union Army to concentrate its forces on the unsuspecting Lee at Gettysburg.[28]

The widespread use of the electric telegraph also signaled the beginning electronic warfare as both sides benefited from tapping each other's telegraph lines. As early as 1861 southern signal corps soldiers regularly intercepted Union telegraphs between the Army of the Potomac in Virginia and the War Department in Washington. By the end of 1862, these Confederates carried telegraph keys to intercept, and sometimes send bogus signals over the Union wires.

The other major technological communications innovation during the Civil War which had perhaps less of a lasting impact was flag telegraphy, or wig wag signaling. This system of sending messages via the waving of flags or torches was an update on the French Chappe system as well as existing naval systems of flag telegraphy. Like these systems, this land-based version was effective within visual range extended using telescopes.

Dr. Albert Myer invented this land based wig wag system after observing Indian smoke signals in the New Mexico frontier of the 1850s. In 1858, Dr. Myer petitioned the War Department to adopt his system but was rebuffed. He later took his case to the Senate Armed Forces Committee for inclusion in the Army budget. There, the chairman, Senator Jefferson Davis, directed that he test the system in New York harbor with a colonel of engineers named Robert E. Lee. The test was a success and the first army Signal Corps was born at Fort Monroe, Virginia in 1859 under Myer.

The Union Army used wig wag as an extension of the telegraph when wires were impractical, often on the move or during the tactical offense. These systems used flags during the day and torches at night to signal a prearranged set of letters and numbers.

Grant related how the system worked:

> The signal service [wig wag] was used on the march . . . they would go in advance, or on the flanks, and seize upon high points of ground . . . and would denote, by signals, the positions of different parts of our own army, and often the movements of the enemy. They would also take off the signals of the enemy and transmit them.[29]

As noted, the wig wag system did have some unintended consequences, such as its utility as an intelligence asset and liability. At the battle of First Manassas, Confederate lieutenant Porter Alexander, a former protégé of Dr. Myer, established four signaling stations on the high ground around Bull Run. Alexander personally observed the turning movement of the Union commander, General Irwin McDowell during the battle. Grasping the significance of this maneuver, Porter signaled, "Look out for your left, you are turned" to Confederate Brigadier General Evans who promptly countered with Thomas "Stonewall" Jackson's brigade, thereby determining the outcome of the battle.[30]

The technological advances of industrial age America created an environment conducive to a revolution in military command and control. Unfortunately, the full capabilities that these advances represented were probably not well understood by commanders in the field. American generals on both sides of the Civil War employed with some success the new communications means and, as a result, gained not only in greater control but also in intelligence of their situation. Yet like the allied commanders in the Crimea, many Civil War operational commanders resented what they saw as a means to interfere with the traditional autonomy of the field commander. In other words, new C2 procedures and organizations were not developed and implemented to leverage

the increase in communications represented by the innovations of the telegraph and wig wag.

Grant was perhaps unique in that he understood the strategic, operational, and tactical utilities of these systems of enhanced communications. By informing his political leaders of his intent and status via regular encrypted telegraphic dispatches, Grant was able to keep Washington informed and supportive of his efforts. His failed attempt to use the telegraph to coordinate his overall campaign was a precursor to future systems reliant on decentralized control through improved communications. Finally, Grant and Meade's ability to communicate nearly instantaneously with the widely dispersed wings of his immediate tactical force via telegraph gave them a means by which they were able to counter the moves of Lee enroute to the final confrontations of the war through Virginia to Petersburg and Appomattox.

The relatively immobile nature of the telegraph contributed to the general shift from the tactical offense to the tactical defense in war. During the Napoleonic age massed frontal and flanking attacks were the primary means of achieving victory. The telegraph, as primarily a stationary communications system, was part of the advance in technology which changed warfare from a mobile search for a decisive battle to a firepower intensive struggle to breach entrenched defensive lines linked to supporting artillery and mobile reserves.

The Franco-Prussian War: General Staff and Telegraph

The telegraph as a part of an enhanced C2 system reached its apex in the Prussian Army of the late nineteenth century under their Chief of the General Staff, General Helmuth von Moltke. In their three wars of unification against the Danes in 1864, the

Austrians in 1866 and the French in 1870 and 1871, the use of the telegraph was successively advanced and widened by the Prussians until it became the primary means of strategic and operational communications for their army. Von Moltke effectively leveraged the telegraph through carefully measured C2 procedures and organizations built upon the Napoleonic system of balanced command and control.[31]

German Organization

The German Army facing France in the summer of 1870 consisted of three wings of combined arms corps. The right wing under an irascible General Von Steinmetz consisted of two corps, while the center under Prince Frederick Charles, and the left wing under the Crown Prince of Prussia both consisted of four corps. All told, the three armies totaled 384,000 men which made it the largest field army since Napoleon's *Grand Armee* invaded of Russia fifty-five years earlier.[32] By 1871 this first true German army increased to mobilize, equip, and field over 1,183,000 troops, an army larger than any since the days of the vast Persian armies of Darius the Great and Xerxes.[33] In organization, the German army's span of control of between two and four was smaller was larger than Napoleon's because of von Moltke's desire to encourage decentralized decision making which could be recentralized at the upper echelons as he himself saw fit. Once a subordinate created a situation which could be strategically exploited, von Moltke redirected his armies and corps to the new strategic direction through fragmentary orders sent via telegraph.

The Prussian Army of this period also standardized its combined arms corps to the degree of specifying how many spoons each unit was authorized. The Prussians, through this standardization, attempted to form a body of generic, semi-independent parts

below field army level. While Prussian Armies maximized standardization, the major armies of their allied states such as Hanover, Baden, and Saxony generally followed the Prussian system of two brigades per division and two divisions per corps, but their armaments and tactics varied.

To provide a degree of procedural and tactical standardization within this larger operational context, each German army, corps, and division (including the allied corps of the north and south German states) was issued a number of trained staff officers from von Moltke's headquarters. A captain or junior major was assigned to each division and three officers, one captain, one major and one colonel was assigned to each corps.[34] Over 200 of these *Kriegsakademie* and General Staff trained staffers were posted across the army in 1870 on the eve of war.[35] Like Berthier, these officers reviewed all communications, intelligence, and plans and were authorized to issue orders in the commander's absence.[36] Perhaps more importantly, they brought a common understanding of operations and execution to the army. The result was a relatively cohesive, large body of interchangeable parts consisting of corps and divisions which could be employed over a wide area but controlled centrally.

While on campaign in France, von Moltke's headquarters of the German General Staff consisted of one colonel in charge of all movements, one in charge of rail transport and supply, and one in charge of intelligence. In addition to these three principal officers there were eleven staff officers, ten draftsmen, seven clerks, and fifty-nine other junior officers and soldiers, perhaps the leanest army headquarters in control of a force that size ever created.

The General Staff, acting as the clearinghouse for all orders and information flow, ensured von Moltke's position as the operational commander of the army through the subordinate staffs of the field armies. Kaiser Wilhelm, having established a concrete trust in the chief of staff during the successful campaign against Austria in 1866, backed up von Moltke repeatedly in disagreements with the field army commanders, to include overruling his son, the Crown Prince.[37] Since the subordinate army commanders were princes and members of the royal family while von Moltke was a mere noble, there was often friction in his superior status in the Army. To alleviate this situation von Moltke issued all orders to field armies in the name of the Kaiser, often beginning with, "His Majesty has ordered . . . ." or, "The King's orders are . . . ." thus preserving the façade of royal direct command. On more than one occasion the field commanders attempted to circumvent von Moltke by going over his head to the King. For instance, in 1870, General Steinmetz effectively wrecked von Moltke's invasion plans when he advanced too far too fast thus exposing his army to counterattack. The necessary changes in plan were developed and put into action by von Moltke and the General Staff within hours. The Kaiser did not respond himself to Steinmetz's pleadings, but allowed von Moltke to answer the queries. Von Moltke's replies to Steinmetz elucidates this unique command relationship:

> I quite agree with Your Excellency as to the importance of the army commanders having insight into the motives underlying the King's orders issued to them. I therefore have the honor of answering more fully in writing . . . . As was already explained at Berlin-I think to Your Excellency in person, but certainly to your Chief of Staff and Quartermaster General [the von Moltke-trained staff officers provided to Steinmetz by the General Staff] -the mission of the First Army, can attest that the General Staff will provide all answers and responses[38] (*emphasis mine*).

German Communications

Before the Franco-Prussian War, the German General Staff worked at incorporating new technologies which enhanced German military communications. Von Moltke oversaw the introduction of dedicated field telegraph units to the German Army in the late 1850s. Unlike Prussia's enemies, he supported the building of telegraphs and railroads rather than frontier fortifications in peacetime along Prussia's borders with Austria and France for quicker mobilization and increased operational flexibility.[39] Von Moltke foresaw the strategic value of the railroad and telegraph to the degree that he personally addressed the issue of captured assets, as he indicated in his communiqué sent to all army commanders at the height of the war in France on 11 August:

> Cases of quite needless destruction of railways by our troops have constantly occurred, and it is therefore necessary again and again most distinctly to forbid any destruction of railways and telegraphs between the advancing armies and the enemy and to make the units, especially their officers, specially responsible for the observance of this order.[40]

The assignment of General Staff officers not only provided each major unit an officer knowledgeable of the common army doctrine, but also established a link to the other units and echelons through the *Generalstabsdientweg*, or informal staff to staff information channels of the army.[41] This channel formed a sort of nervous system for the army which reported informally, but directly to the General Staff under von Moltke thereby constituting a form of directed telescope. An additional benefit gained was a degree of understanding and ground truth at each command not only for von Moltke, but each General Staff officer throughout the Army.[42]

The German General Staff also relied heavily on messenger service throughout the war. This was an absolute necessity because long, daily reports and detailed orders

would have clogged the telegraph wires which were reserved for current operational intelligence and direction. Messengers were also necessary because von Moltke needed a less conspicuous method of informally contacting staff officers across the army.

The communications system used by the German General Staff to control the offensive into France in 1870 was effective but far from perfect. Von Moltke took the precaution of moving his headquarters into former army level headquarters as the armies themselves moved forward. This provided rail and telegraph links for near continuous contact. When this was not possible, the General Staff repaired telegraph lines where possible and ensured messenger traffic systems were in place to each army headquarters and the political leaders in Berlin.[43]

Information management lapses in the German Army during the war were, for the most part, common but never catastrophic. Von Moltke was constantly asking subordinate chiefs of staff for information about the enemy, the location of their field trains, and most often, where their command posts were located.[44] The placement of the subordinate army headquarters was another area which von Moltke consistently took personal interest during the war.[45] Because army and corps headquarters moved as many as three times per day, this was critical to ensuring continuous communications between echelons of the army.

Von Moltke's small German Headquarters of the General Staff itself moved by rail whenever possible, usually every two days. It remained approximately ten miles behind the central army throughout the advance towards Paris. In this way, von Moltke remained in contact with both the strategic center at Berlin via telegraph, and each army

tactical headquarters via telegraph, rail, and messenger. As the hub of operational level direction, von Moltke coordinated the operational with the strategic German war effort.

German Procedures

Von Moltke realized from experience in Denmark and Austria that if he were to exercise effective operational and strategic control on campaign he had to relinquish control at the tactical level. He further realized that the corps commanders were the ones with the necessary information to exert effective and timely tactical command and control. To enable this system, Von Moltke provided these commanders with combined arms to execute local maneuvers and the General Staff officers as trained experts in tactics and campaigning. The limited communications between the corps, and army, and von Moltke's headquarters provided by the fixed telegraph required that its use be reserved for only the most critical directions and coordination.

While the Prussians had fought the campaign against the French numerous times in exercises and war games, von Moltke ensured that flexibility was maintained in the actual execution of the plan. The single overall campaign plan reflected only a general guide for von Moltke, who wrote of the fluidity of warfare in his memoirs:

> It is delusion to imagine that a plan of campaign can be laid down far ahead and fulfilled with exactitude. The first collision with the enemy creates a new situation in accordance with its result. Some things become impracticable; others, which originally seemed impossible, become feasible. All that the leader of an army can do is to form a correct estimate of the circumstances, to decide what is best for the moment and carry out his purpose unflinchingly.[46]

What enabled the Prussians to react to the changing situation were the decentralizing principles of *Absicht* and *Auftragstaktik,*[47] both of which were fully inculcated into every staff officer's training during his education at the *Kriegsakademie.*

These principles were reinforced by the General Staff supervised maneuvers and staff rides, as well the rotation of General Staff officers to posts and units throughout the army.

The General Staff provided *Absicht*, literally meaning purpose or intent, to the army commanders for each major operation. The army commander then provided his version of the intent to his subordinate corps commanders and so on. In Prussian military doctrine and teaching, the highest priority *Absicht* belonged to the commander two levels up. Also, depending on the situation a commander could safely ignore his immediate superior's directed tasks if he followed the *Absicht* of the commander two levels up. This system weakened the army level command and control exercised by von Moltke because the royal army commanders attempted to defer to the king. However, it lent strength to von Moltke's control over the key operational echelon, the corps.

Closely associated with *Absicht* was *Auftragstaktik*, literally "instruction tactics." In today's lexicon this would be described as mission type orders. The central notion was that, based on the overall intent, the commander was provided only with general objectives to be gained. Von Moltke described the philosophy behind this when he wrote:

> The advantage which a commander thinks he can attain through personal intervention is largely illusory. By engaging in it he assumes a task which really belongs to others, whose effectiveness he thus destroys. He also multiplies his own tasks to a point where he can no longer fulfill the whole of them.[48]

Each commander was expected to use initiative to accomplish those objectives as long as the situation permitted. Von Moltke could safely assume that through the General Staff network corps commanders would adhere to his *Absicht*, or that he would find out about it if they did not. For the large and dispersed German Army

of the 1870s this balance of overlapping centralized organization and decentralizing procedures constituted an extremely successful command and control system.

Because von Moltke experienced the ineptitude of some of the army level commanders during the war with Austria in 1866 firsthand, he took measures to limit the impact of future potential mistakes.[49] He knew that by giving corps and division commanders the maximum leeway through the doctrines of *Absicht* and *Auftragstaktik* these men might supersede counterproductive decisions made by their uninformed or untrained superiors at army or corps level. This system also ensured that von Moltke's own general directives, all sent with apparent royal blessing, were immutable at least to corps level, the key combined arms echelon he targeted with most of his specific directions during the war with France.

The regular information flows of the army were largely one way and highly regularized. The daily reports from the brigades, divisions, corps, and armies all flowed towards the top. These reports had grown significantly in size and detail since the time of Napoleon. Von Moltke's outgoing messages and directions, usually a total of about ten per day, contained only the most basic information and instructions and often contained only a few lines. Orders, typically drafted by the staff and edited by von Moltke, presented a short picture of the enemy situation, desired movement of the addressee army corps in relation to the latest position of its neighboring forces, and the intent or object to be gained.[50] By his principle that "An order shall contain everything that a commander cannot do by himself, and nothing more"[51] von Moltke provided the subordinate with the space for local initiative based on closer knowledge of the immediate situation and

potential opportunities.[52] Brevity was also desirable due to the limited capacity of telegraph lines and the limited information processing and operational oversight capability of Moltke's small headquarters.

The General Staff was an essential extension of Army headquarters into every command post of the army. Before and between the three Prussian wars of unification, the staffs of the various armies, corps, and divisions came together to be trained by the General Staff. Part of the General Staff spring training maneuvers, such as the *Kaisermanover,*[53] and the traditional staff rides required the officers to develop and execute not only nested plans, but also to act in the absence of orders.[54] To counter the inevitable fog of war, the staff officers were taught to use intelligence, garnered from cavalry reconnaissance, to enlighten them on the local decisive points, which lead to decision and execution. When the tactical situation was determined, the instructors expected the student staffs to apply *Auftragstaktik* within a specified *Absicht.*

In the war with France where intelligence was scant and often faulty, commanders and staffs created local successes within their sectors on a tactical level repeatedly, often without specific direction from higher. On the operational level, von Moltke and his staff adjusted and maintained the army's focus despite blunders and mistakes made by commanders at all levels. In a sense, this system was a reactive one. Like Napoleon, von Moltke never planned a campaign from beginning to end beforehand. In fact, von Moltke never planned operations past the first encounter with the enemy.[55] Through his telegraphic communications, through formal and informal chains of command, and a common, flexible doctrine, von Moltke balanced centralization and decentralization through the hierarchy of the German Army successfully.

While the German Army of 1870 lacked Napoleon's single genius, it did have his combined arms organizations, his mission type orders, his commander's intent, and perhaps most importantly, his mental capacities in the form of the German General Staff system. Von Moltke, like Grant, understood that the telegraph represented a means to coordinate operations and share intelligence over long distances. But Moltke realized that faster, longer-range communications did not constitute increased cohesion and synchronization by itself. Prussian doctrine and C2 procedures, with a complementary organization made the most of the telegraph by being more flexible and reactive to enemy moves and local advantages. Command and control remained, ". . . an art, a creative activity based on character, ability, and mental power"[56]

Major world powers soon adopted the professional staff organization and fielded their own signal corps to keep them in touch with commanders in the field. Commercial telegraph cables soon spanned the world, linking distant capitols to remote empire outposts as well as ever-distant wings of the larger and larger armies in the field. If the advance in communications that the telegraph represented did not provide universal cohesion for the Germans in France, when matched with superior organization and procedures it did enable a superior command and control system which major world powers attempted to match over the next forty years.

World War I: The Telephone

By the first decade of the twentieth century, the telegraph had been eclipsed by another commercial communications advance, the telephone. Now, commanders could exchange greater volumes of information and instructions verbally over the furthest distances of the battlefield as well as from the tactical to strategic levels. Not only did

this vastly increase the amount of information sent over long distances, it improved the accuracy of that information. Yet, when this communications advance was extended to units at all echelons during the first world war it inhibited more effective C2 systems by encouraging static commanders to provide perhaps too much detail too quickly to a chain of command which could not process and react to this increase efficiently. Commanders from remote outposts reacted as they had been trained to do, with determination rather than reflection and consideration on the situation when changes or obstacles presented themselves through the telephone.

Organizationally, the telephone separated commanders from their units, from each other, and from supporting arms. Beginning in 1914 with the Schlieffen Plan the telephone gave strategic and operational planners on both sides the illusion that they could exert more direct control over lower echelons. By the time the western front settled down to static trench warfare, division commanders often did not see all their major units in a month. At lower echelons, commanders on immovable telephones became isolated from the fight, making them more dependent on messengers and other C2 means for information about what they might have been observing first hand. The natural result of all these changes for C2 was, as J. F. C. Fuller put it, so much, "talking, talking, talking rather than leading, leading, leading."[57] Fuller also considered the change in the commander's location during World War I. While this development was inevitable at

higher echelons, it was resisted by commanders, as Fuller's wistful reflection shows:

> It was the amazing unconscious change which rose out of the Franco-Prussian War, and which in a few years obliterated true generalship, dehumanizing and despiritualizing the general, until he was turned into an office soldier, a telephone operator, a dug-out dweller, a mechanical presser of buttons which would detonate battles, as if armies were well tamped explosives or intricate soulless machines.[58]

Procedurally, the primary C2 development of the war was a closer synchronization of infantry and artillery. The trench battles of the western front in particular favored the use of the coordinated infantry artillery attacks across no man's land. However, since artillery barrages often cut telephone wires, both sides centrally planned artillery support for corps, divisions, brigades, and battalions in major operations at army level. This precluded the adjustment of fires based on the local situation once the attack had begun, resulting in greater centralization. The rolling barrage, as was used with such great hopes on the Somme in 1915, in many cases failed to enable an infantry penetration. The lagging infantry, held up by unexpected barriers such as uncut barbed wire, were unable to adjust the artillery and coordination was lost.

The British in particular centralized planning and the amount of detail in plans to the point of affecting every aspect of attacks by constraining initiative at all levels. At Neuve Chappele, the local penetration of a British battalion led their officers to call back for permission to continue the advance past the first day's stipulated objectives. It took six hours to get the request back and for the higher-level staff to draft a response for the resumption of the attack and transmit it to the front. By the time approval was given the Germans had recovered and began their inevitable counter barrage on the advanced pockets of the British troops.[59]

Communications overall during the First World War was a mix of advanced and anachronistic systems. While the remote voice over the telephone gave commanders a sense of control and reassurance never before known, it did not lessen the amount of reports and orders required at all levels of the army on both sides. The evidence shows that all this moving information did not enhance higher level commander's situational awareness due to remoteness and the "dugout mentality" referred to by Fuller. Also, while telephones moved massive amounts of information, that information began dissipating as soon as the line was disconnected. Paper reports again expanded and proliferated, requiring messengers to deliver it. Since the messenger remained one of the most precarious occupations throughout the war, both sides employed pigeons and dogs in large numbers, forming specialized units to provide animal messengers. In the attack the messenger was required to leave the security of the trench or shell hole and brave the machine guns and artillery of no man's land. In the defense, communications trenches were dug to enable the deep burial of telephone wires as well as facilitate the movement of messages, supplies, reinforcement, and casualties.

Later in the war, the advancing infantry was provided with other, innovative methods of communications. Some methods used to adjust artillery fires in the attack were older such as visual telegraphy (flags) and visual signals (smoke). Yet on the smoky battlefields of World War I, these visual signals were of limited use and messengers remained the most reliable means of communications. A new development was the use of aerial observers which were able to coordinate the two ground branches via signal flares. Both the British and American Signal Corps were the primary developers and employers of the airplane early in the war.

Another major innovation in communications was the development of the first radio systems. These machines were large, wagon mounted, and underpowered, making them useful for front and sector operational and strategic communications, as well as tactical communications in the defense. Useless to attacking ground troops, radios were employed late in the war in the offense on airplanes to relay status and artillery coordination information back to the rear. But since these early radios could not be tuned, they were easy to intercept and jam. Airplanes and any tall structure were used for this electronic warfare mission, famously including the Eiffel Tower. Like the telegraph, the amount of information which could be transmitted via rudimentary radios was limited, making them unfit for sharing long operations orders and reports.

As the war dragged on, both sides experimented in alternative C2 organizations and procedures eventually restoring a degree of local control and lower echelon initiative. In the attack, the Germans lead the way with their infiltration tactics by small groups of infantry "storm troopers," directly supported by organic indirect fires, engineers, and other support arms forming a small unit combined-arms combat team. Experimental in 1917 when first attempted on the Western Front, these successful tactics were adopted by the entire German Army on the western front and were a major factor in the near German victory in the spring of 1918.[59] The relative success of these organizations and decentralized control methods pointed German Army towards lower echelon combined arms capable of penetrations of the enemy based on small unit leader initiative. As such, these methods were an extension of von Moltke's *Absicht* and *Auftragstaktik* which would point the post-war German Army towards blitzkrieg.

On balance, the innovation of telephone and radio communications on the Western Front served not to enhance the flexibility of tactical and operational C2 systems of the combatants but to make them more rigid. Centralized planning of combined arms assets led commanders to attempt to exert a greater degree of direct control of lower level operations. The centralization of planning details which were once left to junior officers was emphasized at the expense of local initiative, resulting in micromanagement. Advanced communications systems such as the telephone and rudimentary radios expanded the amount of information on the battlefield but their immobility separated and blinded commanders to ongoing developments.

World War II: Radio Controlled Blitzkrieg

At the outset of World War II a fundamental breakthrough in C2 systems was announced to the world when the six panzer divisions of the German Wehrmacht crashed into Poland in September 1939. The emerging German command and control system of the 1930s was, in part, a reaction to the stalemate on the western front of World War I. It also reflected a desire to incorporate the new technologies of the tank, attack aircraft, and the mobile radio despite the restrictions of the Versailles Treaty. The result a new system incorporating the best of old and new organizations, procedures, and technology. The mobile radio was the key technological innovation which enabled the development of the flexible and mobile blitzkrieg attack. Yet while all the major nations had the radio and tank, the Germans applied these technologies in new organizations with decentralized procedures to maximize effectiveness.

Blitzkrieg Organization

During the interwar period the German Army began building combined arms divisions of infantry, artillery, and cavalry as well as signal and engineer troops. Most crucial was the decision by the German General Staff to attempt to motorize complete combat and support forces when assets became available. This movement within the German Army would allow the Wehrmacht to overcome two of the three shortcomings of the German Army of the Great War defined by the interwar Chief of Staff General von Seeckt, namely: (1) mobility by the fullest extent possible by motor transport, (2) a logistical system based on motor transport capable of continuous movement of men and material to the front, and (3) a lesser emphasis on civilian reserves so that the army might mobilize, take the initiative, and strike before the enemy could fully mobilize its forces. The post Versailles German Army of the interwar years were not allowed to, nor could they afford to create the new regular army combined arms formations advocated by Seeckt, yet limited motorization and the continuation of discussion and debate within the army created wide knowledge of, if not agreement with these advanced ideas in the small cadre of German Army officers.

The first three panzer divisions were added to the Army's roles following Hitler's approving observation of panzer maneuvers in 1935. These divisions were the first in the world to be fully motorized. While the British and French experimented with mobile tanks supported by horse drawn logistics systems, the Germans created a fully motorized panzer division which was more self contained in that all its combined and supporting arms were motorized. The German Army continued its of motorized combined-arms divisions throughout the 1930s until the weeks before the invasion of France in the spring

of 1940. The German lessons learned in the invasion of Poland accelerated the motorization of the army over the winter of 1939 and 1940. While the panzer concept was fully validated, flexibility, mobility, and firepower were found wanting across the army and the German General Staff directed a near total redistribution of type units from squad level to the field army beginning immediately in December 1939.[60]

Since the General Staff found that their motorized infantry divisions were too cumbersome for sustained advance, these were changed from three regiments to two for more direct control and decreased logistics requirements. Also, light infantry divisions were found to be too immobile, too lightly armed, and lacking in armored assets in Poland. These were combined and converted over the winter of 1939 and 1940 to ad hoc panzer divisions using captured Czech tanks.[61] The motorized infantry and panzer divisions were further combined by the General Staff into panzer corps to provide more substantial infantry support to the armored forces, creating a more balanced, more mobile combined arms team at the corps level.[62] These panzer corps was created to be a self contained vanguard of an army which remained heavily foot and horse mobile throughout the war.[63]

The final form of the Panzer division included one or two panzer regiments and one or two motorized infantry regiments, a reconnaissance squadron(s), a motorized artillery regiment, engineer, signal, antiaircraft, and antitank battalions, and a logistics battalion, all of which were motorized.[64] In comparison, the U.S. Army armored division of 1943 had nearly equivalent artillery and engineer formations, but was less self supporting in organic reconnaissance, signal, antiaircraft, antitank, and logistics to its German counterpart of 1940. The ten panzer and five motorized divisions attacking

France in 1940 also included dedicated Luftwaffe liaison, antiaircraft units (with their 88-millimeter guns), and on call bomber support for a three-dimensional attack.

The Luftwaffe as a military service contributed profoundly to blitzkrieg operations. Granted its independence in 1935, Goering's air force focused on close air support of ground operations rather than strategic bombing and included paratroopers, antiaircraft guns, and interdiction fighter bombers. With its doctrine and operational exercises focused on supporting ground war to a higher degree than any other air force during the war, the Luftwaffe was a key element and a major part of the combined arms team in blitzkrieg tactics.

At the center of all the German innovation was the General Staff which had also evolved since von Moltke. General Franz Halder's General Staff of 1940 included the traditional functions of planning and maneuver direction, but it added dedicated sections to oversee communications, transportation, logistics, air support, organization, and training.[65] The German General Staff retained its broad oversight and its continued close, direct relationship with every part of the army through the distribution of staff officers. This allowed it to plan and implement the reorganization and retraining of the German Army in the six months after the invasion of Poland, during the invasions of Denmark and Norway, and just before the invasion of France. No less astounding was the ability of the General Staff to oversee the transportation of two-thirds of the field combat power to the western front, while concurrently establishing new training standards, ad hoc schools, and, most importantly, conducting operational and tactical level exercises. The winter exercises of 1939 and 1940 were essential in validating the new formations and drilling junior and midlevel battalion, brigade, and division officers.

In preparation for the invasion of France, the General Staff continued its operational planning function with the help of extensive intelligence from a wide net of informants, observers, spies, and aerial photographs. German intelligence units intercepted signals, scouted defenses, and photographed enemy lines extensively. The result was that by the time the Wehrmacht crossed the border into Belgium, each corps commander had the location, status, and movements of eighty-two of the ninety-six Allied divisions in France and Belgium by May 1940.[66]

Blitzkrieg Communications

The father of blitzkrieg, General Heinz Guderian, a former signal officer of World War I, understood that the mobility and flexibility of the armored thrust required mobile communications. He therefore insisted as early as 1935 that all his tanks be equipped with tactical AM radios, giving them the ability to maneuver in conjunction with similarly equipped supporting infantry and artillery forces of the panzer divisions. For himself, Guderian created a widely copied command radio half track from which he followed directly behind his lead divisional headquarters as it penetrated into enemy territory.

The wide distribution of mobile radios to all echelons of the army was an innovation which, while hotly debated in the German Army before the war, represented an unprecedented advance in communications capability at all echelons. The radio freed the leaders from the dugouts and chateaus of the last war, and reestablished the possibility of the flexible, synchronized concentration of mobile combat power.

General Praun, another early proponents of panzer operations highlighted the importance of communication to blitzkrieg maneuver:

> Of particular importance was reliable radio communications between tanks and motorized units, and this applied not only to the troops in combat but also to communications between the staffs of the armored corps, armored and motorized divisions, and their regiments. As shown by successes in many different campaigns this problem of communications between tanks was solved admirably by means of ultra short-wave equipment. But the mobile radio detachments of the higher and intermediate command also obtained excellent results with their signal communications systems, which were never interrupted even during the longest and most rapid movement in France and Russia. Command was most flexible where the classic Guderian in France and Russia, Rommel in France and Africa, hurried from one point of main effort to another accompanied by their "general sections", which were later imitated by many other commanders, and an armored radio section with a few tank operators, to command their armored divisions, armored corps, and armored armies exclusive by radio from the foremost line (*emphasis mine*).[67]

This focus on communications capability led the Germans to equip all their divisions with a full signal battalion consisting of a radio company, a telephone company, and a transportation company. Each corps was provided with two additional signal battalions, one of communications and one of construction.[68] This contrasted with Allied divisions of the war which were typically provided a single, multifunctional signal company per division resulting in far less organic C2 capability at division echelon and below.

Traditional German infantry formations were likewise outfitted with radios in increasing numbers by 1939. At the tactical level, a typical German infantry battalion commander had two radios, one short range 5-watt and a longer range 15-watt set. This arrangement was intended for the battalion commander to remain forward in battle using the shorter range 5-watt radio while reporting to the rear using the longer range set.[69]

While tactical communications was one of the successes of the Polish operation the reorganization of the German Army over the winter of 1939 and 1940 the General Staff recognized a need for new communications procedures. As a result, signal units were directed to develop and complete new doctrine and techniques army wide during the 1939 and 1940 field exercises.[70] Training programs emphasized tactical use of brief, standardized reporting to enhance the flow of information securely over the air. Radio nets were separated and standardized for command, operations, intelligence, and logistics. These nets were designed for each echelon to enable initiative rather than for higher commanders to increase their control, as had been the emphasis in the last war. Like Napoleon and von Moltke, operational and tactical level commanders could now skip echelons in control via radio when necessary and in fact were obliged to do so when they encountered operational inertia. This was possible in part because while the German Army expanded the types of combined arms organic to subordinate units, it did not increase the span of control, usually fixed between two and six.

Guderian provides several examples of this particularly German C2 measure in his memoirs. For instance, while leading the spearhead Panzer corps through the Ardennes in 1940, Guderian the corps commander had several conversations with Von Rundstedt at Army Group A headquarters over a range of forty miles and lasting upwards of thirty minutes over the head of his immediate supervisor, the Army commander von Kliest.[71] This skip echelon communications, enabling control over units two echelons below a commander was common in German Army C2 during World War II. However, two echelons was typically the lowest commanders chose to expand their control in the Wehrmacht. The mobile nature of radio communications tied together all branches of the

German combined arms team from panzers, infantry, artillery to air support assets. It also enabled a continuous and speedy flow of information, intelligence, and direction from the company to the army level.[72]

Blitzkrieg Procedures

The development of blitzkrieg C2 procedures began with the formal review of World War I operations and continued through the 1939 reorganization of the German Army. The lessons learned from intensive and objective after action reviews were incorporated into a new doctrine and the publication of *Army Regulation 487: Leadership and Battle with Combined Arms* in 1921. This manual captured the essence of German infiltration tactics used so successfully toward the end of World War I with its emphasis on lower level initiative and greater control of supporting arms by junior leadership at the point of attack.

The combined arms version of infiltration was anticipated by General von Seeckt as early as 1925, "The whole future of warfare appears to me to be in the employment of mobile armies, relatively small but of high quality, and rendered distinctly more effective by the addition of aircraft." Actual operational application of the doctrine of blitzkrieg also reemphasized one of von Moltke's priorities, the *Schwerpunkt* (literally meaning "heavy point") in the attack. German General Thoma described the 1940 combined arms version of this concept as, "The concentration of all forces on the point of penetration in cooperation with bombers."[73]

The continued German emphasis on decentralized execution in battle echoed this concept in their doctrinal manuals of the 1930s:

> Commanders who merely wait for orders cannot seize favorable opportunities. They must always keep in mind that indecision and failure to act might be just as fatal as action based on the wrong decision.[74]

The introduction of mobile communications greatly increased the ability of junior commanders to coordinate operations and use initiative. Despite the huge expansion of the German Army in the 1930s the Wehrmacht continued to emphasize initiative to the point that those leaders who failed to display initiative in training or in operations in Poland were considered disobeying standing orders and sent for retraining.[75] The high rate of officer casualties in Poland led the Wehrmacht to further devolve initiative in the 1939 training exercises and ad hoc schools to junior officer and NCO levels.

The predominance of multiechelon initiative and decentralized execution in the German Army began with the German General Staff itself engendered flexibility through decentralized execution. Using *Absicht*, Chief of Staff Halder took great pains to ensure that all three Army Groups invading France understood the operational level goals and intent, but refused to become involved with tactical decision making.[76] The General Staff maintained a semblance of standardization and cohesion by assigning its officers to army group headquarters in the tradition of von Moltke seventy years earlier. These officers reviewed plans and made recommendations and recreated the informal reporting network of 1870.[77] Since the royal Generals had been extinguished from the senior officer corps, the general staffers assigned to units were used as advisors on the new warfighting doctrine and as liaisons to enhance horizontal C2 across units. This professionalization of the officer corps also allowed for a greater degree of operational autonomy at lower

echelons. Rather than trying to reduce the fog of war, the Germans again sought to deal with it by enabling the leader with the best view of the fight to act. Finally, the system did not devolve into chaos due to the capabilities of the mobile radio to communicate across the army and from the front to operational and strategic levels.

The flexibility of the overall C2 system was further reflected in the last minute planning for the invasion. When the operation finally kicked off on 10 May, the original plan of distributed, local panzer attacks had been superseded by the armored thrust through the Ardennes by Guderian's corps. This last minute alteration, due to a massive operational security lapse by the Germans, resulted in an even greater degree of latitude by subordinate commanders because of a lack of detail in the new plan. Freed from the iron timetable of von Schlieffens's plan, Guderian argued consistently to be allowed to continue the attack even after the worried General Staff repeatedly called for an operational pause. Like von Moltke, Halder eventually deferred to the field commander's requests, allowing his own plan to be altered based on a junior commander's recommendation.

General Blumentritt of the General Staff outlined the limited nature of General Staff oversight and the preparations made to retain strategic and operational flexibility through limited, but appropriately strategic guidance:

> There was only one big strategic decision during this offensive. When Guderian's Panzer Group was right through the French front . . . the question arose which of three courses it should take. Should it turn east . . . in order to cut off the French armies in Alsace? Should it advance southeast . . . to help the Italians over the Alps? Should it turn southwest towards Bordeaux, in order to cut off the French armies retreating from the Paris area to the Loire and beyond? Three short wireless cues were prepared beforehand for this purpose.[79]

Another impetus for decentralization was the operation in Poland and especially the training exercises of 1939 and 1940. These served as the war gaming and rehearsals for the attack on France for the entire army. They also established many of the branches and sequels which the Germans employed in the offensive. Despite the last minute change in plans, many of the orders used at the tactical level on the attack into France were versions of those used for the winter war games, as General Heinz Guderian noted, "We were forced to take the orders used in the war games at Koblenz from our files and, after changing the dates and times, issue these as the orders for the attack. They perfectly fitted the reality of the situation . . . 1st and 10th Panzer Divisions copied this procedure and so the issuing of orders was an agreeably quick and simple process."[80] These brief orders, one or two page summaries of execution, coupled with short intelligence updates, were perfectly suited to transmission via radio to multiple echelons simultaneously.

The biggest concern for blitzkrieg planners was the protection of the flanks of the Schwerpunkt, to which air interdiction was primarily applied in 1940. During the 1939 and 1940 training exercises close air support (CAS) procedures were developed and the standard CAS request was simplified to five lines. These air support requests were radioed through division to the corps CAS officer (Nahkampffurer), who relayed them to the Luftwaffe air support element of the air force unit in direct support of the ground force corps.[81] During the penetration of France close air support played a key role, especially in the initial stages where the Germans met stiff resistance, as related by

General Blumentritt: [81]

> During this stage the Luftwaffe worked in close cooperation with the armored divisions, in a new form of "street tactics." When a place was defended, the bombers were called up to attack it, and then the advanced detachment of the division took it.[82]

The Luftwaffe also cooperated with the Army in other areas of air support during the operation. For example, German aircraft dropped intelligence photographs within minutes of being taken to advanced panzer columns in France. The Luftwaffe also conducted aerial resupply of the penetration forces with items such as prepackaged ammunition shipments. While Guderian's tanks lightened the logistics load by refueling at French petroleum stations. These measures helped free the limited roads through the Ardennes for follow on forces.[83]

Air assaults were another version of deep attack from the air. Airborne and glider troops were inserted behind enemy lines to seize key objectives throughout Belgium and The Netherlands as part of the operation in France. These new air to ground operations included a seaplane and parachute assaults on the crossings over the Albert Canal, as well as many key bridges across the lowlands of Holland and an air to land attack on the key Belgian fortress of Eben Emael. The deep attacks, which worked with near perfection, created panic and confusion in the rear of the Belgians and Dutch Armies easing the advance of the German infantry divisions.

Overall, the innovation of blitzkrieg was in fact due to a major reevaluation and evolution of command and control organization, procedures, and communications of the interwar German Army. This C2 system enabled a fully motorized, combined arms force to penetrate deep into enemy lines, controlled only by the initiative of the local

commanders operating within a framework of a larger operation. The German system also enabled built in flexibility to take advantage of local opportunities for breakthrough, and support of that breakthrough by follow on infantry and armor forces, resupplied and supported by air, all coordinated primarily by wireless communications using simple, standardized procedures. In effect, the Wehrmacht built innovative organizations and procedures based on the capabilities and limitations of the available technologies, not least of which was the mobile radio which tied it all together.

World War II: American Innovation

The Allies studied and soon adopted aspects of the blitzkrieg with its combined arms armored divisions, mobile communications, close air support, aerial attack and resupply. The U.S. Army in particular adopted the notion of a fully motorized unit, supported from the air and able to keep up with the armored spearhead. The U.S. version of blitzkrieg was created by local corps and army commanders in Europe who semi permanently task organized their divisions in contact with added quartermaster truck companies, tank battalions, and dedicated fighter bomber support. The American blitzkrieg resembled the German version in its motorized and combined arms nature, but differed in that it was an ad hoc; task organized formation employing local lessons learned procedures rather than doctrine.

In communications, the German system of line of sight AM radio on the battlefield remained the state of the art until the American Army in Europe advanced past the Germans with development of more reliable FM radios in 1944. Previously, the U.S. Army assigned only amplitude modulation (AM) radio receivers as low as company level, but this lack of two-way communications proved inadequate early in the war. The

American Army came to rely heavily on the more reliable, all weather, jam resistant, lightweight, and especially two-way frequency modulation (FM) radios by 1943. When radios of any kind were lacking, such as at El Alamein, or inoperable, such as were three quarters of the radios in the first wave at Omaha Beach, American operations suffered.

The American Army expanded this tactical C2 advantage into an integrated system of communications to the strategic level using radio relays and cabled communications. General Bradley recalled the system as:

> the most valued accessory of all. From my desk in Luxembourg I was never more than 30 seconds by phone from any of the Armies. If necessary, I could have every Allied division on the line. Signal Corps officers like to remind us that "although Congress makes a general, it takes communications to make him a commander." The maxim was never more brilliantly evidenced than in this battle for the Ardennes.[84]

What is particularly noteworthy in General Bradley's statement is his stress on the importance of being able to contact front line divisions quickly. This capability was the beginnings of the particularly American version of the directed telescope where strategic commanders sometimes demand constant, direct communications to echelons three or more below them. Bradley's span of control for in terms of corps was nine to one. His span in terms of divisions, if he had chosen to exert it, would have been over thirty-to-one. Communications enabling control of units more than two echelons removed from commanders would eventually reach its zenith in U.S. Army during the war in Vietnam.

American forces also achieved an unprecedented degree of air to ground cooperation in the latter stages of World War II, again as ad hoc measures. During the breakout from Normandy in 1944 and after repeated American failures to employ CAS General Elwood Quesada of the 9th Air Force implemented new, more direct procedures

by placing air force FM radios in jeeps, half tracks, and tanks to enable the closest cooperation between air and forward ground forces. Quesada also placed air control parties with the forward ground forces wherever possible.[85] Subsequently, in the advance across Europe in 1944 and 1945, the Americans utilized their superiority of the air as a trump card in the tactical fight. A captured German General described the American air to ground attack as "the most devastating he had ever witnessed."[86]

The Postwar U.S. Army

The Korean Conflict saw the U.S. military improve its strategic and tactical communications links and information flow from the Second World War, yet no revolutionary tactical innovations in C2 systems were adopted during this period.

The major U.S. Army C2 innovation of the 1950s was organizational. The Army, consigned to a secondary position in the American defense strategy of the 1950s and early 1960s, experimented with different organizational designs with the aim of survivability on the atomic battlefield. The Pentomic Division design, a brainchild of General Maxwell Taylor, the Army Chief of Staff, was the result. Its aim was to create more mobile, combined arms "battle groups" able to operate as dispersed self-contained units. This was an evolutionary change in that it moved the threshold of combined arms maneuver below the divisional level in the U.S. Army.

The Pentomic innovation was stillborn; however, as Army planners failed to gain the necessary time and resources to implement the change in a comprehensive way. As a result, the Army reverted to a divisional structure reminiscent of the armored division of 1947 in the new Reorganized Objective Army Division (ROAD). The major command and control impact of ROAD was two-fold. First the C3I capacity of the division was

enhanced with the addition of full signal and military intelligence battalions. Secondly, the division echelon was confirmed as the keystone combined arms unit as it contained all necessary capabilities to conduct autonomous operations and task organize its infantry and armor battalions and brigades, a permanent version of the temporary task organized units of World War II.

During the Vietnam conflict, Army C2 systems experienced more significant evolution than perhaps any other period in the service's history. The Army took the ROAD division to the conflict in Vietnam, where the war fostered many and varied changes in C2 organization, communication, and procedures. Prominent among these were the introduction of the airmobile division, distributed operations, and helicopter command posts.

The C2 systems employed in Vietnam increased the amount of information at every echelon, most of which fed the dozens of systems analyses ongoing throughout the chain of command. This increase threatened to overwhelm the information and communications systems, leading to General Westmoreland's continuous demands for additional communications capability between 1963 and 1966. The swift Vietnam buildup in 1964 and 1965 required the Army to rush communicators and radio gear to Vietnam from all over the world.

Organizationally, two major issues increased friction on the Allied side in Vietnam. At the strategic level, parallel service centered chains of command, coupled with separate allied and regional chains fragmented the information and coordinating systems. Planning, controlling, and coordinating functions were all made more difficult as stove-piped information systems provided differing pictures of the situation and

requirements. As data flowed up through the chain of command, each echelon slowed and altered these input data with their own analysis, causing a lack of accuracy at the top. Part of the solution to this development was the continuous fact finding missions from the administration and Congress to act as a type of directed telescope for additional information collection.

The other organizational issue which increased friction, the personnel turnover rate, had a devastating effect especially lower echelon Army organizations. Battalion level search and destroy missions continued the trend from the hilltop firefights of the late Korean War where the operational decision threshold slipped from division to brigade and often battalion level. Implicit communications, so important in these lower level echelons were lacking in tactical units due to the yearlong rotation policy, causing an overall lack of trust and cohesion. The constant introduction of new leaders caused micromanagement of tactical operations. Furthermore, since operations such as search and destroy missions often features only one subordinate battalion or company in contact with the enemy at a time, the division entire chain of command often descended on a single battalion commander simultaneously.

At higher echelons, a new type of warfare required new C2 procedures to be devised. Since the determination of the success of the war effort hinged on systems and statistical analysis, information inputs became part of the objective itself. The result was an increase in information-focused missions such as bomb damage assessments, and long range reconnaissance. Battalions on search and destroy missions, focused on gathering indicators such as body counts rather than more traditional unit objectives such as seize, clear, and destroy. This robbed lower level commanders of any initiative where tactical

commanders could not share the strategic and operational perspective on the overall progress of the war they were fighting. Soldiers were tasked to risk their lives for pieces of data which fed complex, remote information processing systems, causing a degree of apathy and detachment.

In communications, the Vietnam Conflict with its increased information requirements saw significant advances in all types of signal equipment. The inability to use long distance cable led the development of long distance troposcatter, satellite, and multichannel relay systems for long haul communications. Tactically, the Army developed the new combat radio, the PRC-25 for extended range and frequency span. Sky Crane helicopters also delivered containerized division command posts with switchboards, multichannel, FM, and telephone systems. World War II landing craft were even enlisted as mobile radio retransmission nodes and modular command posts. Tactical developments were surpassed by the increases in strategic communications capability through direct undersea cables, automatic data information network (AUTODIN), and satellite links across South East Asia, the Pacific, and to the United States. Because the terrain, distance, and weather of Vietnam precluded long-range tactical communications, aerial relays extended the range of man pack PRC-25s from six to over sixty miles. Since these systems could only remain on station for limited time periods they were sent out during all critical events. The natural result was commanders hovering over battlefields in their stacked aerial command posts, each with a span of control of one subordinated unit. Helicopter command nodes often served to confuse battles and usurp command initiative through the entire chain of command. More common was the fixed wing relay, which could remain on station for longer periods. As

early as the major battles in the Ia Drang Valley in 1965, this type of relay was maintained on station for FM retransmission through multiple aircraft for twenty-eight days continuously.[87]

The adaptations in C2 systems helped the Army win engagement after engagement on the battlefield in Vietnam. A major reason for tactical success was the contribution of the new C2 systems which enabled small unit leaders on a nonlinear battlefield to coordinate and employ unprecedented amounts of firepower across long distances. However, since the Army's priority theater remained the inter German border in Europe, many of the ad hoc C2 systems innovations of the Vietnam conflict were not retained across the Army as new organizations (except, of course the 101st Air Assault Division) and doctrinal procedures. In communications systems, the Vietnam Conflict was unique in that the military was the driving force in the development of most new systems. One such advance of the Vietnam era from the Department of Defense, the "DARPAnet" remained an obscure, experiment of technological laboratories ignored by the military for the next twenty years.

The Road to Desert Storm: Joint Task Force C2

By the time the U.S. forces engaged in Desert Storm there were several hard won innovations in American tactical and operational C2 systems worked out over the post Vietnam period. Born of major shortcomings in unity of command experienced during the operation to free American hostages in Iran (Operation Eagle Claw) in 1979 and again against the Caribbean island of Grenada in 1983, the Goldwater-Nichols Act of 1986 forced a fundamental change in C2 organization and procedures at the operational level of conflict.

One positive result of Goldwater-Nichols was to establish a set chain of reporting for strategic leaders. This reduced the possibility of micromanagement from the highest levels of leadership by inserting and clarifying the organizational structure and reporting chain of the warfighting theater commanders in chief (CINC). While President Johnson intervened repeatedly at the operational and tactical level throughout the conflict in Vietnam, President Carter spoke directly with Colonel Beckwith on the ground at Desert One in Iran of 1980, and Secretary of Defense Harold Brown spoke directly with the first Marine Lieutenant evacuating Lebanon in 1983, Goldwater-Nichols inserted a formal, reasonable procedure for notification and reporting to the President.

The 1983 Grenada operation highlighted many of the C2 systems shortcomings of U.S. military communications. The Army soldier who called via the commercial telephone system to Fort Bragg and the Army forces who were pinned down near Marine and Air Force assets on the island attested to the need for more interoperable communications systems.[88] These experiences were a catalyst for more interoperable joint tactical communications, yet services continue to develop and field and use noninteroperable systems along service lines, requiring liaisons to provide connectivity.

Innovation in communication equipment was also marked in the period leading to Desert Storm. Through the late 1980s and early 1990s, the Army fielded its Mobile Subscriber Equipment (MSE) thereby giving commanders on the battlefield what amounted to a vehicular mounted cellular telephone. The MSE system, designed for the Air Land Battle doctrine of the 1970s and 1980s, nonetheless provided a significant improvement on the older, less mobile, analog tactical systems.

The communications effort during Desert Shield and Desert Storm was nothing less than massive. The number of total strategic and operational transmissions paths established to the Central Command theater of operations exceeded the total number of links established to Europe over the previous forty years. The Defense Information Systems Agency was required to move a satellite to a new orbit over Iraq to alleviate saturated communications links moving over 200,000 messages per day.[89] Part of the reason for this increase in communications requirements was the fielding and use of the first operational and tactical information systems. Personnel, logistics, and strategic command and control systems were introduced at the joint task force (JTF), corps, and division levels in Desert Storm. With these systems came the first interoperability and standards issues. For instance, the Air Force's daily production of the air tasking order (ATO) was produced on automated information systems yet had to be printed off (averaging between 200 and 800 pages per day) and flown to the Navy's aircraft carriers which could not receive, read, or convert the automated version. A more successful implementation of advanced technology was in the introduction of large numbers of highly sophisticated sensors at all points on the battlefield. Sensor platforms on satellites, airborne ground radar, night vision devices, and laser range finders all shortened the decision cycle for the users, providing them the ability to see what was happening to their front while the Iraqis remained blinded by jammers, cut C2 lines, and uncertainty.

In tactical communications, Desert Storm was the stage for a number of innovations. The huge amount of communications required caused the military to obtain commercial bandwidth in large quantities for the first time. Intelsat communications terminals proliferated in command posts at every echelon as did the satellite reception of

Cable News Network (CNN) transmissions. In military systems, the Army faced a challenge in that only two of the five divisions in VIIth Corps had the new MSE systems. While interoperability with adjacent units using legacy communications systems caused problems, communications work arounds were created through higher echelon systems. Once the ground war began; however, MSE's mobility limitations forced commanders to leave these systems behind and rely heavily on long range High Frequency and tactical satellite links to maintain effective communications with adjacent and higher level units. Local communications between tactical units remained FM voice, as it had since World War II.

While decentralized at the strategic level by the National Command Authority, Desert Storm was highly centralized at the operational and tactical levels. Centralization at the CINC level of the disparate services and forces enabled greater synchronization by tactical ground commanders. The provision of the combined arms assets to focus effects, coupled with the information from an array of sensors, enabled tactical commanders who had the greatest amount of relevant information on the situation to act when and where necessary. This is not to say that tactical control was centralized at all levels. While the Marines and the 24th Infantry Division exceeded their objectives while the VIIth Corps did not, control was looser than at lower, brigade and battalion echelons where centralized planning injected multiple restrictions on operations.

Procedurally, ground forces planned using the MDMP. This system created intricate and lengthy plans and orders which required numerous briefings, meetings, signal transmissions, and rehearsals to successfully disseminate and implement. The ground warfare plans and operations involved a greater array of combined and supporting

arms assets for the commander. The result was a much higher degree of lethality requiring more intensive C2 systems to coordinate their successful employment. The fact that this was done so successfully by Army units is testament to the ability, hard work, and intelligence of the officers who executed the operation.

The trend of increased centralization through communications capability has continued in certain operations over the next decade. The operation in Bosnia saw the first widespread use of tactical video teleconferencing (VTC). Also, parallel chains of command caused confusion over uniforms in tactical units. In Kosovo, the theater commander in chief commanded the overall operation where, again, dual chains of command hampered operational synchronization. Dual chains of command in the Balkans also reflected the uniquely American method of centralized control through the reduction of spans of control to a single unit with multiple command echelons. The most visible result of this phenomenon was Task Force Hawk, where an organization which began as an aviation brigade ended up with a three-star commander.

In contrast, operations in Haiti and northern Iraq maintained a degree of decentralization by ensuring the unit on the ground was directed by its natural echelon. During operation Provide Comfort for instance, the theater CINC remained in Europe to deal with political and strategic matters while his deputy, Lieutenant General Shalikashvili commanded two joint task forces simultaneously from Turkey. On the ground, Brigadier General Potter and Major General Garner ran the operation over forces and agencies at their disposal.[90]

During the mid-1990s the expansion and simplification of advanced communications technology, spurred by the Internet, led the Army to attempt to harness

these advances for tactical unit C2. The proliferation of branch-specific automated data systems threatened to overwhelm the Army's ability to support them, adding little utility to tactical operations. The Army's ongoing Force XXI initiative represents an effort to synchronize and integrate the tactical systems to provide the commander with a common operational picture (COP). COP represents leap-ahead technology where the commander is provided a dynamic, automatically updated overview of friendly and enemy units on the battlefield.

Conclusions

The advancement of C2 systems has had a profound impact on the conduct of war in many areas. It is clear that an advance in one C2 systems element, most notably communications technology, has not always provided a competitive advantage to the user. Conversely, when coupled with complementary C2 organization and procedures, advanced communications has enabled a significant competitive advantage to the developers and users of the evolutionary C2 systems.

Other key trends of C2 systems over time, most notably the increase in complexity, has had important implications for armies and leaders through time. This phenomenon is due to two related factors: the increase in the numbers and intricacy of arms to be combined, and the rise of information on the battlefield. As complexity increases, friction also increases, which has led to the devolution of the combined arms echelon of decision and more capable, more complicated communications structures. Procedurally, new procedures were devised to incorporate the addition of air, long range, and nonmilitary capabilities.

A final observation on communications is the time lag between the invention of a new capability and its optimum employment in warfare. The telegraph (both visual and electric), telephone, radio, and computer all required a significant trial and error time period before their optimum employment. This trial and error, often in the form of small wars, has led to the rapid development of the optimum organizational structures and procedures enabling the optimum use of the communications innovations.

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[4]S. J. Watson, *By Command of the Emperor: A Life of Marshal Berthier* (London: The Bodley Head, 1911), 106.

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[34]Samuels, *Command or Control?,* 16.

[35]Millotat, *Understanding the Prussian-German General Staff System*, 34.

[36]Samuels, *Command or Control?,* 17.

[37]Ibid., 84.

[38]Howard, *The Franco-Prussian War,* 69.

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[40]Ibid., 85.

[41]Ibid., 17.

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[50]F. E. Whitton, *von Moltke* (London: Constable and Company, 1921), 234.

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[90]Author's notes. The author served as General Potter's aide-de-camp during the conduct of Operation Provide Comfort between April and June 1991.

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[9]Watson, *By Command of the Emperor,* 113.

PART II: COMMAND AND CONTROL ORGANIZATION

> The future of battle command will require us to achieve a level of individual and organizational effectiveness beyond what we enjoy today. Part of the solution will be systems that provide us the information we need, and in the format we need. Part of the solution will be well-conceived doctrine, organizational structures and processes.[1]
>
> BG (Ret) Huba Wass de Czege, *Military Review*

This chapter on the organizational aspects of command and control systems provides the context and information to consider the Army's division structure as stated in Division XXI documents and practice. From the previous historical study it is apparent that organizational structures are key aspects of how armies leverage new capabilities for enhanced command and control. Division XXI's organizational structure is the embodiment of how the Army is attempting to leverage the current information revolution to reach a new paradigm of operational capability, through the enhanced command and control of its units.

This review of organizational issues begins with a baseline theory of common organizational structures from commonly accepted organizational theorists of the last century. This is followed by a review of how commercial organizations and firms have effectively evolved to alternative structures to compete and prosper in the current environment of enhanced information technology. The issues of span of control, decentralization, and unit specialization are the baseline parameters in contemplating changes in organizational structures. Since the military organization is subject to vastly different environments than commerce, with implications for organizational roles,

purposes, and norms, a review of the unique issues surrounding military organizations is in order. The actual organizational structure of the Division XXI is considered in light of these parameters and the environment of warfare to identify its implications for the evolving C2 system. The last part of this chapter is a series of case studies of current and proposed alternative military organization structures which provide some context and insight into the variables of organizational design facing the Army as it strives to redesign itself as a twenty-first century force.

Organizations and Change

The evolution of military organizations has been a story of adaptation to the changing environment of war. In terms of C2, organizations have changed to deal with new technology, increasing information on the battlefield, and the addition of arms in the combined arms capabilities of armies. It was Napoleon Bonaparte who established the basic army structure of the corps as well as the staff directed telescope by 1805. By 1870 the professional General Staff system, with special emphases on decentralized control and lower echelon initiative, added further command and control structure and capabilities. Based on these evolutions, the Germans further established the modern version of the combined arms division and air-ground task force at the outset of the Second World War. The United States completed the development of the JTF for the joint application of combat power by 1986. In each case, the evolutionary change in military organizations had a profound and lasting impact on the overall effectiveness and efficiency of the command and control system.

In the current information age, the U.S. Army is attempting to create a new model for the basic ground force of the future. The Force XXI initiative (also referred to as the

Digitized Division, or simply digitization) has wide organizational implications for command and control. As a model of how the Army intends to leverage the technologic advances in telecommunications and information systems, Force XXI represents a version of the Army's model for future, technologically enhanced organizations.

Baseline Theory of Organizations

The question of how to most effectively organize any organization rests on a few common tradeoffs according to organizational theorists. The major variables in organizing: span of control, centralization versus decentralization; and uniformity versus specialization; are all reflected in the framework and internal mechanisms which are built into any unit to enable it to deal with the outside world. Organizational theorists offer insight on how organizations develop and function for maximum efficiency and effectiveness depending on their environment, goals, culture, and location. Likewise, these parameters impact on the basic command and control of any military organization.

Henri Fayol, a French engineer and organizational theorist, laid out in the most basic theory of management and organization in his 1916 book *Administration Industrielle et Generale*. Fayol stated that there were executive functions which could be applied to any organization in the pursuit of efficiency and effectiveness: planning, organizing, leading, coordinating, and controlling.[2] These functions were meant to be all-inclusive and semi sequential. Briefly, planning involves establishing objectives, allocating resources, and sequencing activities. Organizing involves the establishment of line and staff authority, span of control, degree of specialization in subordinates, and the imposition of a unified command structure. Leading is the motivating and inspiring of subordinates as well as distributing rewards and sanctions. Coordinating is the

synchronizing of activities across organizations. Controlling is exerting authority by various means such as policy or expertise without formal commands or directives.

These five executive functions have direct applicability to military organizations to varying degrees. Obviously, planning, leading, controlling, and coordinating are all common activities of leaders throughout the military at every level. Yet organizing is an activity which is not normally conducted by military leaders throughout a hierarchy. At lower levels task organizing is more directed and less decided by leaders; yet, as officers rise in rank their organizing leeway increases until, as a Joint Task Force commander, they form their entire organization on an ad hoc basis using general principles and prescriptive precedents.

Other organizational theorists developed a body of thought and principles specific to this organizing function. These men determined a set of common organizational parameters or variables for internal structure and relationships which can be summarized into four categories: degree of specialization, unity of command, authority and responsibility, and spans of control. The degree of specialization relates to the division of labor between the units of an echelon, in other words, how units of different types bring specialized capabilities. Unity of command is self evident to all military readers as the need for a central authority. Military structures assume unity of command; therefore, this parameter does not apply as an organizing variable in most organizations in this study. Authority and responsibility (or degree of decentralization) involves the tradeoffs of power in the chain of command versus staffs and the vertical devolution of powers throughout a hierarchy. Span of control specifies the degree of command exerted at each level per subordinate units.

Knowing the functions of the manager and the basic organizing principles one can assemble a generic organization and describe the attributes of the different types of organizing. The basic Army battalion (figure 1) exhibits all the common types and parameters of organizations within its basic structure.

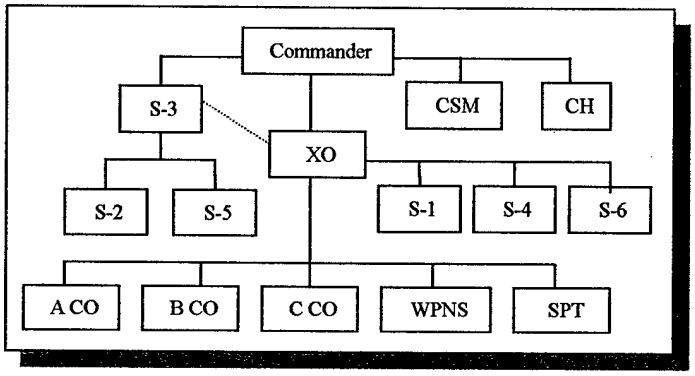

Figure 1. Generic Military Hierarchy

Like all military organizations, this unit is a hierarchy. To organizational theorists, hierarchical structures normally favor large, geographically dispersed organizations which must make decisions and implement them rapidly. Hierarchical organizational types also work well in environments which exhibit high levels of complexity and uncertainty, giving them great utility in warfare.

The organizational "line of command" is the traditional overall hierarchical chain of command, here represented by the commander, executive officer (XO), and company commanders. The commander and his chain of command focus on the Fayol functions of command and control, with purview over all four functions. Specifically, these leaders provide organizational vision, leadership, information, operational directives, rewards and sanctions, as well as necessary resources for the unit to efficiently move towards its

goals. The chain of command, specifically the commander, determines the degree of decentralized authority in the organization by defining who makes which decisions across the organization.

The middle management in typical organizations, here represented by the XO, usually have special focus on the Fayol functions of coordinating and controlling. As the place where the staff and chain of command come together, coordination is the key function of the XO in the diagram. Also, as the place through which much of the unit's information flows, and where informal command policy and procedures are established and enforced, middle management exerts a great degree of control over subordinate activities.

The staff lines include all the specialty trained "S" series officers as well as the commander's personal staff of the command sergeant major (CSM) and chaplain. Staffs have a dual role in any organization. First, staffs focus on planning and coordinating as they advise the commander on their area of expertise, thereby freeing the commander to concentrate on operational issues. Secondly, staffs coordinate the unit-wide efforts of activities and operations relating to their specialty area within the context of the commander's orders and plans. In this way they exert a measure of control over subordinate units. The CSM and chaplain are especially skilled individuals who directly assist the commander, but generally engage mostly in internal communications and inspection tasks. The CSM and chaplain also have a critical mission to act as the commander's directed telescope in leadership issue such as morale, cohesion, and any other area which might not appear on a status report or briefing. Staff elements therefore

concentrate on the Fayol function of planning and, to a lesser degree coordinating and controlling within their area of expertise.

Line units in the model are the companies, lettered and specialized. As the lowest level echelon, they represent the primary place in the organization where it encounters the environment and works to achieve its goals. Specialized units such as the weapons and support companies represent some essential, commonly needed, and usually technical function required by the rest of the organization for basic operations. As an organizational parameter, specialization is the degree to which these functions are removed from line units and centralized in a separate unit. The more specialized the overall organization, the more task organizing is required for the unit's basic operations. The other issue in line units, span of control, refers to the ratio of line units per headquarters. The commander's span of control in the diagram is five. Generally, wider spans of control imply greater degrees of decentralization because of the limited capacity of commanders to supervise large numbers of subordinates.

Commercial Organizational Trends

The IT revolution has resulted in significant changes in the structure and internal arrangement of commercial organizations. Henry Mintzberg, a leading organizational theorist and analyst, studied organizations who enhance their effectiveness through the addition of information technology to achieve efficiencies. He found that firms often migrated from a hierarchical organizational type to some alternative organizational structures: flat, networked, and matrixed in the course of enhancing their operations. These alternative structures can represent entirely new organizational forms or methods

which hierarchies create new internal relationships and substructures to respond to the modern competitive environment.

Flat Organizations

Flat organizations are those who employ an extended span of control with reduced middle management in their vertical hierarchy. Many commercial firms have flattened their existing organization (figure 2) by eliminating expensive middle management positions and expanding generic line units, thereby extending their span of control. In this way, firms use advanced IT to achieve cost savings and increase their operational base.

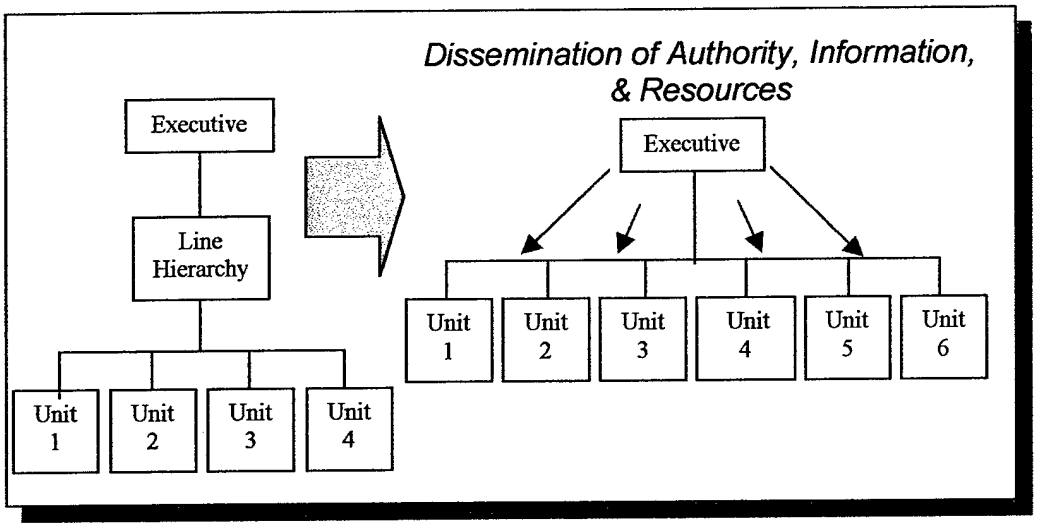

Figure 2. Flattening of Organizations

Flattening an organization requires a reshuffling of the internal relationship between the leader and the line unit because eliminated middle management no longer attends to the functions of control and coordination. These must be assumed by the

remaining entities, especially staff elements. This form also changes the relationship between the overall commander and subordinate commanders. Typically, the executive moves from centralized directive command and control to more decentralized "management by exception" or "management by objective." Management by exception is the intervention of the leader only when necessary, such as to distribute rewards or sanctions. Management by objective, roughly analogous to mission command or *Absicht*, provides corporate goals and operational assets to the units and leaves them to their initiative to achieve success. Since there is less vertical management to attend to the coordination between specialized subunits, line units are often made more multifunctional or generic. For these reasons, flatter structures require highly trained and cohesive subordinate units to succeed in the environment of increased independence.

Another major function of this middle management is information flow. In the flatter organization there is naturally increased information flow between echelons with less filtering and information processing. To make up for this deficiency, firms introduce enhanced IT tools to the executive, staff, and line units to increase and focus information exchange horizontally across the line units rather than vertically through the hierarchy. However, since internal communications are often distorted or slowed by middle management, the elimination of the intermediary hierarchy can increase the information efficiency of the organization through its elimination of intermediate levels of command.

The primary challenge in flat organizations is working in complex environments where flexibility is needed. Flat organizations, usually employed in dynamic or rapidly changing markets, often have a hard time adapting to environmental factors outside their normal scope of operations. Flat organizations' hierarchical structure makes reorganizing

to meet unanticipated conditions difficult. Furthermore, by definition, the less robust leadership in these organizations is sometimes less aware of operational conditions. Other issues these organizations also experience are problems with career paths, especially for specialists assigned to line organizations.

An essential issue for flat organizations is the set of underlying policies and communications processes to ensure cooperation and coordination between the line units and leadership. Controlling policy and communications procedures which are set too restrictively or too loosely can be damaging in this type of organization with its balance of centralized goals and decentralized effort. Communications and information flow must be carefully structured to ensure effectiveness without causing information overload.

Networked Organizations

Networked organizations consist of semi independent, highly specialized units which are joined to form an overall organization, often temporarily to accomplish some specific objective. The specialized parts (representing different core competencies) come together selectively to accomplish particular objectives and share knowledge based on the task at hand (figure 3). While this type represents the maximum in specialization, it also involves a high degree of decentralization because of the disparity in cultures and competencies as well as separate administrative sustaining systems involved. Success is the primary motivating force for cooperation rather than a hierarchical administration's stated goals and objectives. For this reason and the fact that networks are organized only as long as the task remains undone, makes questions of span of control less relevant.

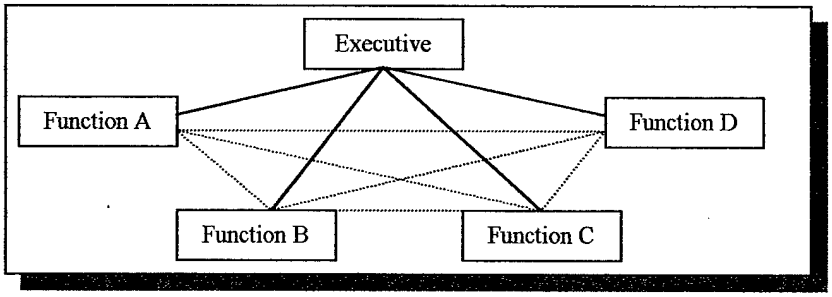

Figure 3. Networked Organization

The major consideration in networked organizations is the degree of specialization between units. Smaller organizations or those who face uncertain environments rapidly tend to mirror networked structures because they create and employ functional (specialized) rather than generic line units through outsourcing or collaborative partnerships. Specialized, plug-in units reduce duplication of effort, achieve economies of scale, and encourage technical expertise due to the increased internal information exchange within these units.

This structure maximizes flexibility because it can rapidly orient on the problem or issue at hand to a greater degree than other organizations. There is no need for permanent infrastructure and therefore less need for traditional or formalized hierarchy in networked structures. These types of firms are also run inexpensively because there is little or no overhead, especially when a number of the networked functions are outsourced. Networked firms are able to maximize their efficiency because they contain a high degree of proficiency in the highly specialized units which joint to form the organization. Advanced collaborative information systems are employed to connect the parts of the organization, often with limited information flow rules or norms, which can add to the synergistic strength of the end result.

Drawbacks to networked organizations are many. Of course, a lack of a central hierarchy creates a command and planning vacuum. Coordination and control functions are also strained due to the near total decentralization of this organization. All these functions are also extremely difficult because of a lack of standards, cohesion, and a reward and sanction system. Interestingly, according to Mintzberg, networked organizations often experience crippling information overload as many trivial issues are networked across the enhanced communications systems with no procedures, filtering, management, or policy.

Matrix Organizations

Matrix organizations are hybrids which contain interdependencies at all levels. The staff in all Army organizations is partially matrixed organizations because they address specific issues across all line units. In essence, the matrix organization (figure 4) represents the maximization of staff control of the line units. Within their area of expertise, each staff section or function directly supervises all subunits. The result is a streamlined organization consisting of a number of generic line units which contain all necessary specializations for operations.

Matixed organizations are useful to consider because they address the issue of staff versus line, and unit specialization. When specialization is implemented through a matrix or staff rather than the addition of a specialized unit, the generic line units can be made more self sufficient because they have their organic slice of the specialty function while the matrixed staff section provides intellectual capital for planning and coordinating as well as policy for control. In effect, a staff adds matrix attributes to an organization without creating the need for additional specialized subordinate units.

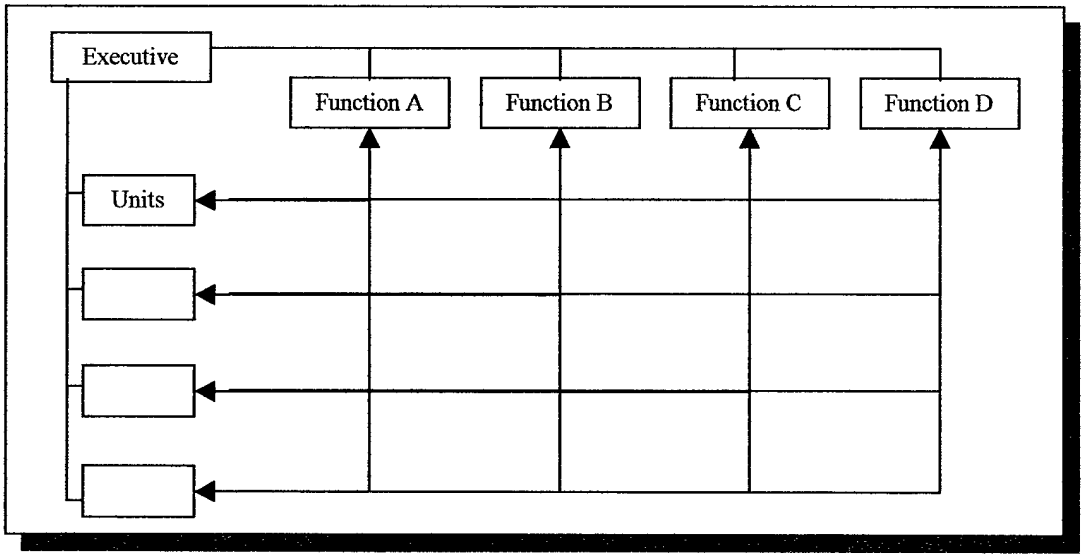

Figure 4. Matrix Organization

The degree of matrixing in organizations can also be a function of the bureaucratic structures present. Mintzberg states that the more the system is regulated, the more bureaucratic the organization. It follows that the more rules are imposed on an organization, the more bodies of specialized regulators, or staffs will be needed to supervise, support, and regulate the conduct of the work across the line units.

The drawbacks to the matrix organization include the fragmentation of supervision, and some limited flexibility in complex environments. These structures represent a mix of strengths and weaknesses. Most importantly, they are challenged in following an overall organizational direction where the chain of command itself is divided, which is a major drawback at lower echelons in military organizations. Yet, matrixes can add flexibility to flat organizations in order to better equip them to deal with complexity. Matrixing can also add conformity to networked organizations where all the subunits are functionally unique.

Mintzberg contends that these and other, more radical nontraditional structures are usually implemented as ways of organizing rather than forms of organizations themselves because these nontraditional forms more often occur within existing hierarchical structures.[3] On occasion, these forms are also implemented as formal, semiformal, or informal connections between parts of existing hierarchical organizations. The reason why few organizations fully adopt completely flat, networked, or matrixed organizational structures is because of the limitations and weaknesses of nontraditional organizations such as information overload, command vacuums, imbalances in control, lack of career progression, and even lack of flexibility depending on the form. Also, the implementation of these forms requires exacting balances in decentralization, information flow, specialization, and spans of control to realize efficiencies and avoid disaster.

The optimum degree of specialization, decentralization, and span of control depend on the external environment and internal proficiency. Specifically, hierarchical and flat organizations are preferable in dynamic but simple environments, especially where high stress and rapid decisions are the norm. Networked and matrixed organizations flourish in complex environments where the uncertainty high.

The standard military hierarchy in figure 1 contains aspects of each of the three alternative organizational types. For instance, the standard battalion staff has matrix organizational aspects while the hierarchical structure remains. Generic line and specialized supporting units using initiative to collaborate on problems and issues at their own level exhibit similar attributes to the flat organizational type. The task organization of subordinate units to form goal or mission-oriented teams is common to mixed armor-mechanized infantry brigades and divisions, and networked organizations.

Military Organizational Trend Lines

Organizational theorists have borrowed heavily from the military experience in their development of the ideas of management theory. Conversely, the military and its organizing principles, while traditional in nature, have not been unaffected by trends in society, politics, technology, and business and management or organizational theory. Yet the unique aspects of the military environment are critical aspects to the military organizes and sustains for effective and efficient C2.

The Environment of War

The military prepares to operate in a vastly different environment than commercial business. The intensity, gravity, and unpredictability of conflict makes military organizations subject to special organizing considerations. Although this is not a trend per se, the environment of combat is the most important distinction between military and commercial organizations. While firms in the private sector are constantly engaged in their primary functions such as manufacturing and providing services, the military engages in its primary mission only rarely. The Army trains for the eventuality of war constantly but the actual experience of it is often lost through attrition of personnel. The level of competition is also a significant difference between the military and business environments. While a private firm may feel gratified to achieve a second place position in their respective industry, in warfare second place is catastrophic.

Clausewitz's timeless description, "everything in war is very simple, but the simplest thing is difficult"[4] exemplifies the problems specific to the environment of conflict. The reaction of the individual to the intensity of the combat environment with increased fear and adrenaline puts higher requirements on military organizations to retain

effective cohesion. Military organizations have traditionally had an interest in their lowest echelon members being able to blindly and instantaneously follow orders without second thoughts or reflection. This industrial age concept remains critical to a squad or platoon level, but is less appropriate in the networked, fluid commercial environment or even high level military organizations.

A dynamic environment, to Mintzberg, often requires more organic line units, or, a flatter organizational structure with a greater span of control. He suggests here that a rapidly changing environment requires units which are more alike to apply to changing conditions. In military organizations this relates to a greater number of self contained, permanently task organized subordinate units available to a commander.

A complex environment where uncertainty is prevalent at all levels requires, to Mintzberg, a high degree of decentralization due to the inevitable imbalance in the distribution of information. Since the unit in contact with the enemy has better and more information than any other element, their leader typically has the most effective inputs to his decision process to arrive at the best course of action. Conversely, as higher echelons gain in situational awareness, they also gain confidence in decision making. This is the basis of arguments contending that information technology will inevitably reduce the fog of war through the improved collection, distribution, and sharing of battlefield information. It is also the basis for micromanagement through better information where higher echelons gain only a perception of greater awareness.

The complexity of modern warfare also requires a high degree of specialization. As leaders are confronted with a growing list of considerations and a wider array of potential operations, their units have added specialized capabilities to deal with each

challenge. The combined arms corps of the Napoleonic wars has evolved into a complex system itself, where dozens of specialists whose high technology skills and equipment require advanced training, maintenance, and support structures. The impact on the traditional environment of militaries, long periods of sometimes monotonous peace broken by brief periods of high intensity warfare, has required modern militaries to attend to its upkeep, sometimes stressing peacetime organizations. Conflict has also fragmented, from high intensity warfare into a range of conflicts including a proliferating list of "peace" missions. Leaders now confront an increased complexity in their environment with complex forces, with a major result being the sharp increase in specialization at all echelons.

The last consideration is the "hostility" of the environment, which defines traditional, high intensity warfare. Mintzberg believes that a high degree of actual danger in an environment warrants centralization of an organization's authority and structure where the environment is encountered. This suggests that at the point of the military spear in tactical operations, more centralized, hierarchical control is more effective than decentralized control because fast and tightly controlled reactions are necessary.

It remains possible, if not common to decentralize at higher echelons of military organizations to maximize efficiency and effectiveness. The remote nature of higher echelons, their more experienced personnel, and often their specialized nature makes decentralization more likely at operational and strategic levels. This disparity of controlling rules, orders, and limitations at lower and higher echelons is reflected in Clausewitz's idea of "routine":

> Routine, apart from its sheer inevitability, also contains one positive advantage. Constant practice leads to brisk, precise, and reliable leadership, reducing natural friction and easing the working of the machine. In short, routine will be more frequent and indispensable, the lower the level of action. As the level rises, its use will decrease to the point where, at the summit, it disappears completely. Consequently, it is more appropriate to tactics than to strategy [emphasis mine].[5]

Therefore, relevant question for the military on the parameters of organizations is often not whether to apply wider spans, decentralization, and specialization, but how far down the vertical hierarchy to apply them. For instance, the company and below will probably always remain an organic, unchanging team. This is necessary for unit cohesion, trust, and teamwork. At higher echelons more leeway is possible for each successively experienced commander. A battalion commander can task organize his weapons and support assets. Brigade commanders have more leeway to alter the forces he uses to engage the enemy. The division commander has much more materiel and human capability to add to lower level commands. Yet at some point, the commander becomes so far removed from the fight that his inability to see and stay abreast of developments precludes his making tactical decisions. The question for army planners has gone beyond the Napoleonic and German question of which echelon should be provided organic combined arms. Now, army planners must balance complex combined effects and how to make them available to the command echelon capable of making near instantaneous employment decisions on the battlefield.

Soldier Sophistication

The basic element of the military organization, the individual soldier, has evolved dramatically over the years of the twentieth century. During World War I industrial armies often put soldiers into battle after two weeks of basic training, only to be mowed

down by enemy machine gun fire or killed in artillery barrages. The basic infantryman in the British Army of 1914 was thought to be too raw to be provided with any measure of initiative or even tactical proficiency. By the Second World War, draftee soldiers had the benefit of at least six weeks of basic training before they too were sent to combat, sometimes in entirely raw divisions such as the ill-fated 106th in the Battle of the Bulge.

Now, large standing armies of professional volunteers now are continuously trained from the first month and one-half of basic training and Advanced Individual Training through leadership schools such as Primary Leadership Development Course, Basic Noncommissioned Officer Course, and the Advanced Noncommissioned Officer Course. The majority of these high school graduates also achieve some degree of college education during their service life.

Officer training is even more in depth. Beginning with the required college degree, officers are provided an additional year to two years of specialized training in their branch basic and advanced courses as well as the Combined Arms Services Staff School and the CGSC. This is not to mention the myriad additional voluntary courses such as airborne, ranger, and air assault as well as short theater-specific or unit and job specific courses encountered through the typical military career. The result of increased education is highly trained and intelligent soldiers who are more comfortable with the complex technologic tools of modern war than their senior leaders.

This emphasis on more and deeper education is a necessary interest of modern armies with complex combat systems and situations. Clausewitz, living in a much less complex world, wrote about the need for men of ability in the subordinate ranks of an army in his book, *On War*:

> Since in our view even junior positions of command require outstanding intellectual qualities for outstanding achievement, and since the standard rises with every step, it follows that we recognize the abilities that are needed if the second positions in an army are to be filled with distinction.[6]

Organizational theorists cite subordinate education and training as on of the key prerequisites for networked and flat organizations which feature high degrees of decentralization. There are drawbacks of course. The cost in terms of time away from units, educational infrastructure, and fiscal resources is enormous. Also, while the modern soldier is more expected to perform with initiative, he or she also expects a degree of *Absicht* about the overall mission's purpose in order to work most effectively. This expectation is coupled with an increased awareness of soldier benefits, legal rights, and policy, complicating the administrative and supporting infrastructures of armies, not to mention the increased requirements that accompany the higher rates of soldiers with spouses and families.

Along with increased educations level of the modern soldier, are the societal changes affecting military organizations as new recruits are drawn from the post baby boom generation. While "generation X" soldiers are often more technologically astute than their own leaders, this generation of soldiers, according to leadership guru Jay Conger, is also less likely to be blindly loyal to their organization. They seek success rather than stability from the organization, where leaders are looked upon as mentors and coaches rather than directors.[7] These characteristics favor networked organizations where highly specialized units are motivated from "buy in" to corporate goals rather than written directives. This highly educated force enables modern armies to leverage a greater degree of initiative and innovation at lower echelons.

An American corollary to the general trends in soldier sophistication is the activist nature of the American officer. Like all officers, Americans reflect the values, norms, and standards of behavior of the society from which they come. American society, with its value of independence and action, creates an officer corps which values aspects of decentralization and centralization at the same time. American officers orient more on action, movement, and decision than those of other nations. While American leaders tend toward the centralization of control of assigned lower echelons these same leaders shun centralization from above, citing micromanagement and "boot licking" causing a leadership challenge to all involved.

Smaller Operational Threshold

Throughout history, the threshold at which combined arms formations has been reduced from the army itself under a single commander to increasingly lower level echelons. Frederick the Great and commanders before him, as despot as well as overall commander of their armies in the field, were the integrators who employed combined arms to achieve their political and military aims simultaneously. As has been discussed, Napoleon devolved the operational decision threshold in a limited way to combined-arms corps. Grant and von Moltke employed corps as the primary independent, combined arms subdivision of an army in the nineteenth century.

The U.S. Army of the late twentieth century has chosen to equip the divisional echelon with the organic support structure to conduct independent operations for a limited period of time. This degree of decentralization to division level reflects the trust and expectations the Army holds for commanders who enjoy a relatively high level of authority and responsibility; yet remain in touch with tactical operations. Below the

current division level there exists a high degree of specialization in separate support units such as artillery, aviation, engineers, signal, military intelligence, and air defense. This specialization requires subordinate brigade commanders to rely on the division level to optimally combine essential functions for each operation, thereby limiting the autonomy of lower level echelons. The repeated task organization of units also limits cohesiveness and internal intellectual capital in these functions within the brigades. Yet, this structure achieves an economy of scale for these specialized functions, and it does engender continued professional growth of the special functions within their division level specialized units.

The divisional structure, refined during the Second World War, has continued as the primary operational decision threshold echelon of the Army. Consequently, the division commander is, to a degree, the focus of effort for the C2 system. A full military intelligence battalion, largely through links established by the signal battalion, provides inputs to this commander's decision process. The signal battalion also carries friendly force status and higher echelon directives and information to the division commander. The decision process itself is aided by a robust staff organization. To enact these decision outputs, the signal battalion again takes center stage to transmit orders and directives to subordinate units. The wide collection of specialized organic subunits, controlled by the staff, is reorganized and combined by the division with the maneuver brigades or employed enmasse to accomplish the mission. No other echelon has enjoyed the combination of tools and proximity to ground truth information to engage in complex operations which the current U.S. Army division contains.

There is also undoubtedly an emotional aspect to the relationship the U.S. Army has with its divisions. This phenomenon was highlighted when it was challenged by a groundswell of interest in the book, *Breaking the Phalanx* by then Lieutenant Colonel Douglas MacGregor in 1997.[8] The book recommends the elimination of the division echelon in order to create more lethal, mobile, lighter strike forces centered on enhanced brigades. The Army leadership reacted by closing ranks on the division structure despite a nagging resiliency of the idea that the brigade might be the primary combined arms echelon of the future. The emotional aspect of the Army leadership's attachment to the division organizational structure is embodied in the quote from TRADOC commander General Hartzog in *Military Review*, "To those who remember as far back as World War II, their division represents the defining moment of their lives. . . . conversations held among senior Army leaders after the Gulf War revealed a deep identification with and passion for the division."[9]

Yet, since World War II, conflict has seen the basic operational unit devolve to echelons below division. During the latter stages of the Korean War, individual brigades and battalions fought over hilltops along what would be called the demilitarized zone with supporting artillery and armor provided by the division. In the Vietnam War, the battalion again was asked to execute independently as the primary echelon engaged in search and destroy missions. Supported by division aviation and artillery, these battalions were the focus of effort and the primary independent warfighting echelon in Vietnam.

In the last quarter of the twentieth century, brigades and battalions have continued to operate with varying degrees of independence in the majority of conflicts with the

significant exception of Operation Desert Storm. For instance, armor brigades in the Arab-Israeli conflicts were the basic maneuver units studied by General Donn Starry in his prepatory work for the Army's Airland Battle doctrine. In 1982, the British Army and Marine forces employed a single brigade-sized ground force to retake the Falklands Islands. During Operation Urgent Fury in Grenada the U.S. initially invaded with 1,900 Army Airborne and Marine troops. Within five days the total had grown to approximately 5,000 (including Marine Air-Ground Task Force and Special Operations Forces), where the Army contingent was an enlarged brigade. During Operation Just Cause in Panama, the Army employed both the 7th Infantry and 82d Airborne Divisions; yet the deployment of these units, and the objectives taken by them were individual brigade missions, not linear division level maneuvers. The forces deployed to the Somalia operations, I-FOR and S-FOR in Bosnia, Task Force Hawk and K-FOR in Kosovo, and the Australian and American forces in East Timor were all built around brigade combat teams.

The major differences in these battalion and brigade-sized forces involve the amount of specialized organizations which was added to them based on the situation. For instance, Task Force Hawk, for instance, added an armor battalion and rocket artillery battery to an aviation brigade, totaling about 5,000 soldiers. The U.S. contribution in East Timor consisted of 5,000 sailors and marines offshore built around a Marine Expeditionary Unit and commanded by a brigadier general. The division's role in these operations, as was the case in Panama, Somalia, and Bosnia, included the coordination and planning capabilities of a JTF and the distribution of Army and joint resources to brigades conducting individual operations. The division's role consisted was as a source

of specialized units and coordination contrasts with the traditional command functions of planning, directing, and controlling division level, multiple-brigade operations.

The Increase of Information

The infusion of information, and its accompanying technology in war may prove to be the most important trend in warfighting in the new century. Driven by the overheated commercial information technology industry, the increase in IT is significantly affecting every aspect of warfighting. While this potential "Revolution in Military Affairs" (RMA) is still being debated, militaries are accelerating their investments in IT to exponentially increase the amount of information available to commanders and staffs.

Napoleon was perhaps the last single information nexus of any army in history. Yet his information system required the addition on a directed telescope to add context and depth to what he learned from standard reporting systems. Von Moltke added the telegraph to separate and speed the movement of key information and the General Staff to process and utilize this increased availability of information at all echelons. Von Halder's Wehrmacht General Staff continued and expanded this trend through the widespread fielding of radios and dealt with the change by pushing decentralized operations and initiative to junior officers and NCOs. The U.S. Army vastly increased the information collection, processing, and movement assets available to commanders between Vietnam and Desert Storm. The Army's method of enabling commanders to deal with increased information has been, in part, to expand the military decision-making process to ensure complete and regimented consideration of relevant factors of all situations.

The current main object of applied information technology, the common operational picture, may reduce Clausewitz's fog of war as advertised, but the chances of eliminating it entirely are small. Military innovators have previously heralded several communications and information technology advances as the answer to the problem of uncertainty. The telephone and radio are the most recent command and control "silver bullets" which have settled into roles as additional C2 tools the commander has come to expect in his command and control effort.

Part of the reason why information has increased is the rising complexity of conflict. Modern IT systems, especially the COP, undoubtedly offer a technical tool to reduce uncertainty. Yet if improperly or incompletely implemented, IT systems may add to the fog of war. In this case, information technology, rather than increasing synchronization of the current myriad warfighting capabilities, might irreversibly add to them a host of new capabilities to be synchronized as well as vulnerabilities to be protected, thereby increasing the potential friction on the battlefield.

Span of Control

The notion that a person's attention span allows them to attend to a limited number of subordinates has roots in British Army of the interwar era. Sir Ian Hamilton, in his book *The Soul and Body of an Army*, published in 1921, noted, "the average human brain finds its effective scope in handling from three to six other brains."[10] Organizational theorists subsequently adopted this idea.

Luther Gulick, a well known organizational theorist of the 1940s and 50s who established and worked in numerous U.S. government administration offices during World War II. During his tenure as the head of the Control Division of the War

Department during 1942 he advised Generals George Marshall and L. J. McNair on the reorganization of the Army.[11] Gulick directly observed the problem with large spans of control in civilian strategic leaders during the World War II who were overwhelmed with unforeseen demands for their attention. He noted, "Executives were driven by emergencies rather than their own energies and programs."[12] He saw how the "span of control was stretched beyond any reasonable practical limit. . . . The result was inability to cover the whole field of responsibility, attention primarily to elements of immediate concern, the tragic development of unnecessary internal jurisdictional and personal conflicts, and the neglect of future problems until the future was upon us."[13]

The obvious remedy for too large a span is the insertion of an additional layer of command, "If the brigades become too large--then a corps headquarters must be inserted. But one must bear in mind that this adds another power to the chain of command, while simultaneously reducing all others."[14] Modern organizational agree that, "Every additional link in the chain of command reduces the effect of an order in two ways: by the process of being transferred, and by the additional time needed to pass it on."[15] The tradeoffs of arriving at the optimum span of control and levels of hierarchy therefore involves not only by organizational structure, but also policies, communications, and human capital capability.

Gulick agreed with these parameters, in part because he believed that the workload of war imposed inevitable information overload on all leaders as, "This is inescapable." The answer, to Gulick, was to have the proper internal procedures and policies for cohesive operations and a highly trained, goal-oriented body of personnel to carry out the policy. It was these policies themselves, not stemming the overflow of

information from the outside world, which was the key to a span of control which can deal with information overload and avoid crisis management. Gulick further recognized that in the military organization a staff assisting a commander does, in fact, exercise a measure of indirect control over subordinate units besides planning and advising, thereby expanding the commander's potential span.

Clausewitz asserted that the actual span of control number of subordinate corps or division was a balance to be based on only two criteria: the capabilities of the subordinate commanders and the availability of communications between echelons. While those measures still make sense, the number he arrives at was based on Napoleon's use of eight corps in his campaigns of Clausewitz's day.[16] Echoing the modern trend to flatten organizations through improved telecommunications (especially at higher echelons), Clausewitz observed, "It is hard enough to manage eight subdivisions from one headquarters; ten is probably the limit. In case of a division; however, in which there are far fewer means for transmitting orders into action, four, or at the most five subunits, must be considered the appropriate figure."[17] Von Moltke added the consideration of transparent C2 procedures to the question of span of control as he decreased his span to three maneuver armies over a much larger army.

Modern notions of military span of control have traditionally relied on experience, personal ability, physical distance, and tradition. While span of control is situation-dependent, Army doctrinal span of control is between two and five elements per headquarters[18] while the Marine Corps puts the number at between three and seven.[19] The ultimate answer to the span of control question was successfully addressed by trial and error throughout history. This is the method which allowed Napoleon, von Moltke,

and von Halder to arrive at different; yet effective spans for their armies. The key variable in arriving at a proper balance has traditionally been successful experimentation on a wide variety of policy and organizational options with realistic tests and objective analyses. The analysis of organizational types, since it involves such a wide variety of factors, is most effective when it involves actual combat operations rather than theory or computer modeling. Furthermore, affordability has not normally been a consideration in successful structures because the optimum organizational form generates its own efficiencies over the long run.

Decentralization and Specialization

There are significant pressures which are felt by digitized and nondigitized units alike which favor greater centralization. Perhaps the strongest of these is the need to incorporate specialized functions to apply to modern conflict. For instance, to coordinate the planning and use of organic long range precision munitions, or, the need to create economies of scale through highly centralized "just-in-time" schemes. The air tasking order is a primary example of this where planners must account for the desired effect seventy-two to thirty-six hours ahead of time, with flexibility in providing this asset reduced exponentially over time as the "strike package" is rested, then planned, armed, and delivered. A related pressure is resource scarcity, which affects the employment of all high value assets including million-dollar bombs and missiles. Also, the increase in political-military aspects of lower echelon operations, especially in a MOOTW environment creates a situation where a single incident, especially in the presence of the media, could have strategic impacts. Finally, a fear of casualties, whether warranted or

not, especially in MOOTW situations clearly acts as a centralizing force, limiting initiative in the extreme.

Decentralized operations have been so successful in warfare because of uncertainty caused by the dynamic nature of conflict. From Napoleon's missing corps at Jena to instant, surprise ambushes of battalions in Vietnam, operational and strategic leaders often found out that their subordinate unit had been in a serious fight after the fact. The situation had not been so mysterious to the participants, yet it changed so rapidly that higher echelons and their communications systems could not possibly cope with directing subordinate unit in every situation. Therefore, the original reason for increased decentralization was to increase lower level efficiency due to uncertainty at higher echelons.

Since the ability to decentralize clearly involves communications capability, commanders often grant a degree of decentralization through the limitations of their communications assets. The age-old rule of thumb of putting the best unit the furthest away was used by Napoleon and continues in modern armies. It works since distance implies degraded communications and, therefore, greater autonomy. To S. L. A. Marshall, "the search for information and the giving of it are the true beginnings of what is called initiative."[20]

Decentralization, in and of itself, does not constitute a virtue, especially since increased complexity in modern warfare has required commanders to devise and implement new structures to deal with previously unknown dimensions. Centralization (table 1) is an effective alternative where it is desirable to reduce uncertainty at higher levels or enact rapid movements over large, poorly organized forces. The commander's

level of uncertainty can be limited to certain types of operations, perhaps relating to the extension of military operations into cyberspace, outer space, the electronic spectrum, the media, and among civilian populace. Centralization also is prevalent in situations where organizations experience friction from internal complexity, which has also risen in recent years. While viable, centralization must be applied with care because of its relative rigidity and increased long term (table 2).

Table 1. Centralized versus Decentralized Comparison

Centralized	*Decentralized*
•Advantages –Speed –Certainty (higher) •Disadvantages –Brittleness –Sclerosis –Routinization –Risk (long run)	•Advantages –Flexibility –Certainty (lower) •Disadvantages –Hard to control –Unpredictable –Risk (short run)

Now, with digitization, this disparity in uncertainty has been significantly reduced, enabling greater synchronization of the entire force. This may be an emerging trend in high intensity conflict stemming from the example of the land force in Desert Storm, which successfully reduced potential friction through increased centralization. The risk of centralization; however, has not changed. Soviet style tactics have failed in every major conflict since World War II, most notably in the Korea and the Middle East. Furthermore, if the leadership is blinded, as is often the case in the fog of war, the results to a centralized system are potentially catastrophic. In the end, if the distribution of

information is successfully equalized between higher and lower echelons, the degree of decentralization depends largely on which organization has the assets to act quickly on the battlefield, and the trust of their higher headquarters to employ them.[21] While friction may have been reduced through digitization, the fog of war still favors some degree of decentralization. In Vietnam, Somalia, and Chechnya warfare proved its unpredictable complexity, requiring subordinate units to act quickly, often without contemplation or guidance.

> Napoleon would solve the centralization/decentralization [sic] dilemma by: organizing self-contained mission-oriented units, instituting a system of standardized reports and orders, establishing a headquarters staff to deal with reports and orders, and instituting a "directed telescope" system of adjutant generals to provide alternative sources of information.[22]

The Napoleonic system represents the rational approach of "trust, but verify." The military has had to hedge its bets in this area because the tradeoff in greater efficiency through decentralization is balanced by a loss of control and sometimes synchronization. Numerous methods exist to verify, the directed telescope being one of the most popular through time. To organizational theorists, what is not a viable option is perpetuation. Paying lip service to initiative does not work because real decentralization requires trust, a thing which cannot be delivered "just in time." For instance, the Air Force mantra of "centralized control, decentralized execution" would be considered a meaningless oxymoron to Mintzberg or Gulick because the military, being a hierarchy, always centralizes control in commanders and staffs, and decentralizes execution in units. The pertinent issue is to what degree to decentralize, which, in decentralized organizations, is usually left to local leadership to determine.

The desired effects of all organizational changes: improved decision making, reduced uncertainty, improved synchronization, conservation of resources, and greater initiative at all levels depends to a high degree on improved information flow between all echelons and units. These and related goals are the reason why the infusion of information technology has accompanied so many organizational changes in industry and commerce and point t a comprehensive reconsideration of organizational forms and relationships in the pursuit of effectiveness and efficiency.

Division XXI Organization

"Historically, the introduction of new technologies has been followed by the development of a new organizational structure to optimize its exploitation."[23] Captain Frank Snyder's comment on the need for new organizational structures encapsulates the drive to new formations which have manifest themselves in the current information revolution. The Army initiative to redesign the baseline combined arms combat formation, the heavy division, to leverage advanced information technology has been the subject of numerous Army Warfighting Experiments (AWEs), conferences, reports, and operational tests. The 4th Infantry Division at Fort Hood, Texas is the embodiment of what the Army sees as the military force of the future. As such, it bears investigation into how the organization called Division XXI has been developed, structured, and fielded.

Study for the new divisional structure began in earnest in 1995 when serving brigade and division commanders were brought together by TRADOC to evaluate the original eleven proposed organizational structures for Division XXI. They chose seven versions for further study. Since the Army was in the waning years of the post-Cold War draw down, "these seven were later reduced to four, based on affordability."[24] Three

designs: the Conservative Heavy Division (CHD), the Strike Division, and the "Brigadist" division were tested at the Task Force Army Warfighting Experiment (AWE) at the National Training Center and the Division AWE (DAWE) at Fort Hood, Texas, both in 1997. The tests used the 1st Brigade of the 4th Infantry Division from Fort Hood, the first unit in the Army outfitted with digitized equipment systems, the Army Tactical Command and Control Systems (ATCCS). Based on the tests of this "Experimental Force," the conservative heavy division design was selected, according to General Hartzog, Commander of TRADOC, based on "lethality and affordability" resulting in the organizational structure for the new Division XXI in 1998.[25]

The resulting Force XXI digitized division design (figure 5) is smaller than the traditional heavy division (figure 6) at 15,719 soldiers (down to 15,538 as of 2000), largely because the new design eliminates the brigade engineer headquarters and reduces the standard infantry battalion from four maneuver companies to three. The division features increased capability in its brigades through an organic reconnaissance troop to include an unmanned aerial vehicle (UAV) section, an engineer battalion to provide mobility support, organic reconnaissance companies, and dedicated liaison elements will provide the capacity to expand the organization's influence to external services. The division military intelligence battalion has also been reorganized to provide one company in direct support of each maneuver brigade. This degree of de-specialization of the division echelon makes brigades more capable of semi independent operations, especially through increased information resources of the reconnaissance troop and dedicated intelligence company at brigade level.

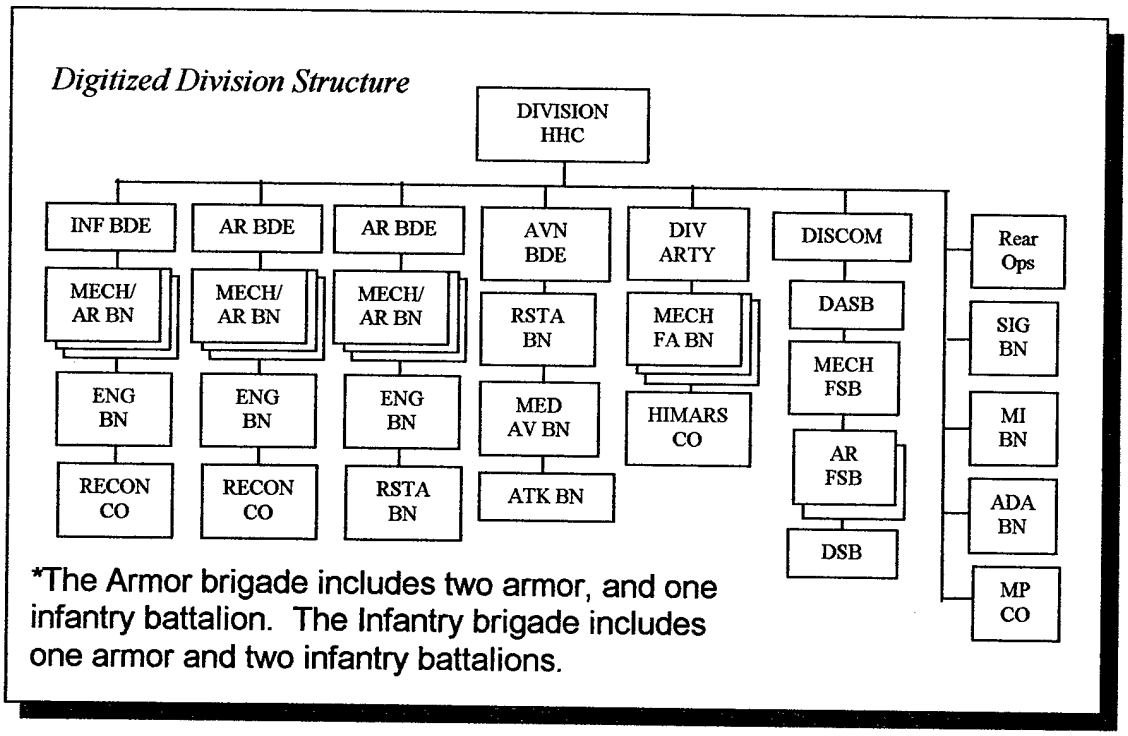

Figure 5. Force XXI Divisional Organization

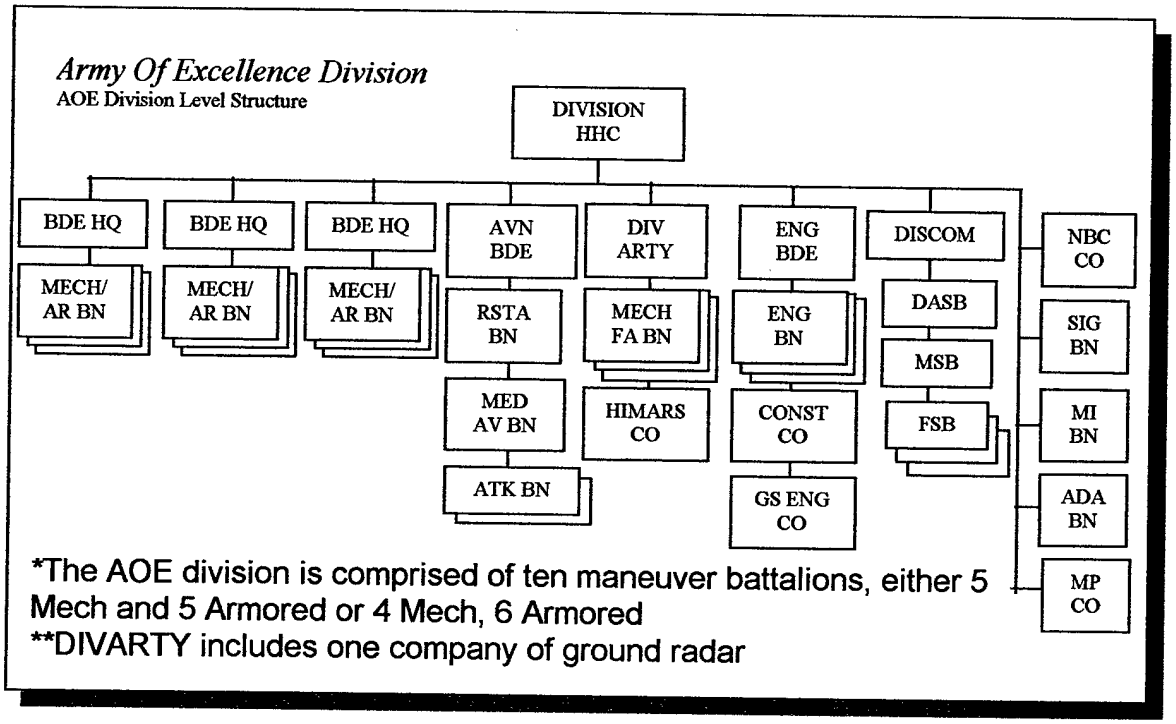

Figure 6. Army of Excellence Divisional Organization

The main capabilities of Division XXI, to TRADOC are specified as follows:[26]

a. Increased operational area to 100 by 120 square kilometers

b. The ability to conduct sustained operations for thirty hours as an initial entry force for a corps

c. The ability to defeat an enemy of equal size or defend against three enemy equivalent forces

d. The ability to operate as part of the corps or JTF as an Army Force (ARFOR) or joint forces land component command (JFLCC) in high intensity conflict or stability and support operations (SASO)

e. The incorporation of reserve component personnel within the section, squad, platoon, and company levels across the division

f. The ability to be tailored for all missions by the addition of corps level capabilities

There are inevitable organizational implications from these capabilities. For instance, the expanded battlespace of the division implies a more capable organization with better communications. The increased operational area is coupled with the deletion of the division rear tactical operations center (TOC), which has been consolidated into the division main TOC. Also, the division's ability to serve as an ARFOR means that it contains a certain amount of flexibility and interoperability with joint and other service C2 systems. The presence of reserve component personnel can provide unique skills and outlooks to the division's units. Corps level support relationships, enhanced due to the slimmed down structure of Division XXI provide a degree of streamlined command and

control for many support functions which have been moved from division level such as nuclear, biological, and chemical (NBC) and engineer support.

Unfortunately, the original modeling and simulation programs which produced the Force XXI division design depended on conditions which may never become a reality. For instance, the cuts in maneuver companies, engineer brigade, and air defense battalion were predicated on systems capabilities which have been subsequently cut back or cancelled such as M1A2 tank upgrade, the Grizzly and Wolverine engineer systems, the Sentinel air defense system, and the Crusader artillery system. Other modeled capabilities used to justify the division design have not been developed and fielded as advertised. For instance, "just in time" logistics relied heavily on the Global Combat Support System-Army (GCSS-A), an automated logistics system with significant problems which is being restructured as of this writing.[27]

Furthermore, the organization of the digitized division itself changes the dynamic of traditional information flows to and from the commander on the battlefield in several ways. First, the distributed nature of digitized operations ensures that the commander may not be able to personally convey his intent or observe rehearsals, especially in a more dynamic, ongoing battle. Whether the advantages of digitization make up for this is to be determined. Secondly, enhanced collaborative planning amongst staff sections and across echelons based on enhanced IT and reconnaissance and surveillance capabilities will put pressure on the traditional autonomous echelon of division to shift some decision making downwards to the more capable brigades, in effect, decentralizing planning and execution. The change from three tactical division headquarters to two will concentrate and simplify the information flows on the battlefield but it will encumber the remaining

TOCs with additional personnel and equipment, making them less mobile. This deletion of a TOC will also strain the communications transmission system which must reach further across the larger operational area. Finally, other functions transferred to corps level such as chemical support cannot be counted as organic to division and operational redundancies may need to be planned differently to ensure support.

The structure of the division further ensures that constant organizational change will affect cohesiveness. For instance, the integration of reserve personnel into regular army units creates a situation where unfamiliar working units inhibit the forming of cohesive teams. Furthermore, the reliance on in tailored support from the corps level, especially in logistic and NBC functions and capabilities, ensures the division maneuver and support units will lack some traditional cohesion in these areas. While engineer support to brigades has been enhanced through the addition of an engineer battalion, the division engineer staff officer will encounter additional coordination and control duties.

TRADOC Pamphlet 525-5, *Force XXI Operations*, outlines the ways in which enhanced information technology will impact the organization and capabilities for digitized Army operations. In the pamphlet there are a number of "marks on the wall" with organizational implications. "Aided by information technology, organizations will tend to grow flatter and less rigidly hierarchical."[28] While the clearest way to make organizations flatter and less hierarchical is to design and structure them that way, Division XXI is less flat and more hierarchical in the deletion of one maneuver company per battalion. IT can enable an organization to "tend to grow flatter and less rigidly hierarchical" by the incorporation of networked, flattened, and matrixed attributes to alter internal relationships. The networking advantages of the digitization systems include

greater horizontal and intra-functional coordination across echelons, which could empower lower level commanders to react to uncertainty on the battlefield more effectively. However, this normally requires targeted procedures for doing so such as directed telescopes, *Auftragstaktik* training and doctrine, and/or strict control of information flow.

The actual flattening of the engineer and military intelligence support structure, coupled with the enhanced capabilities of subordinate brigades in other specialized functions will enable commanders, through COP, to better synchronize assigned and attached supporting arms (if these combined arms are effectively connected via digitization). Yet, the hierarchical nature of the organization may potentially cancel or otherwise impair these advantages through structural centralization. For example, since the hierarchy is less flattened while information flow is enhanced, middle managers at the brigade and division level may be marginalized, leading them to interject thereby slowing or distorting the flow of information. Also, the retention of other key specialized units at the division level will ensure that lower echelons will continue to be subject to the division hierarchy in the application of these functions.

Division XXI seeks to achieve manpower efficiencies by the increase in information systems, especially in staff functions. *Force XXI Operations* states:

> We must look at reducing manpower by increasing automation in areas that deal with rations, fuel, and other housekeeping staff functions. We must not reduce staffs solely for the sake of reducing them. The assimilation of data and information and application of judgment for key decisions will continue to require competent teams assisting commanders. Clearly, future automated information operations promise a capability to operate with unprecedented control in routine staff formations, allowing commanders and staff to focus on more complex, integrative tasks.[29]

The reduction in staffs dedicated to "housekeeping" functions is possible through enhanced information technology as long as the expertise is replaced with a commensurate increase in available knowledge and capability via the IT system and an IT support staff. Information management functions require an increased number of cells to scan, capture, process, fuse, package, store, and track the increased information, across the organization. These information technology and information management cells or sections may be existing troops with a new mission, but would preferably be an added capability, implying additional personnel.

With regards to span of control and decentralization, Division XXI is basically an Army of Excellence divisional structure with enhanced information technology. While the addition of IT in commercial firms has enabled them to realize increased efficiency and effectiveness through to flatter or more networked organizational forms. The Force XXI division continues the networked aspects of the Army of Excellence division where brigades and battalions must be task organized for every operation. This type of networking centralizes control at the division level where these organizing decisions are made.

A final potential pressure to centralization is the simple tendency for commanders to attempt to micromanage operations. Regardless of current policy or training, there always exists a certain percentage of commanders who attempt to exert a high level of control "it is a weakness that is found in many conscientious officers."[30] While this is not unique to Force XXI, the enhanced situational awareness afforded by the digitized systems makes this possibility exponentially more likely. The common operational picture gives all commanders a directed telescope focused on unit location and

movement. It would be natural for commanders to use this new tool to try to exert more control over a messy battlefield as the British did with their new telephones in World War I and the Americans tried to do with their new helicopters in Vietnam. In many ways, the organizational aspects of Force XXI may represent a more synchronized, but a less flexible overall organization than the traditional Army of Excellence version.

C2 Organizational Case Studies

The following are examples of divisional staff and suborganizational structures with notes and observations based on the previously discussed parameters, organizational forms, and trend lines. These organizational charts provide an overview of the structure of the different models, but they cannot provide the internal procedures by which each would operate. Therefore, they are relevant and interesting, but should be considered in context.

Figure 7 presents the unit and staff structure in use at the 4th Infantry Division. It is typical of like units across the Army where the maneuver and support units have been grouped under assistant division commanders for maneuver (ADC-M) and support (ADC-S). Like any Army unit, the chief of staff 's span of control issue (twelve separate staff sections), is negated by the networked nature of the staff and its division in operations between tactical headquarters. The elimination of one of these TOCs in Division XXI, and the additional information-related functions of the staff may cause additional stresses on the staff and its chief.

While specialized units which directly support brigade operations, such as the aviation and division artillery brigades, are centralized under the ADC-M, the coordination requirements are reduced by traditional support relationships such as in the

division support and MI units. Ad hoc measures make the structural span of control more manageable and provide a degree of network-type flexibility for the division commander in organizing for operations.

Figure 8 presents what a doctrinal division staff might look like if commercial and theoretical principals were applied to a division organized for traditional as well as potential JTF headquarters missions. The staff sections are grouped by specialization under four functional assistant chiefs of staff who report to a single chief. The hierarchical structure is reflected below the Assistant Chiefs of Staff where the staff elements are grouped by function. Obviously, these elements would network together depending on operational necessities.

There are a number of significant differences from the standard divisional staff organization. For instance, the information flow elements (here the intelligence and communications) are consolidated under a chief information officer (CIO), called the Assistant Chief of Staff-C4I (ACofS-C4I). The model also adds several elements to manage functions which are common to the majority of MOOTW missions and Joint Task Forces such as contracting, Automatic Data Processing and Global Command and Control Systems (ADP), host nation support coordination (HNS), information operations (IO), civil affairs (CA), and space operations coordination (SPCOORD). The information management element (IMO) is also added to account for the overall management of the information flow, distribution, dissemination, and routing. While the personal staff group remains, a body of aides and an inspector general are added to provide a "directed telescope" to the division commander.

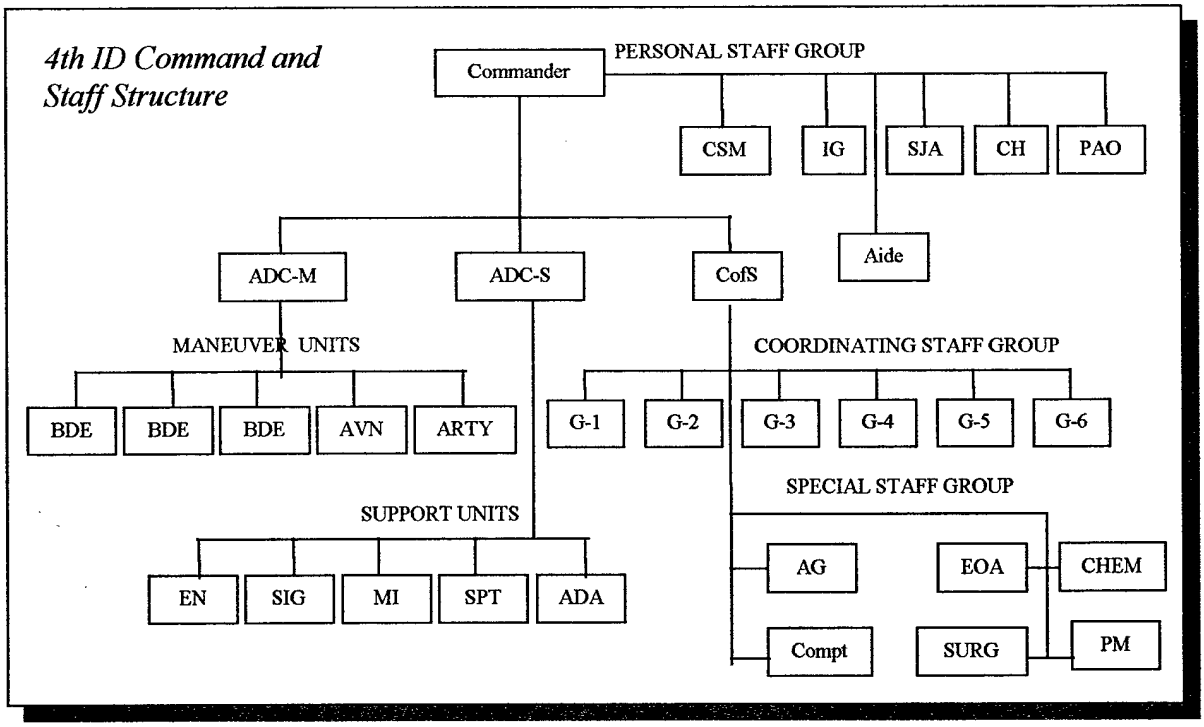

Figure 7. Typical Division Structure: 4th Infantry Division

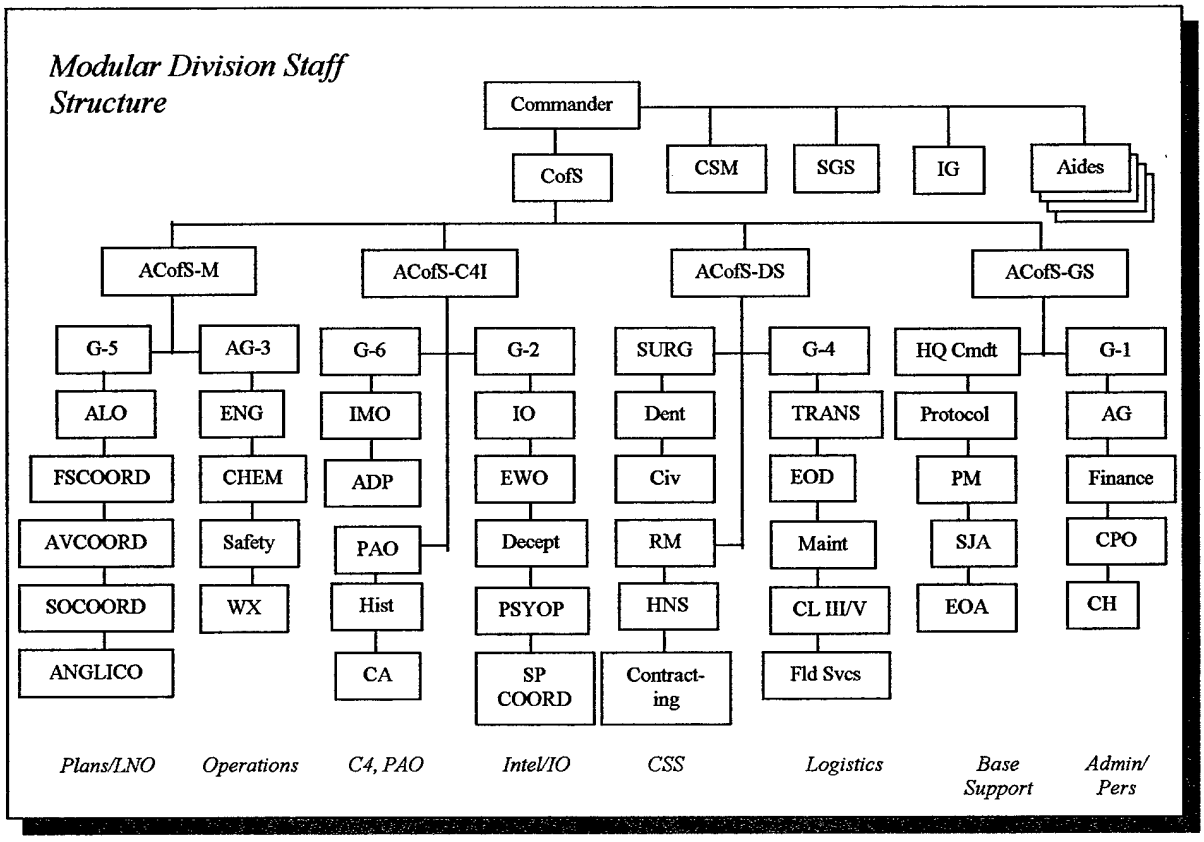

Figure 8. Alternative Divisional Staff Structure

The Pentomic Infantry Division of the late 1950s and early 1960s (figure 9) was the Army's first major attempt to flatten the basic combat organization of the Army using enhanced communications. This structure was the brainchild of General Maxwell Taylor who, as Army Chief of Staff, proposed to radically change the division structure in order to enable it to continue to operate on the atomic battlefield.

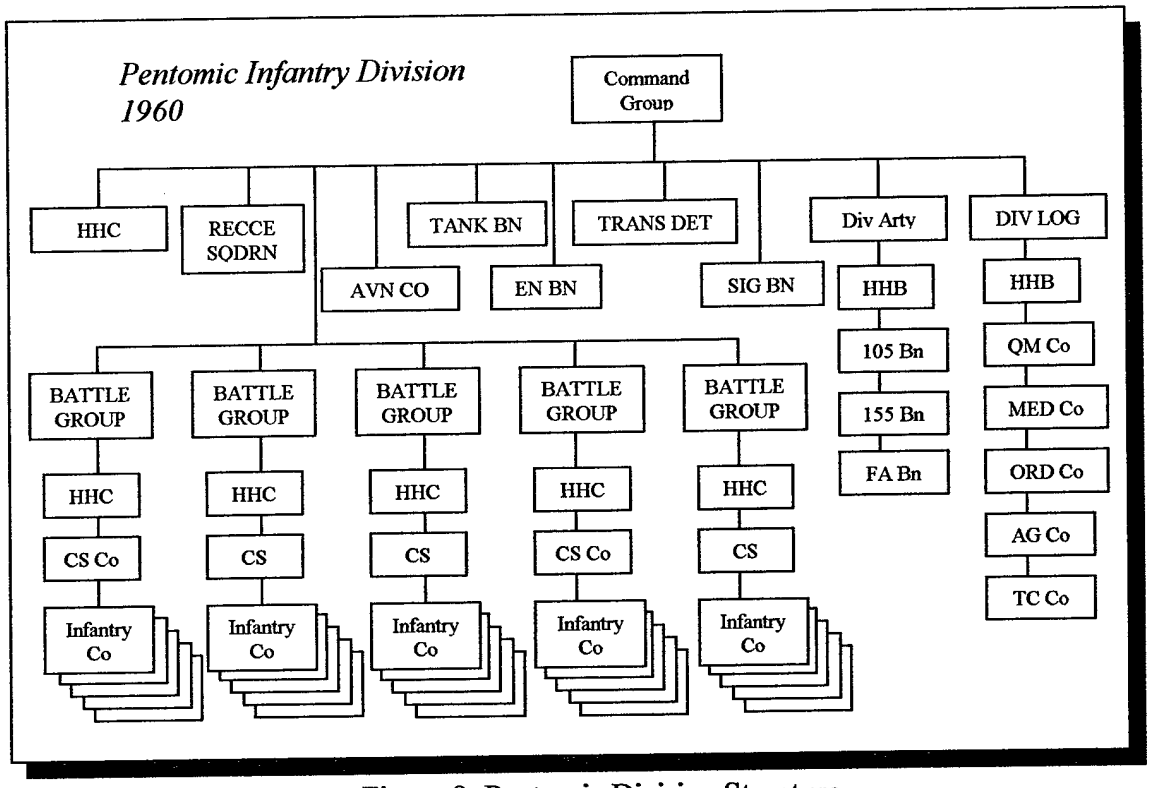

Figure 9. Pentomic Division Structure

The key alteration was the elimination of the brigade echelon and the creation of combined arms "battle groups" consisting of five infantry companies, a mortar battery, and a combat support element (unlike modern combined arms brigades which feature infantry and armor battalions). These battle groups were meant to be self-contained, self-sustaining land combat organizations of four infantry platoons and a weapons platoon

each. The division relied on improved tactical communications to enable the division commander to control the five dispersed groups despite reduced staff and combat service support elements. The centralization of key specialized units allowed the division commander to add one company each of tanks, artillery, and engineers to each battle group.

The overall effort was a failure. This networking of specialized functions of transportation, armor, and aviation retained flexibility for the division commander but destroyed cohesion in the battle groups. This also expanded the span of control of each battle group commander to nine, which proved unworkable with existing communications assets despite the innovation, for an American division, of a full signal battalion. Furthermore, since the transportation and aviation companies at division could only move one battle group at a time, these assets centralized operations because groups without transportation remained oversized, relatively immobile light infantry battalions. Finally, the higher coordination requirements of the organization could not be met with the reduced staff and expanded spans of control at each echelon.

The corps structure in figure 10 is based on the propositions in Colonel Macgregor's *Breaking the Phalanx*.[31] While Macgregor does not put the pieces of his alternative designs together into a corps, this diagram is in line with his organizational descriptions and principles. The most controversial aspect of this design is the lack of division level echelon, which has been replaced by the oversized brigades, here called groups and the corps. This design represents a distribution of specialized functions to each group, each with organic reconnaissance, fires, and support battalions. Furthermore, each group commander is provided with the means to gather information necessary for

decision, and then execute C2 of his three combined arms battalions through the organic command, control, communications, and intelligence (C4I) battalion. Specialized supporting functions such as engineer, rocket artillery, and air defense are centralized at corps, while aviation is collected into a separate maneuver group.

The overall design is balanced in each group, but the organization of the whole sacrifices flexibility due to the prepackaged composition of the groups. The lack of a division level combined-arms structure provides cost savings and decentralized operations at the group level, but this attribute presents C2 issues where the environment is complex and uncertainty high because the selective concentration of assets from across groups would require reorganization. Furthermore, the lack of a division echelon and the relatively high span of control at corps level severely limit the corps headquarters' ability to perform in a joint environment as an ARFOR or JTF headquarters. Despite the criticisms of this "brigadist" approach, the organizational structure and Macgregor's concepts are valuable for spurring debate and rethinking organizational structures within the Army for the new century.

The proposed divisional structure in figure 11 was developed by Brigadier General (Ret) Huba Wass de Czege in October 1999 and presented to CGSC in January 2001.[32] This large division of 12,000 to 13,000 personnel is meant to replace the corps as the "highest tactical combined arms echelon." The division, and its regiments contain organic support structures containing staff, recon, fires, and CSS. This structure of the robust maneuver elements below division makes the overall structure similar to Macgregor's corps except that it is much flatter, enhancing the decentralization of the unit and increasing its ability to deal with rapid change.

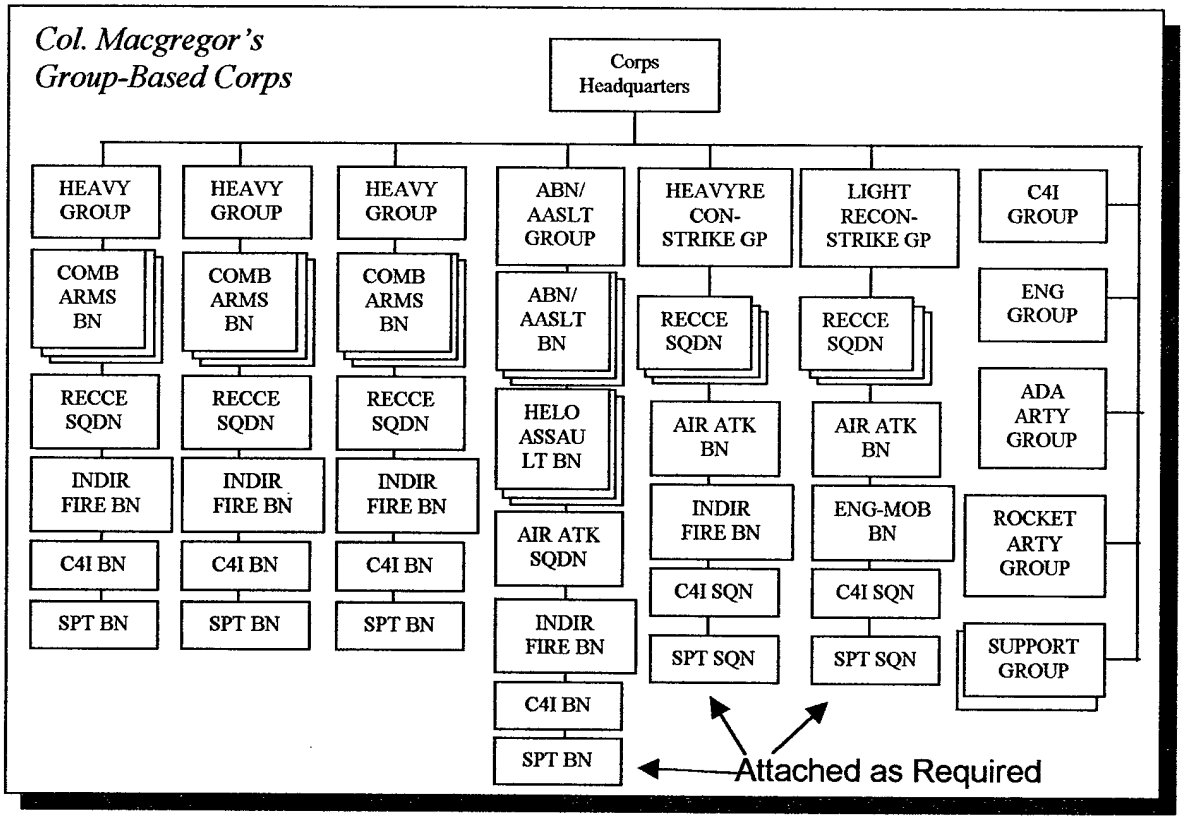

Figure 10. Macgregor's Alternative to Divisions

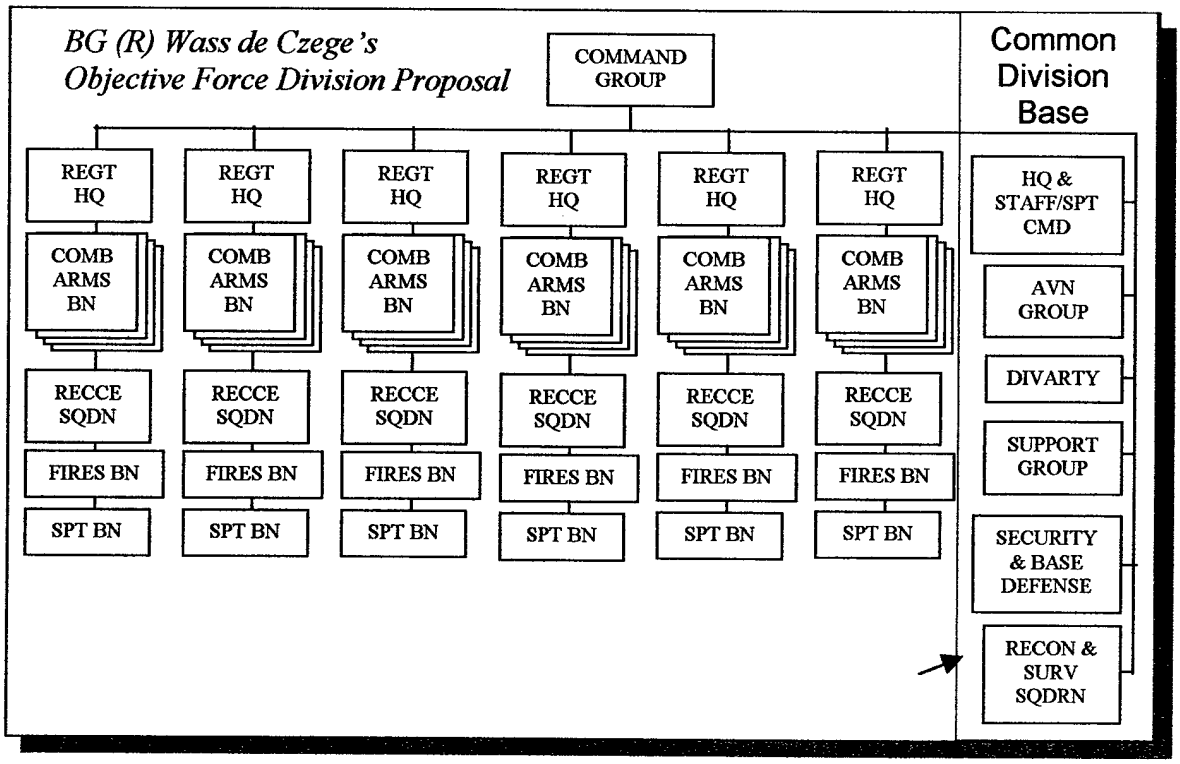

Figure 11. BG Wass de Czege's Division Proposal

The increase in the number of combined-arms regiments, and battalions undoubtedly increases the combat power of the division and enables increased dispersion. Wass de Czege's retention of the specialized units at division level such as aviation and artillery retains a degree of flexibility to create networked packages. However, the increase in spans of control at multiple echelons decreases the stability of the whole organization in complex environments. The lack of dedicated signal and military intelligence units is probably an oversight; yet is weakens the case for information technology being the enabler of the flatter structure. Also, this structure would certainly require special attention to C2 procedures between the division and its regiments to enable the increased span.

In both MacGregor's corps and Wass de Czege's division, organizational theorists would observe that the distribution of previously centralized specialized units such as engineer, NBC, and air defense would decrease in the economies of scale of these functions. This would increase the overall staff requirements to coordinate and control these functions across the maneuver units, which digitization would enable. Soldiers in these specialties would also lose their community of interest with its synergistic advances and a career path. These drawbacks are probably compensated by the fact that lower level echelons, which require the highest degree of cohesion and teamwork, gain greater control of the necessary combined arms functions. Digitization also undoubtedly enhances the ability of lower level leaders to command and control these more robust, combined arms assets.

General Shinseki's The Army's interim division of 17,552 personnel, shown in figure 12, was designed to maximize firepower per pound of tonnage for rapid

deployment into and within a theater of operations. The overall structure of the division level structure does not differ significantly from the Army of Excellence (AOE) division of the 1980s and 1990s. The structure borrows from Force XXI the downsized engineer brigade (here an engineer group with three companies versus three battalions), the lack of an NBC company (now a corps function), and the reduced air defense battalion (now a company), while a mobile gun system battalion for antiarmor has been added.

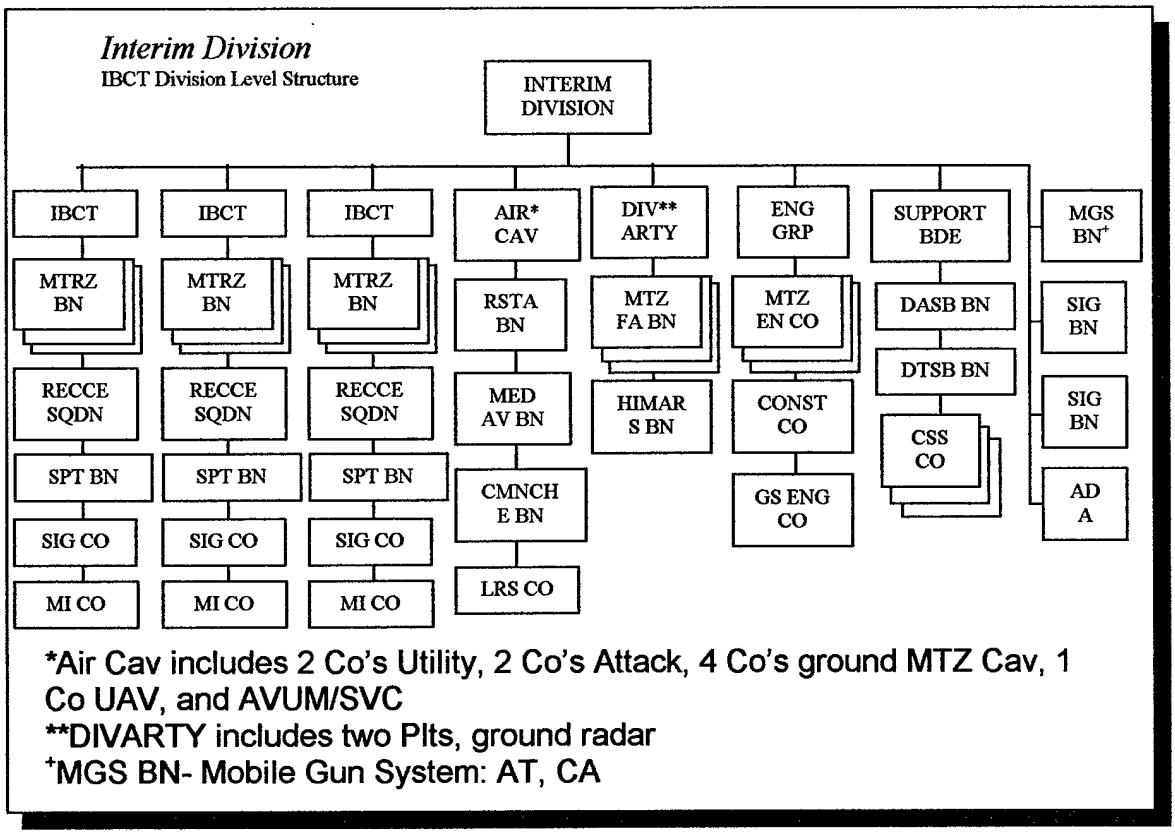

Figure 12. Interim Division Organizational Design

The main change in the division is the enhanced capabilities of the individual maneuver brigades. Each brigade is now more autonomous with organic signal and MI companies and reconnaissance, surveillance, and target acquisition (RSTA) battalions.

This vastly increases the information capabilities of the brigade commanders, which, coupled with prearranged artillery, engineer, and support packages from division, represents a complete shift from division to brigades level as the decisive echelon. While these specialized units are organized primarily to support individual brigades, their centralization at division level retains the economies of scale and division level flexibility in these specializations. Overall, the spans of control across the division and the size of the division have not been radically altered; yet the increase in organic capability enables the individual brigades to operate more effectively and for longer periods than those of the AOE or Force XXI divisions. This combines the best aspects of the MacGregor and Wass de Czege "brigadist" approaches, while retaining positive aspects of the division echelon.

The version of the First Digitized Corps structure in figure 13[33] was originally designed to act as a sustaining and C2 capability for digitized divisions, as well as a JTF headquarters. The numbers below each unit in the diagram correspond to the green portions of the force structure, representing the reserve component percentages of each element. Organizationally, the structure is heavy in personnel and equipment; yet it is meant to provide "plug in" capabilities to the division or JTF. As such, it is highly networked in operations. The relatively large percentages of reserve component participation signals that the unit would take a long time to prepare and deploy, and that its internal cohesion would be suspect at multiple levels. However, being a fairly high echelon, cohesion is less of a factor than at lower levels. If it were ever employed as shown, the digitized corps would include over fourteen specialized functional subordinate units (brigades and groups) in support of the two subordinate maneuver divisions,

implying an unprecedented tooth to tail ratio, highly centralized support, and an unworkable span of control. The coordination and control requirements, coupled with the challenges of providing C2 of joint, combined, and allied forces (with the potential for added governmental and nongovernmental elements) would certainly strain the C2 capacities of the command group in its JTF headquarters mission. Digitization tools would assist in this effort; however, since many of these are Army-specific, their utility would be limited in the joint environment.

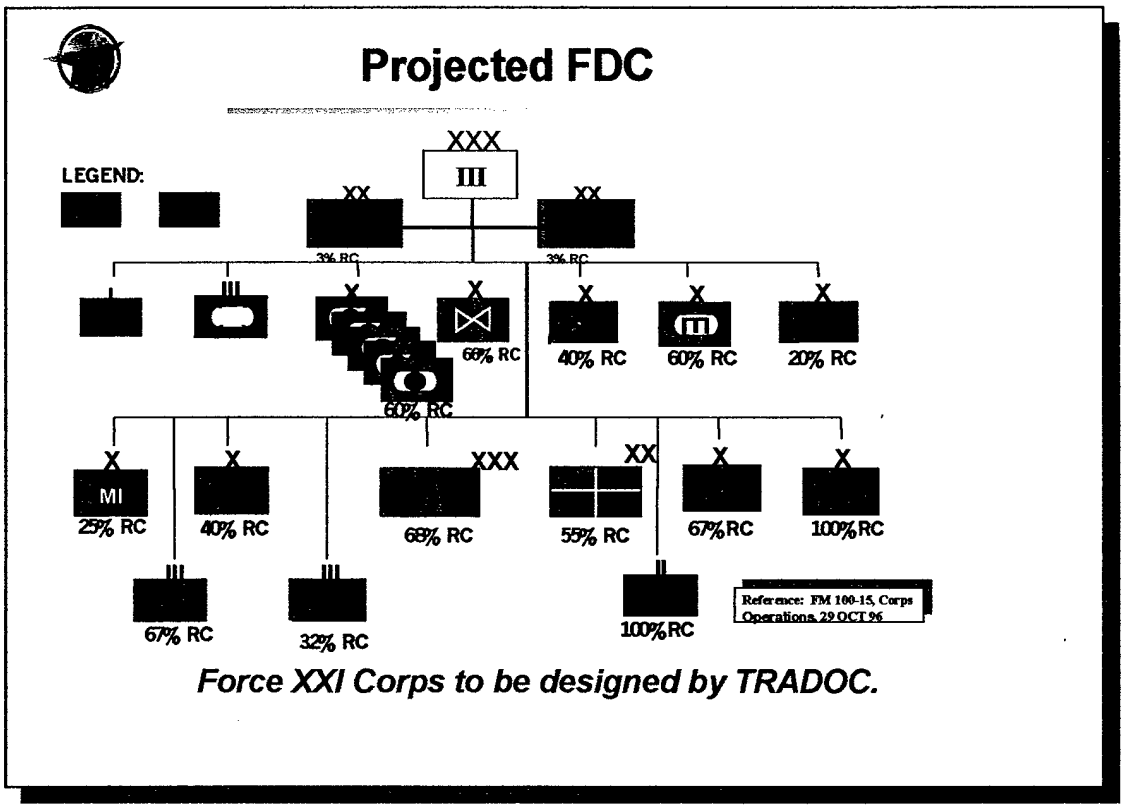

Figure 13. First Digitized Corps Organizational Design

Conclusions

> The Army, for its part, needs to recognize that the benefits of changes in technology cannot be fully realized until they are incorporated into new organizational forms, and that organizational innovation is as important as innovation in weapons systems.[34]
>
> Fukuyama and Shulsky, *The "Virtual Corporation" and Army Organization*

The major trends in commercial organizing in the digital age have the effect of incorporating degrees of flattening, networking, and matrixing within the existing hierarchical structure of the basic organization. The military has long used aspects of these alternative structures to improve efficiency and effectiveness through staffs, task-organization, and joint task forces. What is new is the effort to increase the span of control and decentralization through the injection of information technology. Undoubtedly, increased leader and soldier sophistication enables units to deal more effectively with a more complex environment with vastly increased information flows. While the increase in battlefield complexity may prevent the reduction of the vertical hierarchy, the addition of subordinate units per headquarters is possible by allowing these soldiers to assume a greater role in the information flow.

The organizational aspects of digitization are central considerations which have received limited attention in the movement to Force XXI. Organizational structures, based in part on affordability and tradition, do not assure optimum effectiveness in the fog of future conflict. While historical examples show that the distribution of information was a major factor in how armies were organized, digitization provides ubiquitous information through the common operational picture. Force XXI adds capability to brigades, but the advertised "flattening" and decentralization is not reflected

in the existing structure with its smaller span of control at lower echelons and reliance on division level specialized support units rather than brigade combat teams with organic capabilities for autonomous operations.

While modern C2 systems such as digitization alleviate the complexity challenge in synchronization, they do require an increase in the IT staff to ensure availability and maximum utility of the new IT systems. The movement of specialized units from division to brigade level also increases staff requirements and the matrixed nature of the organization. This rise of staffs versus separate, specialized units further implies an increased span within the hierarchy of the staff, requiring readjustment to ensure effectiveness and efficiency. The example of the commercial CIO is the most glaring organizational oversight in military organizations and models of the future.

A relevant question in changing organizational structure away from the current heavy Army of Excellence division is the amount of risk to assume in high intensity, Desert Storm-type operations. If digitization increases the ability of the organization to work through complexity, the devolution of assets to brigade level is advisable to ensure the optimally cohesive organization for the majority of operations across the spectrum of conflict. Like most of the proposed division structure proposals of recent years, the IBCT moves the relevant echelon of decision from division to brigade, thereby increasing decentralization. Conversely, Force XXI concentrates on high echelon combat operations which reduces risk in the long run, but increases it in the short run, especially when the Army has a need to demonstrate its value to the political and public "consumers" of the unique capabilities of a dominant ground force.

The question of centralization versus decentralization in Force XXI is one of complexity and uncertainty. Because digitization reduces the overall level of uncertainty, it reduces some friction among unit echelons and between supporting and supported units. The question is how far down the hierarchy to decentralize by providing that echelon the information and assets to act. If history is an indication, the brigade echelon will continue to be the key organization for the majority of operations for the foreseeable future.

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[1]Brigadier General Huba Wass de Czege, "Optimizing Future Battle Command Technologies," *Military Review* 78, no. 2 (March-April 1998); available from http://www-cgsc.army.mil/milrev/ English/MarApr98/; internet; accessed on 17 February 2001.

[2]Henri Fayol, *General and Industrial Management.* trans. Constance Storrs (London: Sir Isaac Pitman and Sons, 1949), 132.

[3]Henry Mintzberg and James Brian Quinn, *Readings in the Strategy Process* (Upper Saddle River, New Jersey: Prentice-Hall, Inc., 1998), 162-3.

[4]Clausewitz, *On War,* 119.

[5]Ibid., 153.

[6]Ibid., 111.

[7]Frances Hesselbein, Marshall Goldsmith, and Richard Beckhard, "How Generational Shifts Will Transform Organizational Life," in *The Organization of the Future*, ed. Jay A. Conger (San Francisco, California: Jossey-Bass Publishers, 1997), 23.

[8]Colonel Douglas A. Macgregor, *Breaking the Phalanx: A Design for Landpower in the 21st Century* (Westport, Connecticut: Praeger Publishers, 1997), 23.

[9]General William W. Hartzog, "Building the 21st-Century Heavy Division," *Military Review* 78, no. 2 (March-April 1998); available from http://www-cgsc.army.mil/milrev/English/MarApr98/hartzog.html; internet; accessed on 15 January 2001.

[10]Lyndall F. Urwick, *The Pattern of Management* (Minneapolis, Minnesota: University of Minnesota Press, 1956), 59.

[11]Luther Gulick, *Administrative Reflections from World War II* (Birmingham, Alabama: University of Alabama Press, 1948), *x*.

[12]Ibid., 102.

[13]Ibid., 103.

[14]Ibid., 294.

[15]Ibid., 295.

[16]Clausewitz, *On War,* 294.

[17]Ibid., 293.

[18]Department of the Army, Field Manual 101-5 *Staff Organization and Operations* (Washington, D.C.: Department of the Army, 1997), 5-14.

[19]Marine Corps Doctrinal Publication 6, *Command and Control* (Washington, D.C.: Headquarters, U.S. Marine Corps, 1996), 91.

[20]S. L. A. Marshall, *Men Against Fire, The Problem of Battle Command in Future War* (Alexandria, VA: Byrrd Enterprises, 1947), 128.

[21]Francis Fukuyama and Abram N. Shulsky, *The "Virtual Corporation" and Army Organization.* (Santa Monica, California: RAND, Arroyo Center, 1997), 19. Table 1 "Centralization/Decentralization" also derived from this RAND work.

[22]Frank M. Snyder, *Command and Control, The Literature and Commentaries* (Washington, D.C.: National Defense University Press, 1993), 49.

[23]Ibid., 46.

[24]Hartzog, "Building the 21st-Century Heavy Division."

[25]Ibid.

[26]Colonel John J. Twohig, Major Thomas J. Stokowski, and Major Bienvenido Rivera. "Structuring Division XXI," *Military Review* 78, no. 3 (May-June 1998); available from http://www-cgsc.army.mil/milrev/English/MayJun98/; internet; accessed on 15 December 2001.

[27]Bill Murray, "Army Delays Logistics Rollout." *Government Computer News* vol. 9 no. 24 (Aug 2000) 1.

[28]Training and Doctrine Command Pamphlet 525-5, *Force XXI Operations* (Fort Monroe, Virginia: TRADOC, 1994) Chapter 3; available from http://www.monroe.army.mil/tpubs/pams/p525-toc.htm; internet; accessed on 15 March 2001.

[29]Ibid.

[30]Marshall, *Men Against Fire*, 189.

[31]Macgregor, *Breaking the Phalanx*, 53.

[32]Brigadier General Huba Wass de Czege, "New Paradigm Tactics" (presentation to the U.S. Army Command and General Staff College, Class A308, Fort Leavenworth, Kansas, January 2001); available from http://www.cgsc.army.mil/a308/PDFs/NP%20 Tactics8.pdf; internet; accessed on 12 February 2001.

[33]Army Digitization Office, "Force XXI Overview" (presentation, 1998). available from http://www.ado.army.mil/BrfsDocs/docs/ata/Default.htm, Internet.

[34]Fukuyama and Shulsky, *The "Virtual Corporation" and Army Organization,* 81.

PART III: COMMAND AND CONTROL PROCEDURES

> Hierarchy and structure in an organization should not be confused with process. Processes are the means by which organizations act to accomplish a task. It is possible, therefore, to have a well-structured organization that is highly agile because of the processes used. One great value of such a *flatter* organization is its increased versatility.[1]
>
> TRADOC Pam 525-5, *Force XXI Operations*

While the quote above incorrectly attributes versatility to flatter (versus networked) hierarchies, it does point out the importance and impact of "processes" or C2 procedures. These procedures are the rules and norms by which the parts of the organization interact in operational situations. These may be called policies, doctrine, orders, regulations, or, more commonly, tactics, techniques, and procedures (TTP). They serve to frame the standard reactions of organizations internally, and to the constantly to changing circumstances of their environment.

This chapter explores the procedures by which Army units interact with each other and their environment which enable, standardize, and enhance the process of command and control. Procedures are important factors in the design of any C2 system because they frame the flow of information through the organization with the commander and his decision as the focus of effort. They also determine the means, format, and method by which that decision to be put into action across the unit. The individual C2 procedures, such as reporting procedures and orders formats, compliment and reflect the C2 organization in its drive to reduce overall uncertainty and enhance synchronization in planning and operations.

Command and Control Models

Command and control models, while wildly simplistic, assist in understanding some of the base impetuses and movements in the processes of C2. In their most basic form, command and control systems enable the commander's decision and its execution. This dual nature of C2 in operations allows the closer examination of how C2 procedures affect and enable decisions and execution. Like any system, C2 systems have inputs, processes, and outputs. Inputs to the decision include higher level orders and guidance, external intelligence and coordinating information, and internal unit status reports. The decision process itself relies on continuous and accurate input, and is reached by means of staff analysis and the commander's judgment and experience. The outputs are created to enact the decision on the battlefield and can include the orders, direction, and any other pointed guidance such as commander's intent and unit boundaries. The C2 procedures are the rules and measures adopted to ensure the optimum flow of all the involved types of information and direction.

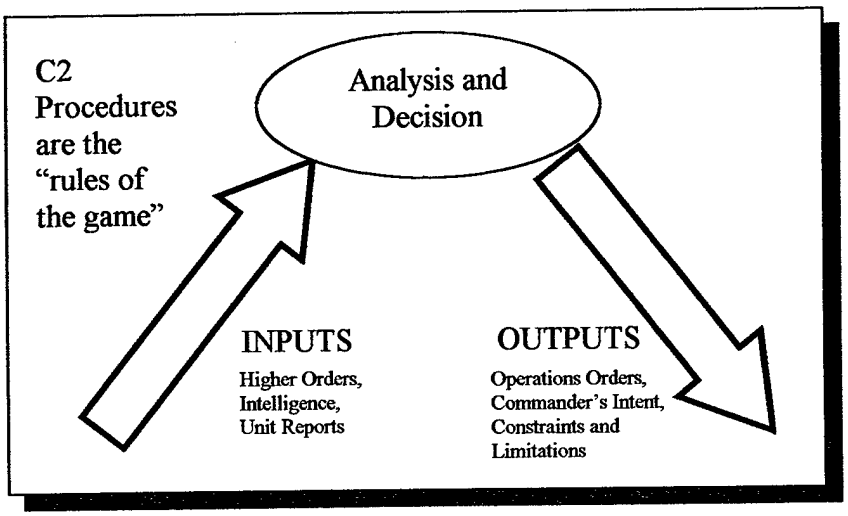

Figure 14. Command and Control System

This simplistic model in figure 14 represents only the basics of command and control. More intricate models are used to describe how the command and control process fits into the larger context of unit planning and operation. Two of the most prominent of these currently are the OODA loop which elucidates the planning process and how decision making occurs, and the Plan-Prepare-Execute model which focuses on a unit's movement to action.

The OODA Loop

The Observe-Orient-Decide-Act (OODA) loop is the most common model of decision cycles used in worldwide. The U.S. joint force community as well as the U.S. Marine Corps and Air Force have adopted it as the basic model for decisions, as have many foreign militaries, many of them U.S. allies, have likewise adopted the OODA model. Developed by a former Air Force fighter pilot and Pentagon analyst, Colonel "Genghis John" Boyd, the OODA loop has changed how leaders view decision making in the competitive environment of combat.

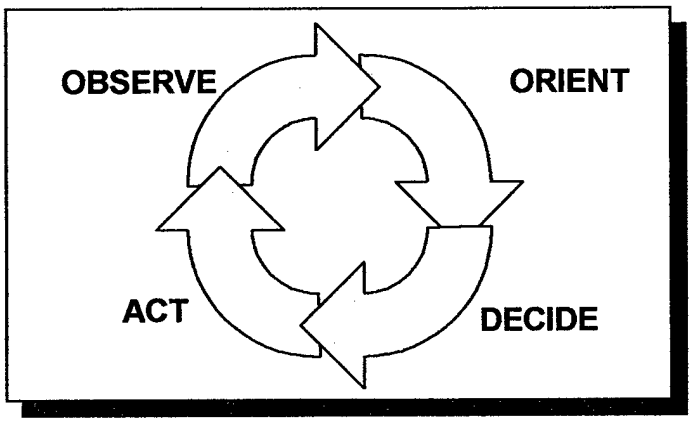

Figure 15. The OODA Loop

The parts of the OODA loop follow a natural, progressive, and interrelated pattern which reflects how individuals and organizations arrive at decisions. In the context of military operations, the "observe" step represents all sensor and intelligence input data as well as friendly force information. The "orient" step makes sense of these data in relation to each other and the situation and begins the formation of the visualization in the mind of the commander. The 'decide" step develops and considers the available courses of action and chooses one. The "act" step involves direction, movement, and execution.

One reason why the OODA loop or cycle has become ubiquitous is because it approximates the natural rhythm of a military decision at every level, whether it is a deliberate MDMP cycle engaged in by the entire staff, or an instantaneously reached, intuitive command decision reached in the heat of battle. For instance, the OODA loop is analogous to the military decision-making process in its mission analysis step (observe), course of action development and war gaming (orient), and course of action selection (decide) and orders production (act). On a smaller scale, an individual commander might see some new development on the battlefield (observe), consider it in the context of his existing visualization (orient), make a decision (decide) and communicate it (Act) all nearly instantaneously.

The OODA loop; however, is widely misunderstood because it was originally derived from the context of single pilot aerial combat. The original title: "A Discourse on Winning and Losing,"[2] reflected the model's emphasis on the psychology behind decision making regardless of service, size, echelon or number of participants. The key to the model is the orient step where the actor makes sense of the outside world. This is done by the necessary destruction of an existing worldview based on observed input

sensory data. This destruction of followed in the orient step by the creation of a new worldview or visualization upon which to base a decision. Since this requires accurate inputs and time to create the necessary orientation, "getting inside" an enemy's decision cycle is the conscious manipulation of this process with an aim of ensuring a faulty orientation (which results in a faulty decision), or providing conflicting or massive amounts of input ensuring that the adversary never achieves a coherent orientation (strategic paralysis) and thus no decision. This paralysis, sometimes called dislocation, echoes Clausewitz's contention that imperfect knowledge of the situation would bring an army to a standstill.[3]

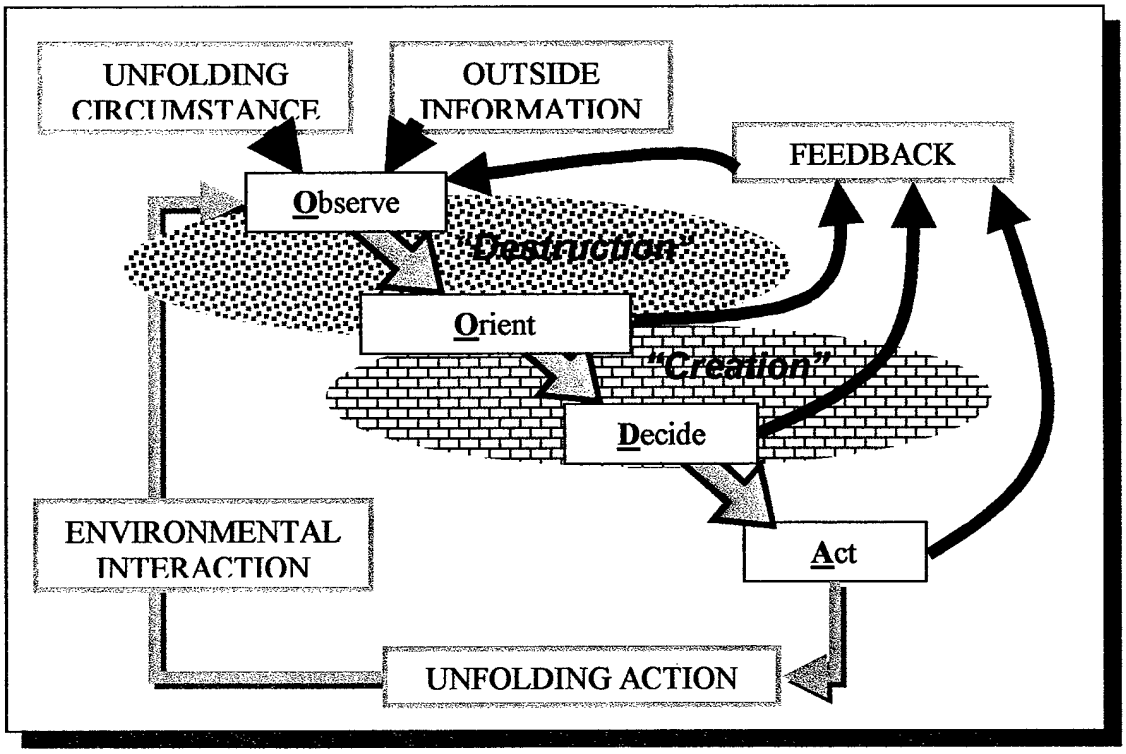

Figure 16: Boyd's Destruction and Creation

The key environmental variable which the OODA loop concentrates on is time. Boyd spoke of a "competition in time" where the side which moved faster through the cycle would automatically create paralysis on the other side through the control of the operational tempo of the conflict. Most often, this would occur through multiple, rapid, and observed actions which constantly change the inputs or observations of the adversary.

Assess-Plan-Prepare-Execute

The Army eschewed use of the OODA loop in favor of the Assess-Plan-Prepare-Execute (PPE), shown in figure 17, operations process which is a more detailed and broader model. Rather than focus on the commander's arrival at a decision, PPE is concerned with how a unit moves to action.[4] The basic PPE cycle, like the OODA loop, follows a logical sequence, is continuous, and occurs at many levels simultaneously within an organization. The first step, "Plan," includes troop leading procedures and the entire MDMP. "Prepare" includes all unit activities which involve battle preparation such as reconnaissance, plan revision, precombat checks, rehearsals, and movement. "Execute" includes the employment and direction of forces. Assessments at each phase provide feedback on the progress and effectiveness of each step, as well as an update of the situational understanding of the commander. Battle command in the model standardizes, controls, and adjusts the operations process through command inputs at each step.

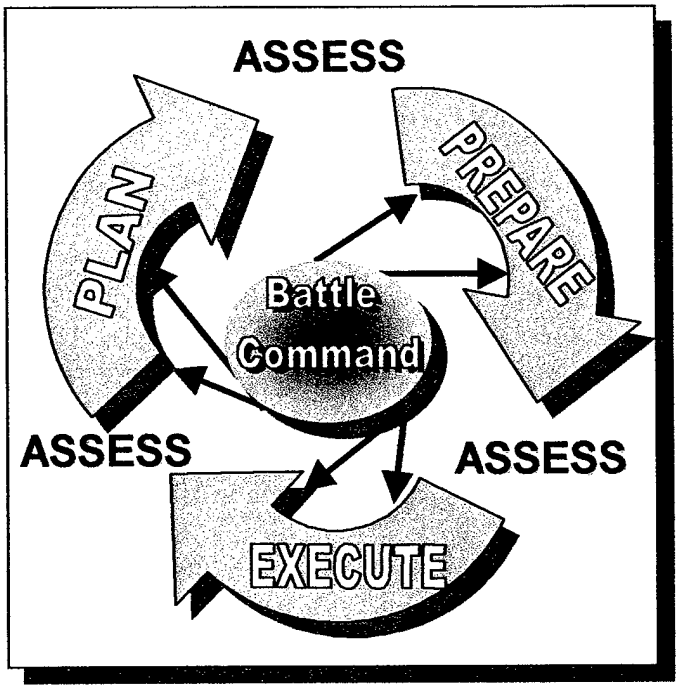

Figure 17. Plan-Prepare-Execute-Assess Cycle

This model was specifically designed for Army operations with MDMP and Army battle command specific issues related to each step. Battle command, as the place where the commander forms and maintains his visualization, also replaces the OODA loop's emphasis on the critical Orient step. Where Boyd's model might focus on a commander looking at a COP on a screen and creating a new visualization of the operation, PPE considers this an interaction between Battle Command and the Plan step.

C2 Procedures in Planning

In the planning phase of any operation the purpose of information inputs is to enable a visualization and decision by the commander. This initial decision-making process is the central procedure in how units are commanded and controlled because it

sets the parameters (limitations and constraints for instance) and establishes subprocesses for command and control in future execution. The MDMP process is the basic framework for how Army units gather the information inputs, create situational awareness and understanding, and execute operations.

MDMP C2 Procedures

The Army's current version of the MDMP has evolved over the last century to form the basic, Army-approved process by which a commander assesses the situation and reaches a decision. The original decision-making process began as the "Estimate of the Situation" prior to World War I. After World War II a more formal, rules-based process has continued to evolve. By the 1984 publication of FM 101-5 *Staff Organization and Operations,* the MDMP was the standard method used by commanders and staffs to arrive at and execute tactical decisions. This version outlined a process whereby the staff analyzed the mission, produced estimates, developed a course of action (COA), and produced an order based on the commander's guidance and decision. The process was prescribed as a guide because "time available, urgency of the situation, and the judgment of the commander all affect the application of this logical approach to decision making."[5]

In the 1997 version of FM 101-5, the MDMP (table 2) had grown considerably, adding the consideration of, and additional steps relating to risk assessment, commander's critical information requirements (CCIR), war gaming, combat power comparisons, decisive points, and targeting to become the "single, established, and proven analytical process. . . . the full MDMP is a detailed, deliberate, sequential, and time-consuming process used when adequate planning time and sufficient staff support are available."[6] The MDMP is now more than steps, it is a framework and mental

Table 2. The Military Decision-Making Process

Receipt of Mission	Commander's Initial Guidance (12 tasks) Issue WARNORD
Mission Analysis 17 Steps:	Analyze Higher's Order (7 tasks) Initial IPB (6 steps) Determine Specified and Implied Tasks (6 tasks) Review Assets (6 tasks) Determine Constraints Identify Facts and Assumptions (5 tasks) Risk Assessment (2 tasks) Determine CCIR (4 tasks) Determine Recon Annex (12 tasks) Plan Use of Time (3 tasks) Restated Mission Conduct Mission Analysis Briefing Approve Restated Mission Develop Commander's Intent (2 tasks) Issue Commander's Planning Guidance (14 tasks) WARNORD 2 (3 tasks) Review Facts and Assumptions (2 tasks)
COA Development 6 Steps:	Analyze Relative Combat Power (7 tasks) Generate Options (5 tasks) Array Initial Forces (6 tasks) Develop Scheme of Maneuver (20 tasks) Assign Headquarters Prep COA Statements and Sketches (2 tasks)
COA Analysis 8 Steps:	Gather the Tools (3 tasks) List All Friendly Forces List Assumptions List Critical Events and Decisive Points (3 Determine Evaluation Criteria Select the War Game Method Select a Method to Record and Display War Game and Assess (36 tasks)
COA Comparison	Compare COA (5 tasks)
COA Approval	Approved COA (7 tasks)
Orders Production	Refined Commander's Intent High Payoff Target List Issue OPLAN/OPORD

Total Number of Major Steps: 8. Total Number of Minor Steps: 39. Total Number of Tasks: 213. Total Number of Tasks for Three COAs Considered: 369 (156 COA-specific tasks.

process for all decision making and problem solving encapsulated in the observe, orient, and decide steps of the OODA loop, and the assess and plan aspects of PPE model.

The MDMP is a key to C2 because it involves numerous and varied command and control procedures which frame how commanders arrive at decisions and put them into action. There are four major, direct C2 procedures embedded in the MDMP. IPB as the engine of situational awareness establishes how and what is observed as input to the process. CCIR is the primary information management instrument for a commander which establishes priorities for inputs subsequent to IPB. Commander's intent is the description of a commander's vision and is used to delineate the degree of decentralization between the units and echelons. Formal orders, overlays, and matrixes such as the warning and operations orders are specific methods of directing not only execution; they delimit the C2 between commanders at each echelon through specified tasks and constraints. The only major planning C2 procedure not directly impacted by the MDMP is standard reporting, which is constrained by unit SOPs and communications means.

Yet the MDMP in general, and its nested C2 procedures in particular, has been under fire for being too cumbersome and time-consuming. In its review of *Battalion-Level Command and Control at the National Training Center*, RAND's John Grossman noted, "C2 problems crop up so frequently that they appear to be systemic."[7] The Army Research Institute (ARI) conducted an in depth analysis of the effects of digitization on the MDMP.[8] This study reiterated numerous previous findings of Army-sponsored studies and NTC reports which found that the doctrinal MDMP is too cumbersome, too inflexible, and too time-consuming, often resulting in inadequate plans and orders.

Most, but not all of the noted "C2 problems" noted in these and other reports were directly related to a lack of time for the doctrinal completion of the MDMP.

The Army recognizes that the completion of all the MDMP steps in a time-constrained environment is often not possible and has provided a doctrinally approved alternative in FM 101-5.[9] The doctrinal time period for an MDMP process is twenty hours, while this is tempered by the stipulation that units consume only one-thirds to one-fifth of available time in their planning process in order to ensure that subordinate units have adequate time to conduct their own planning process. In altered versions of the MDMP, commanders are provided with five options for reaching a more timely decision: increasing the involvement of the commander in the MDMP, increasing the detail provided in the commander's guidance, developing fewer COAs, reducing the amount of detail and coordination in the OPORD, and reducing the flexibility and latitude in the staff's work.

In the time-constrained environment of the NTC, commanders typically assess time as a part of their initial METT-TC analysis and find that they should utilize a time-constrained version of the MDMP. The units in the ARI studies averaged sixteen hours for the completion of their version of the shortened MDMP yet the study concluded that "a decision-making process was needed that could be completed in six hours or less."[10] In COA development, "The task force commander and S3 generate most of the plan, which, without staff input, tends not to give full consideration to all information and battlefield operating systems."[11] The study also noted that the IPB was frequently late, incomplete, or unused. The immediate result of these issues included weak COA analysis, inflexible plans, and wargaming during the unit rehearsal. In other words,

despite the attempt to conserve time, these commanders and staffs failed in their attempt to effectively plan an operation.

A recurring effect of these time-management problems was that the units observed typically did not analyze information received and apply it to battle preparation. In terms of Boyd's OODA loop, these units experienced some paralysis in the orientation step due to faulty or excessive input, causing an incomplete or faulty orientation. The evaluators realized the information management nature of the problem while the units reported only a lack of time. Obviously, an excess of on-hand information relative to the time available to process and use it causes information overload and contributes to uncertainty, resulting in a reduction in potential synchronization and effectiveness of operation.

Intelligence Preparation of the Battlefield

IPB is critical to C2 because it is the step of the MDMP where the commander and his staff begin to develop a common situational understanding. The collective review of the environmental and enemy considerations provides an appreciation of the situation, with the key result being the identification of the "decision points" on the battlefield. Since the IPB attempts to weave together all relevant known facts concerning an adversary and the environment, it also frames the subsequent information inputs for these situational issues. These subsequent C2 inputs are normally managed through the development of commander-approved Priority Intelligence Requirements (PIR).

"The IPB is the commander's and each staff officer's responsibility; the G2 (S2) does not do the entire IPB himself. Staff officers must assist the G2 (S2) in developing the situation template (SITEMP) within their own areas of expertise."[12] The situation

template is a graphic depiction of enemy and environmental factors in an area of operations. It leads to an event template which projects potential enemy courses of action. The event template, in turn, is the primary input to a decision support template (DST) which identified for the commander each of the branches and sequels possible at any given point in an operation. The staff inputs BOS-specific measures to the DST to create a decision support matrix (DSM), which provides a synchronization tool for executing branches and sequels.

While doctrine constrains the entire staff to participate in the IPB, beginning with the situation template, most staffs observed at the NTC left the IPB to the intelligence section with staffs generally providing input to the DST and DSM. In the hectic planning process of a battalion or brigade staff headquarters, this is predictable because each staff section has a set of planning processes it must complete for individual BOS estimates of the situation. Furthermore, the IPB was initially developed at a time when a paucity of information compelled the intelligence producing elements of staffs to provide as much input, in the forms of information and intelligence as possible. With the addition of greatly enhanced collectors, information overload in the IPB process is exacerbated.

The inputs to the IPB are not predictable because they vary with the situation, yet the key output of the DST requires staff input and is an essential C2 tool throughout the operation. The decision support matrix, based on the decision points developed in the IPB, provides the commander with a handy guide for branches and sequels to the operation. This graphically-oriented guide, coupled with the synchronization matrix, enables the reader to comprehend how the commander anticipates the unit may have to alter its course of action and apply its available combat power in a variety of potential

scenarios. As such, the DSM offers flexibility, based on the CCIR, to a single COA and it forms the framework for fragmentary orders. This C2 tool is often not produced if the IPB process is not completed in the available time or if staff input to the DSM is not forthcoming.

The battlespace itself is expanding into areas which the traditional IPB process does not consider. The expanded battlespace of a digitized division further anticipates nonphysical and other nontraditional dimensions such as urban areas, local populace, allied sentiments, cyberspace, and the electronic spectrum. The need to incorporate products which describe more clearly these dimensions suggests a need for an updated, more flexible, less time intensive IPB.

The results of study and analysis in AWEs and by RAND at the NTC and JRTC suggest the IPB may be altered with minimal impact on the common situational understanding as a result of new, enhanced C2 systems. Indeed, most units in the studies voided doctrine by shortening the IPB to various degrees, including ignoring it altogether. The promises of more relevant intelligence availability through the use of enhanced sensors such as unmanned aerial vehicles (UAVs) and improved information management systems in particular offer the basic tools to update this procedure for enhanced mission accomplishment through increased speed, accuracy, dissemination, and utility. New IPB tools incorporated into digitized systems enable the intelligence officer and his or her staff to more rapidly and fully develop IPB products, calling on other staff members only when their input is necessary. New C2 systems also promise faster creation of focused, easy to digest intelligence products which can be transmitted across dispersed battlespaces.

Since the IPB focuses on the most likely (and most dangerous) enemy course of action it limits the initial actions of the commander through the COAs which address this single enemy COA, which itself is developed at the point in the overall operation where uncertainty is greatest. With greater awareness of the initial enemy situation through JSTARS and UAVs, a future the IPB will likely be derived from a set of updated enemy COAs. This would provide more flexibility through a reduced emphasis on a single enemy COA. Instead, the decision support template could become the central, graphic plan with multiple responses to a wider array of potential enemy moves. The keys will be to ask the right questions, share the right picture, and look at the right indicators of enemy forces on the developing battlefield rather than a static assumption based on one potential enemy course of action, developed in a relative vacuum.

Commander's Critical Information Requirements

The CCIR remains the primary method of addressing the current problem of information overload caused by traditional MDMP processes because it is the primary information management tool of the commander. CCIR, derived from IPB and other MDMP facts and assumptions, "are elements of information required by commanders that directly affect decision making and dictate the successful execution of military operations."[13]

CCIR are usually limited to ten items of information and are categorized into three parts, the PIR, FFIR, and EEFI. Briefly, PIR are the commander's intelligence requirements about the enemy, FFIR is information about friendly information needed by the commander, and EEFI consists of information about friendly information which would benefit the enemy and therefore should be guarded.

The new Field Manual 6-0 (draft) updates the concept of CCIR for future operations by incorporating it into the process of achieving situational understanding of the environment. Specifically, "the commander's intent, his guidance, and his CCIR all serve to guide and focus the C2 system to support his decision making and communicate his decision for execution."[14] In this way the CCIR is a critical link between the commander's visualization of the situation and his implementation of that vision because it focuses the entire information input set of procedures of the unit.

The FM 6-0 promulgation of battlefield visualization also adds to the scope of commander's information requirements. "Determining critical information requirements requires focus on three aspects of the commander's vision." These are, "the state of friendly and enemy forces," "the ability to clearly discern a desired end state," and "the ability to see and understand the dynamic relationship between opposing forces through the sequence of activity from current situation to friendly end state."[15]

FM 6-0 may not go far enough however, because the information management requirements of a unit are more intricate than simply developing between ten and thirty PIR, EEFI, and FFIR. While the intelligence personnel are adept at managing their PIR, there exists no doctrinal guidance or specifics on prioritizing, reporting, or disseminating CCIR. There is no doctrine on how to present the CCIR to the commander, or how widely to distribute them. CCIR are certain to change as the situation evolves, yet there is no doctrinal procedure or guidance to update the CCIR in the MDMP as the commander's information needs evolve and requirements are found and individual CCIR become moot. Furthermore, EEFI are not prioritized and not linked to specific targets or protecting friendly information.

The CCIR are the informational decision points by which an operation may hinge; yet doctrine provides no central, responsible element in an operation to actively attend to these information lists as "commanders develop them personally."[16] The assignment of the primary information management tool in an organization to the commander limits their effectiveness as information management is subordinated to more pressing command matters.

The new concept of relevant information (RI) was devised to assist in the overall information management effort of Army units. RI is defined as "all information of importance to commanders and staffs in the exercise of C2."[17] Generic information gains the description of "relevant" if it is "accurate, timely, usable, and precise." This optimistic description of what is essentially the basis for situational understanding adds no illumination on the issue of battlefield information management. With all the information pouring into and out of a TOC, especially with digitized systems, the determination of what is relevant is clearly a process unto itself. Using the twenty or so PIR and FFIR items of information which support the commander and not necessarily the staff (which has its own valid information requirements) is completely inadequate.

Commercial organizations and corporations have long known that dedicated information and information systems managers, usually the Chief Information Officer (CIO), are essential elements of an overall information management plan. The development and direct management of an information control plan, based on command and staff priorities and requirements, helps create the factors for success by satisfying the information needs of the organization as a whole, starting with the commander or leader

and addressing information needs and priorities of the staff and subordinate commanders in order.

Commander's Intent

The commander's intent is a key element of C2 in any operation, not only because it is the ultimate no communications contingency, but because it is an attempt to portray the commander's visualization of an operation. It also affords the commander the opportunity to specify the degree of latitude under which subordinates will operate. The commander's intent, doctrinally clearly and concisely frames the key tasks and end state within which subordinates may exercise initiative. In this way the intent encapsulates the overall direction, focus, and tempo of an operation based on the commander's visualization of it. It is also critical to smooth operations because it is the primary guideline for decision making by subordinates when the commander is not available.

There is a renewed emphasis on commander's intent beyond the traditional end state and key tasks. Recent empirical evidence suggests that commanders in digital environments are finding this C2 tool is increasingly important when the operational tempo and subordinate latitude increase by orders of magnitude. According to one commander participating in the digitized Division AWE "Commander's intent--the central theme--became an even more critical operational foundation for their actions."[18] where "their" actions refers to all commanders at every echelon within the division.

New doctrine in FM 3-0 and FM 6-0 provide additional context and guidance on the uses of the intent but the first, long overdue, example of intent. These new manuals also reconcile the disparities between the current definitions of commander's intent with regards to risk and center of gravity. Yet the description of the intent as how

commanders express their vision may be too vague to enable subordinate latitude along the lines of von Moltke's *Absicht*.[19] This is because a vision, depending on personal judgment and experience, can never be accurately captured and written down. Furthermore, too much constricting detail in a description of a commander's vision in intent may unintentionally limit the latitude and initiative of subordinates. Therefore, the provision of key tasks, when they include specific missions such as "seize," "destroy," and "defeat," may be too descriptive in an intent, if that intent attempts to provide an end state and a series of conditions leading to that state, rather than a specific course of action.

Combat Orders

Combat orders are the basis for all command and control during and through execution. The C2 procedures in the MDMP provide for producing two warning orders and the commander's planning guidance to enable parallel planning and speed the orders construction process at multiple echelons. The end product of the MDMP is the detailed operations order which contains "directives a commander issues to subordinate commanders to coordinate the execution of an operation." Also,

> Plans and orders are the means by which the commander expresses to his subordinates his battlefield visualization, intent, and decisions, focusing on the results a commander expects to achieve--his vision of the end state of an operation [the proliferation of visualization beyond intent]. . . . Plans and orders should provide the *what* rather than the *how* to encourage initiative . . . the amount of detail the commander provides in a plan or order depends [notes and emphasis mine].[20]

Constructing and issuing plans and orders, therefore, are the primary C2 procedures in operations. In strict terms of C4I, and the operations order, "command" is included in the mission, intent, and COA; "control" is contained in the task organization,

specified tasks, constraints, limitations, and overlays; "intelligence" comprises paragraph two. "Computers" as part of C4I, are actually nothing more than equipment and therefore do not constitute a functional element. "Communications" is mentioned in paragraph five, but the concept and essential details have been relegated to the Signal Annex where it often remains mysterious and unread by commanders and staff officers.

Detail, despite contrary doctrine, has expanded in orders in recent years. The two page corps and division level orders of World War II (which were actually fragmentary orders) have expanded to current operations plans (OPLANs) and operations orders (OPORDs) which often fill entire binders. While the decrease of implicit communications and increase in personnel turnover is a large factor in the expansion of detail in orders, the Army has added liberally to the doctrinal format for operations orders. For instance, as recently as 1984 there were no requirements for tasks for combat support units, nor were there specified coordinating instructions for risk reduction control measures, rules of engagement, environmental considerations, or force protection. Service and support was a single comprehensive statement of pertinent information.[21] The amount and type of detail in the orders is a key issue in command and control because it partially determines how much latitude the subordinate will retain in the execution of the mission.

Also, if the operations order contains too much detail, there will be information flow problems in an organization for two reasons. First, the available information such as annexes or appendices to the order must wait for the completion of the order (and commander's or chief of staff's signature) before being published and distributed. This creates an information bottleneck by which important information is kept from

subordinates because the order is the only approved means to send it to them. Secondly, the written order has the potential to become an information "time bomb" beyond the capacity of subordinates and their smaller staffs to digest it fully, causing information overload.

Oddly, despite the growth of the importance of communications in recent years, the doctrinal format of last paragraph, command and signal, has gotten smaller since 1984. In the new version of paragraph 5, items such as the location of TOCs, radio silence, liaison requirements and other C2 issues are no longer specifically addressed. Often, a lack of involvement in the planning process by the unit's signal officer harms the eventual plan because in the absence of input on communications risk, commanders and planning officers typically assume that communications will be near perfect in all courses of action. Furthermore, potential signal problems are generally ignored in evaluation processes of high technology, computer-aided simulations to tactical unit wargaming. This can lead to communications outages at critical times in execution, jeopardizing the entire operation. In terms of the modern operations order, the concept of logistics support, which begins paragraph 4 and offers a nonlogistics review of how these functions will support the operation, is warranted in communications as well because the signal officer has a responsibility to clearly articulate how the critical communications systems support the course of action to noncommunicators. Areas of risk, priority for support, and how the communications network will surge to ensure connectivity at the decisive place and time are issues which could be briefly articulated to the user.

As warfare has increased in complexity, orders formats have varied in form and substance to add context, focus on operations, and enhance cognition. Verbal orders,

overlays, matrices, and written orders are all used depending on the situations and amount of information. This reflects current practices in commercial firms where the transmission of instructions has been made more effective by the creation of a limited set of recognizable, yet flexible communications formats and media. The military variations, and commercial formats reflect the streamlined, focused orders of Napoleon and von Moltke, which did do not contain excessive detail but only the most essential directives and purposes for the operation in a commonly understood format. Orders have also varied in their delivery procedures. For instance, a corporate executive might transmit the mission, intent, and execution portions of the order while only providing instructions for how to get specific intelligence and logistics information via the communications system rather than including these in a single document.

This combination of a hierarchy of information formats and delivery means adheres to the information management principles spelled out in MCDP 6-0 Command and Control. Namely, only the most essential information is transmitted in supply-push form to subordinates. If possible, this information is also provided in graphically or with graphic aides to speed understanding of the concepts therein. Detailed information about specific supporting issues is provided in demand-pull fashion and is only transmitted upon request or when needed. FM 6-0 also retains the understanding that command information, especially intent and concept of operations, is best transmitted personally if at all possible, enhancing a common situational understanding to provide the basis for higher cohesion and minimizing the possibility for misunderstandings and micromanagement.

This flexibility in C2 procedures is echoed in FM 6-0:

> Procedures apply only to rote or mechanical tasks. They are not thinking activities. . . . The commander and staff must use, modify, or discard procedures, as the situation requires; they are not rules to follow automatically. . . . The commander should design or use C2 procedures for simplicity and speed. Procedures should be simple to perform quickly and smoothly under conditions of extreme stress, and speedy enough to generate tempo. Streamlined staff planning sequences are preferable to deliberate, elaborate ones.[22]

The new doctrine of command and control as stated in FM 6-0 may reduce the emphasis on the rigid MDMP to a level nearer to pre-1997 levels when the mission analysis process was more command and situation dependent. The current, MDMP versions of C2 procedures employed by commanders may also become more flexible with time. With enhanced communications systems at his disposal, the commander can tailor the systems, and the procedures for employing them, to his needs and desires rather than be constrained doctrinally by a sequential formula as represented by the MDMP.

C2 Procedures in Execution

The C2 procedural problems noted in the NTC and ARI studies continued from planning into the execution phases of most battalion and company rotations. Notably, reporting was found deficient in seventy percent of observed cases. Other C2 execution issues were noted such as communications problems and the TOC's movement during critical times of the battle (thereby losing some control), and company commanders' inability to form a battlefield visualization.[23]

The overall result in unit execution was that at the battalion level TOCs lost track of the battle in sixty-seven percent of cases studied. To overcome this lack of control, commanders usually remained forward directly observing the battle during execution, successfully in sixty-eight percent of these instances. Since these commanders

effectively controlled one company, one might assume that they micromanaged that company to some degree in one hundred percent of cases. The report did state that in these cases the battalion TOC did not share the battalion commander's direct vision and could not coordinate his isolated fight with the overall unit, often executing outdated plans with disastrous results. Significantly, the report stated that since the brigade would have to rely on the battalion TOC for their information, this would lead to "problems in the brigade's ability to deploy its assets to support the task force."[24]

The RAND report summarized that "the task force commander normally stays abreast of the battle but keeps neither the companies nor the TOC apprised of his perceptions. The flow of information up, down, and laterally is weak."[25] Significantly, digitization of the planning and preparation processes, as well as applied technology, were cited as specific recommendations for the fixing many of these problems.

C2 Execution Procedures

Command and control procedures in execution have five main aspects: continuous intelligence updates, the synchronization and decision matrixes, the battle update, reporting procedures, and subsequent or fragmentary orders. During operations, the flow of information and intelligence serves to update the DST and DSM. The synchronization matrix is an information management tool which fuses the commander's options for concentrating battlefield effects depending on the situation. All battlefield operating systems are represented on the synchronization matrix with delivery means, triggers, and coordination measures. The decision support matrix, which represents the coordinated efforts of the intelligence and operations sections, summarizes the branches and sequels available to the commander at any given time. It is based on the initial wargame results if

multiple courses of action are considered, and it confirms or denies enemy courses of action based on battlefield sensors. Reports from subordinate units often consist of graphic representations of the status of friendly combat BOS and anticipated activities. These are usually compiled into "red/amber/green" status charts for quick comprehension by the commander and staff.

For actual decision making, the commander at higher echelons (usually brigade and division) waits for one of the two daily update briefings, called battle update briefings or battle analysis briefings to ensure consideration of all pertinent factors. In this way the decision to alter the course of action is done in a coordinated way with all relevant representatives present or in direct contact via VTC. The commander normally waits for the end or near the end of the briefings before the operations officer or subordinate commander recommends some alternative course of action. The commander will ask for additional input or make a decision which will be transmitted verbally to attending or connected subordinates, staff, and supporting commands. The operations section normally prepares a fragmentary order to ensure clarity and follow through of the change.

Lower echelon commanders and staffs in less capable, more mobile TOCs, conduct less robust, less formal updates and decision-making procedures. They also typically utilize tactical operations maps as the most elaborate graphic aid. These lower level decision cycles also enable faster decisions because there is less need to wait for update briefings due to the fewer number of combat and support arms to synchronize in the case of any change in the concept of operations. These commanders can often issue orders in person to one or more subordinates rather than via radio or written orders. This

ensures comprehension and acknowledgement of the change as some part of the new vision is transferred from the higher commander to the lower.

The methods of command and control during operations involve flexible, varied tools for the commander to employ as necessary. As such, doctrine submits to expediency because time, individual command styles, missions, and units all vary. Yet these tools remain generally understood, available, and useful. The initial planning process as represented by the MDMP is the single most important limiting factor on subsequent operations because it sets the limits of how far the commander may vary from the initial course of action. The initial wargaming establishes the set of available, considered branches and sequels to which the operation may be redirected. While commanders and staffs may continue to wargame branches and sequels subsequent to the determination of a course of action, this method is not prescribed in doctrine. In fact, FM 101-5 concentrates on getting the plan "back on track" if any major variances in operations occur.[26] Ensuring that the commander's plan is faithfully followed is necessary for synchronization of the overall operation, yet units must remain ready to exploit opportunities through initiative. The German doctrinal concept of *Aufstragstaktik* considered a subordinate in violation of an army wide standing order if he did not attempt to do within the intent (*Absicht*) of his commander despite a violation of some specified or implied task. In order to add flexibility to current and future Army operations, and fully leverage digitized systems, this doctrinal emphasis on fighting the plan (rather than the enemy) may require alteration.

C2 Procedures and Digitization

Like the dual nature of C2 itself, digitization supports the inputs and arrival at a decision, and its implementation in different ways. Beyond creating and automatically maintaining the COP, which primarily supports execution, the digitization suite of systems were developed to speed the collection and analysis of information input to decision making.

Digitization Support to Planning and Decision Making

In planning, digitized systems enable the collection, processing, and movement of planning data through the individual BOS-related ABCS. In decision making itself, these systems provide the commander number of map, overlay, and analysis tools. Orders outputs are also compiled and distributed via digitization systems.

To focus on how digitization impacts the MDMP, a series of in depth CEPs were conducted by the Army and analyzed by ARI at Fort Knox, Kentucky starting in 1998. The study focused on the digitized TOC and its functionality during the MDMP.[27] ARI attempted to assess how well C4I systems met the input and decision requirements of the commander and recommend potential areas for change in the formal MDMP.

The result overall was that digitized commanders and staffs significantly accelerated individual MDMP steps and facilitated a less formal planning process. For instance, significant portions of the mission analysis, course of action development, war gaming, and course of action comparison steps of the MDMP were changed, combined, or outright eliminated with the addition of digitized systems.

Overall, the most significant changes which digitization brought to the MDMP centered on three MDMP task areas: IPB, wargaming, and COA comparison. In the ARI

study, IPB was generally abridged because of the unit's ability to gather real time information and intelligence through the use of UAVs. In the AWEs, COA development, wargaming, and COA comparison were streamlined and abridged through the ability of subordinate commanders to participate via collaborative tools such as whiteboard and VTC. Lieutenant Colonel James E. Harris III was a battalion commander in the 4th Infantry Division during both its digitized NTC rotations in the AWEs. In planning operations he noted that, "The ability of the staffs, at all levels, including rifle company commanders, to parallel plan in the development of the order was bolstered by these (digitization) tools" and "In the end, the traditional operations order briefing at the NTC became more routine and not as critical . . . to finalize the operation, due to the parallel planning capabilities provided by digitization." Colonel Harris identified the main downside to digitized systems as information overload in planning, "It was a task in itself for the small staff to filter the huge volume of data for essential information. All the essential information might be there, but it is buried amongst the mountain of nonessential data. At NTC we had perfect intelligence on the enemy at times but did not recognize it due to the high volume of filtering capability."[28]

This participation by subordinate units allowed wargaming, COA comparison, and rehearsal (talk through) allowed alterations to the plan to be identified, incorporated, and distributed before the final operations order was completed. Since subordinate commanders were able to participate in the wargaming process, the commander was able to ensure that his subordinate commanders had an understanding of his visualization, with potential branches and sequels earlier in the planning process. This sharing of a visualization was further enhanced in the productions and distribution of orders, because

"the speed at which orders could be transmitted and visualized with graphics gave us a significant edge over the enemy."[29]

While the units in the ARI study did allow subordinates a greater degree of participation in the MDMP, digitization creates the situation where parallel planning could save large amounts of time for the unit commander in planning and preparation since so much information is available at multiple echelons. To make use of this information, the subordinate unit requires early access to the mission, commander's intent, and as many of the various concepts related to the operation (concept of operations, concept of fires, concept of support etc) that higher can provide early in the MDMP process. These tools, coupled with the available information resident on the digitized systems, constitute the basic inputs necessary for decentralized, parallel planning over and above the existing MDMP parallel planning enablers of the warning orders.

Yet in planning and decision making, the ARI study found that digitization, "fails to adequately enhance the speed or organization of the first six steps" of the MDMP.[30] The reason for this unexpected conclusion related indirectly to the ability of ABCS to compile and share planning information. The mission analysis and COA development steps, in the ARI study, contained too many manual data input procedures to produce products such as task organization, IPB overlays, and COA text and graphics. This manual data input, normally completed by contractors in the AWEs, slowed the overall planning process. Furthermore, the study found that the speed of the completion of the IPB was due to the use of UAVs rather than enhanced capabilities of the ABCS. Finally, the unit did not follow the MDMP in sequence, again due to time constraints which were

not alleviated by the use of digitized tools. The result was that the final output of the planning process, the COA, were not optimized due to the failure of the unit to integrate all BOS staffers.

Digitization Support to Execution

Most observers agreed that the results were "astounding"[31] in the way that they enhanced the commander's ability to track the battle and synchronize ongoing operations. Colonel Harris reflected on the advantage of COP to preparations for execution, "This increased our ability to get units on the move . . . providing more time to plan and prepare for the mission." In movement, "I could always get a grid location on them without ever making a radio call to the unit or asking a TOC NCO" and "Numerous times . . . the situational understanding . . . assisted in the smooth and efficient passage of lines and linkup operations between heavy and light forces during day and night operations" and "The ability to physically see the route we would traverse for an operation or the potential enemy objective through the eyes of real world imagery via UAVs . . . increased our ability to defeat him." In contact, "clearing indirect artillery fires was reduced and expedited because we could see our own units and any other friendly forces in the target area" and "The ability to mark known obstacles or minefields and provide a common picture for all prevented numerous reentries into the same area" finally "Synchronization of operations was enhanced by the ability to observe the movement of all elements into positions across the battlefield . . . to adjacent units on flanks." The bottom line for Colonel Harris was, "I had better visualization of the friendly battlefield than I had in my previous 18 years of service in light infantry."[32]

There were, however, downsides to digitization, as Colonel Stephen Garrett who directly observed the exercise that information overload, primarily from enhanced and more capable intelligence arrays such as the UAV created situations where "frenzied staffs tried to keep up with the accelerating information flow. Vast amounts of commonly shared data accumulated rapidly and were frantically turned into decisionable information for anxious commanders. Decision-making timelines were radically compressed...Staff battle rhythms often appeared to be in disarray."[33]

The implications of digitization on execution are clearly positive. Remote reconnaissance increases speed and awareness across the battlefield. Instant knowledge of friendly unit location reduces the need for constant status updates as well as restrictive fire control measures and boundaries. Branches and sequels are implemented more coherently. Fragmentary order production and electronic distribution of graphically enhanced orders allow greater synchronization in less time. Horizontal linkages and lateral situational awareness between adjacent units creates informal synergies. On the downside, information overload at the TOC stresses the staff in its present state, causing disrupted battle rhythm and lost opportunities.

Significant in all these observations is the underlying theme that digitization is more useful in ongoing operations (command, control, and coordination) than it is during the MDMP (planning). Despite the obvious problems of information overload and potential micromanagement, the observations and studies generally agree that greater situational awareness through digital COP is a significant advance in overall C2. A likely reason for the failure of digitization to impact planning in a more dramatic way is not a lack of electronic mail systems but a failure of the MDMP itself. The evidence of this

problem is conclusive: the consistent planning failures, the chronic time management problems, the continued development of only one COA, the consistent ad hoc adaptations of the MDMP, and the upset battle rhythms of commanders and staffs in digitized and nondigitized units alike. Since the original requirements documents for the digitized suite of systems were based largely on the MDMP itself, the failure of digitization to speed and enhance planning significantly may be in the underlying processes and procedures it was built upon.

Army C2 Evolution

The concepts of battlefield visualization, situational awareness, and a common operational picture constitute a paradigm shift in the Army's changing C2 system. This shift is based primarily on the primary C2 enhancement which digitization provides the commander: a graphic picture of friendly and enemy unit location and status on a computer screen. For this reason, the Army has based its changing notion of C2 procedures on how this common operating picture (COP) enhance the commander's ability to form a visualization and put it into action.

Battlefield Visualization: Nexus of the new C2 System

The notion of the commander's battlefield visualization is not new. Clausewitz and others spoke of the *coup de oil* (stroke of the eye) to describe a similar concept. What is new is the emphasis on the visualization as the central command element in all Army operations. The doctrinal definition of battlefield visualization is the, "process whereby the commander develops a clear understanding of the current state with relation to the enemy and environment, envisions a desired end state which represents mission

accomplishment, and then subsequently visualizes the sequence of activity that moves the commander's force from its current state to the end state."[34]

The commander begins to form his vision through the processes contained in the MDMP. Intelligence and reports feed the first part: the current state with relation to the enemy and environment. Mission analysis forms the second part: the desired end state. Course of action analysis and wargaming help form the last part: the sequence of activity that moves the commander's force from its current state to the end state. In the subprocesses of MDMP, the vision is formed and shared with the staff and subordinate commanders.

Since the actual visualization of the battlefield occurs not on a computer screen, but within the commander's human head, some friction will inevitably remain as this set of thoughts is transferred to staff and subordinates. Also noteworthy is the fact that each commander within a unit has different forces, different challenges, and different immediate adversaries and each commander at each echelon brings different knowledge and different perspectives based on different experience, and intuitive predispositions to the operation. For this reason current Army doctrine correctly states that friction on the battlefield will never be totally eliminated, despite the synchronizing effect of COP.

Situational Understanding: Forming the Vision

Situational understanding "is the product of applying analysis and judgment to the common operational picture to determine the relationships among the factors of METT-TC."[35] This incomplete description is broadened in FM 6-0: "situational understanding supports the commander's visualization. The CCIR, continuously updated, guides the commander's achievement of situational understanding. . . . As the commander achieves

situational understanding . . . he then uses visualization to determine the end state and ways of getting from the present state to the end state."[36]

In other words, situational understanding involves the commander forming a mental worldview, or orientation, as a result of the interaction between his knowledge and experience and the digitized COP. Situational understanding is a METT-TC--informed a mental map on which the commander has unlimited flexibility to wargame, fight, and alter his concept of operations to eventually arrive at a decision. As the operation commences and the situation changes, the commander continuously updates his situational understanding to enable new decisions through visualization.

Marine Corps doctrine is analogous to this concept of situational awareness where it states in MCDP 6-0 that commanders need three pictures of the situation. The first is a close up observation of the situation, such as is expressed by the tone of voice or looking in the eyes of a subordinate when speaking. Secondly, the commander needs an overall picture of the situation to understand the pattern of events in the bigger picture, usually provided in part by a higher commander's intent and METT-TC analysis of both forces. Third, the commander needs to be able to see the situation from the enemy commander's eyes, so that he can deduce probable enemy intentions and anticipate enemy moves.[37] This specific list expands how a commander applies judgment and experience to a COP. The three views also provide a more concrete, less conceptual road map for commanders to achieve a degree of situational understanding.

Common Operational Picture: Enabling the Vision

Common Operational Picture (COP) is defined in FM 6-0 as "An operational picture tailored to the user's requirements, based on common data and information shared

by more than one command."[38] COP represents the lowest commonality of a shared view of the battlefield among commanders and staffs. While there is no way to ensure different commanders derive the same understanding from this image, the fact that it is graphic, relatively current, and shared makes it potentially more powerful than the written intent or guidance. Just as an overlay or matrix order might enable faster and more complete comprehension between commanders, COP represents an exponential improvement on football analogies, service-specific jargon, or other confusing and imprecisely defined concepts sometimes used in verbal or written descriptions in orders.

Despite the tremendous utility and untapped potential of COP for synchronization, there are pitfalls to be aware of in operations. Captain Snyder of the Naval War College commented the problem of transferring a mental image or idea, "If ideas are to move reliably from the mind of one commander to the mind of another, the transformations that are undertaken on the sending side have to be matched on the receiving side, and they have to be matched exactly."[39] This is why the adjustment of COP between units, usually through filter adjustments, represents an important new set of C2 procedures to ensure commonality of the picture while allowing the user to tailor it to his requirements. Overall, COP is a powerful C2 tool which, like any other new tool, requires sharpening, maintenance, and practice to learn the most effective, most efficient methods of use.

Marine Corps doctrine also addresses the power, and the danger, of communicating ideas using images. MCDP-6 states, "Not only do people generally think in images, they understand things best as images and are inspired most by images. . . . People assimilate information more quickly and effectively as visual images than in

text."[40] While images are clearly the best way to communicate complex thoughts quickly, there are also dangers. First, images have an underlying set of thought or understanding which cannot accompany them. Also, they are also subject to the quality of the input (garbage in, garbage out). Not accounting for these problems "is especially dangerous in a high technology age in which impressively displayed information appears especially reliable."[41] Perhaps of greatest concern is the natural human tendency to accept whatever is portrayed on a computer screen as ground truth, while the thinking, hostile enemy in the real world remains.

Battle Command: Executing the Vision

In the new FM 3-0, *Operations*, "Battle Command is the exercise of command in operations against a hostile, thinking enemy." This activity also "applies to the leadership element of combat power to operations . . . Commanders assisted by the staff, visualize the operation, describe it in terms of intent and guidance, and direct the actions of subordinates within their intent."[42]

In essence, battle command removes the technical elements of command and control (which are left to "communications"), from the intangible leadership and command elements of C2, which are retained. *Operations* also distinguishes the altered concept of command and control, "C2 has two components--the commander and the C2 system. Communications systems, intelligence systems, and computer networks form the backbone of C2 systems and allow commanders to lead from any point on the battlefield." This variance the joint definition emphasizes the commander and a collection of inanimate objects and presents them as the command and control system without the procedural and organizational aspects. While the terms associated with C2

have been muddied in recent years with the extension of C2 to C3I, C4I, C4I2, C4ISR, and C2W, battle command usefully redraws the distinction between the leadership and command components and the more technical components of command and control.

Yet, the invention of service-specific doctrinal terms such as "Battle Command" is a self inflicted wound when joint terms such as C2 already exist and are commonly used and understood. The problem created is not only conceptual, it is procedural and technical. Army officers used to the nuances of battle command will either confuse their joint and allied compatriots, or must waste time educating them for complete understanding of a redundant concept. Mismatched terms also make information management and IT systems more complicated. For instance, categorization and information searches are more difficult, and sharing of data between systems requires interfaces and converters. This is the case in the current digitized systems which require converters because of the use of such simple but different terms such as "location" on one system and "position" on another. The previous definition of command and control, which only part of which is now called battle command, is still the one enshrined in Joint and Air Force and Navy definitions, namely, "the exercise of authority and direction by a . . . commander . . . in the accomplishment of the mission." As it stands, the joint definition of "command and control" contradicts the Army's assertion that the parts of C2 are the commander and the C2 system. The vast majority of commonly held doctrinal statements on the subject assert that the two parts of command and control are, not surprisingly, "command" and "control," as in authority and direction rather than the commander and the C2 system. A survey of common ideas and statements on what the Army now calls Battle Command are referred to simply as command in other services,

militaries, and commentaries. The bottom line is that in other service and joint doctrine the commander is inextricably part of the overall C2 system, albeit the most important, most visible focus of effort for that system of procedures, organization, communications, equipment, and facilities.

Overall, the advantages represented by digitization undeniably constitute the most promising advance in the synchronization of an increasingly complex battlefield. In planning, current and future digitized systems contain the potential for more effective, more dynamic, more rapid decision making at multiple echelons. In execution, COP and its resulting situational understanding and battlefield visualization represent a more effective framework to enhance operational tempo and cohesion. The specific C2 procedures to best apply these tools are evolving from current, MDMP-based concepts such as IPB, CCIR, commander's intent, and orders processes through trial and error in the continuing AWEs.

All these advances will be possible if the limitations of digitization are kept in perspective. Commanders must realize that the computer image they share is just that, electrons on a screen. There remains a thinking enemy who will do all he can to distort, disrupt, or obtain the COP. The right outlook and application of these tools are the keys to optimum implementation.

Commercial C2 Procedures

In large private firms, C2 procedures are centered on the "value chain" of how firms procure assets then produce, distribute, and service their products. This disparity with the military effectively limits the portability of commercial C2 procedures to the military environment, especially at tactical levels. Two major areas where commercial

ideas on procedures do apply to military organizations deal with how organizations effect and sustain change as a result of increased information technology through business process reengineering and knowledge management.

Business Process Reengineering

Perhaps the most common, most widespread way commercial firms change as a result of increased IT is through Business Process Reengineering (BPR). Michael Hammer in his book *Reengineering the Corporation* is a major proponent of the BPR system for change where firms focus on their operational objectives from the perspective of the lowest operational echelon, then use a clean sheet of paper approach to designing optimum procedures and processes to reach these objectives.

With regards to information technology, BPR rests on the assumption that current IT can automate and enhance any process, therefore the key is to develop the optimum business process prior to investing in IT. Automating old, bureaucratic processes, also called "paving the cow paths," can only achieve limited gains in productivity, which are often offset by development, maintenance, training, and personnel aspects of IT investment. This is why BPR is properly initiated before the development of new IT systems. Some organizational advances which BPR enable include allowing generalists to do the work of specialists through increased availability of data and information (decreased specialization), and gaining the advantages of centralization and decentralization simultaneously through the targeted application of IT. Some specific technologies championed by BPR enthusiasts include VTC, wireless connectivity, expert systems (knowledge management), and common access to shared databases.

In terms of digitization, a BPR process would employ unit commanders and staffs to identify the essential procedures for effective command and control. Based on these procedures, the unit would design new procedures for maximum effectiveness and efficiency. Based on the ARI and NTC data, the MDMP and IPB would be prime candidates for redesign. The last step is to actually design, test, and field new information systems around the new processes. In this way, the unit may lose some traditional but perhaps unproductive infrastructure because of all the parts of unit would be refocused on the core operational procedures for achieving optimum efficiency and effectiveness.

Knowledge Management

Knowledge management proponents, like Thomas Davenport and Nicholas Negroponte, recommend that organizations focus on intellectual assets rather than personnel and material. They typically recommend that organizations focus on enhancing the cognitive hierarchy, where data is transformed through relevance and purpose to information, and further with context and experience to knowledge. Proponents focus IT systems on the creation, storage, and especially access and sharing of this knowledge.[43] This is analogous to the Army concept of transforming COP to situational awareness and situational understanding, and then to battlefield visualization. Knowledge management would concentrate the business processes and IT to enhance this transformation, then to capture and share the visualization as accurately as possible.

Since knowledge management, at its heart, is enhanced information management, it is concerned with capturing, packaging, storing, and displaying information to increase its value to a wider audience in the organization. Knowledge management seeks to find

and implement these enhancing measures, and usually involves collaborative information technology systems such as Lotus Notes, PeopleSoft, or an internal intranet. A key issue for knowledge management proponents is the development and sharing of lessons learned. The IT system is, in large part, an extension of an active lessons learned development activity. These lessons learned are captured and stored as information and knowledge, and used to populate a user friendly information management system.

Specifically in digitization, while a lot of information is available, it is fragmented, compartmentalized and stored in disparate locations. Currently there are several major Army commands directly spread across the country involved with the continued development and integration of the digitized systems. These commands compile and distribute lessons learned within a limited aspect of digitization, usually for a limited audience. The central integrator of Army knowledge, the Center for Army Lessons Learned, provides general information on single instances of BOS-related digitization such as logistics planning and engineer incorporation, yet there exists no dedicated knowledge development and sharing activity targeted on the integrated design, development, and implementation of digitization tools for tactical operations.

While this study does not endorse a comprehensive BPR and knowledge management evolution in the Army, it is clear that some aspects of these processes would speed the eventual success of digitization. Since the Army has apparently developed the information systems based on current processes, BPR is too late. Yet the concept of a complete examination of existing processes is desirable based on the performance of the current C2 procedures in the noted studies and at the NTC. While no changes may evolve from such a process, the thinking "outside the box" may at least highlight and

comprehend, such as pictures, overlays, and maps; and dissemination is the movement of information via INFOSYS.[47]

While FM 6-0 does not identify any staff element engaged in the conduct information management, the intelligence section of any staff is trained and proficient at all the basic steps. The doctrinal intelligence cycle consists of five steps: plan and direct, collect, process, produce, and disseminate. The steps of the intelligence cycle effectively constitute an information management process with the exception of storage and display, which themselves are necessary steps for any intelligence operation. This means that every tactical operations center has the personnel to execute effective information management regardless of echelon. There are two problems with expanding the scope of the intelligence section to conduct information management for the unit. First, their job of producing intelligence in the digitized environment is significantly more challenging with the inclusion of UAVs, JSTARS, tactical enemy sightings, and higher command and national level assets, all poured into the inbox of the existing staff. The second issue is that the intelligence cycle is doctrinally tied to the MDMP, with planning and directing being conducted while the initial MDMP is ongoing. Rather than only conducting the first steps of information management during the MDMP, each individual piece of information should be "collected, processed, and disseminated" as it comes in. This way a growing, searchable database would be built without information piling up over the course of an operation. Additional information management personnel (such as intelligence soldiers), and the freeing of the intelligence cycle from the MDMP so that each piece of information is processed and stored as it becomes available, would enable greater information management in the digitized TOC.

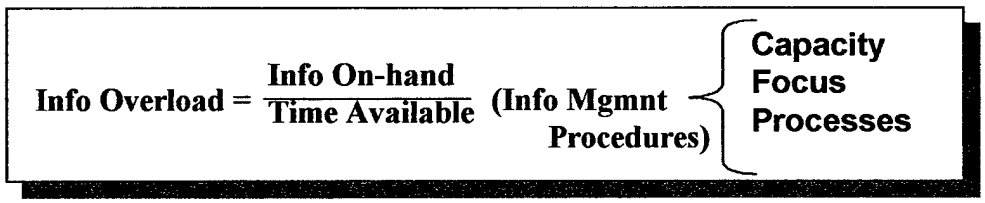

Figure 18. Information Overload

FM 6-0 begins the establishment of a contemporary information management system with a definition of it, and the related concept of RI, "Information management is the provision of RI to the right person at the right time in a usable form to facilitate decision making. It uses procedures and information systems to collect, process, store, display, and disseminate data and information...[it] includes Relevant Information and Information Systems (INFOSYS)."[45] The definition of INFOSYS states, "the equipment and facilities that collect, process, store, display, and disseminate data and information. This includes computers--hardware and software--and communications as well."[46] In this way the Army information management scheme does not address the most important information management asset, trained soldiers. While the facilities, computers, and communications are important, personnel applying procedures is the only way to effectively manage information.

FM 6-0 identifies five information management activities: collection, processing, storage, display, and dissemination. Briefly, collection involves all intelligence, surveillance, and reconnaissance (ISR) assets as well as standard reports and messages; processing involves organizing information into coherent and relevant forms; storage includes the media which contains the information as well as the search engines to enable access; display is the presentation of the information in a form which is easiest to

Information Overload

The challenge of information overload, experienced so keenly by commanders at NTC in nondigitized units, has been being exacerbated by the digitization of Army operations. Digitized AWE's have confirmed this problem, "every time commanders formally conducted circulation of information from the continuous flow, the battle left them behind."[44] Information overload also contributes to staff fatigue as masses of information flowed into a TOC not designed for the enhanced battle rhythm which digitization makes possible. The effort to reduce uncertainty on the battlefield has resulted in such an increase in data and information that staffs and commanders actually gain reduced knowledge of the situation.

Information Management

How to best manage information is not a new problem. As Berthier and Napoleon applied C2 procedures to the problem with their reporting and directed telescopes. Von Moltke applied C2 organization through his General Staff officers. Guderian enjoyed a combination of these and *Abischt* and *Auftragstaktik.* The modern Army faces the challenge of developing enhanced information management procedures and organizations to deal with this problem which threatens to circumscribe the benefits of digitization. The implementation of digitization, which moves hundreds of additional pieces of information in and out of TOCs every day, utilizes existing procedures and organizations. In this way, the digitization program probably makes information overload an inevitable condition.

consolidate existing C2 procedures which already exist in dispersed nature in unit SOPs and after-action reviews.

In order to capture and leverage new ideas, lessons learned in AWEs for instance, should be centrally and uniformly stored distributed through easy-to-access systems from remote locations than has been the case to date. The Army must realize that the goals of the ongoing digitization "experimental force" are not to complete equipment fielding on time or to win the next NTC rotation. The crown jewels of digitization are the experiences which can be used to advance operational warfare. Napoleon did this in Italy and Austria in the 1790s, von Moltke reaped lessons learned in Denmark and Austria in the 1860s, and von Roon and von Halder remorselessly pursued and implemented lessons learned in France in 1918 and Poland in 1939. Likewise, the Army should maximize the experiences of leaders in the AWEs by evaluating new procedures and organizational forms to fully leverage the enhancements which digitization offers.

C2 Challenges

The two major challenges specific to the digitization which deal directly with C2 procedures are information overload and micromanagement. The evidence from after-action reviews, reports, and articles points to these actual (information overload) or potential (micromanagement) major drawbacks in the introduction of digitized systems to the typical Army unit. These are the first and most pressing the challenges the Army must come to grips with in order to realize a competitive advantage in warfighting through digitization.

To commercial information managers, the information management process begins with the determination of information requirements. Information managers such as Thomas Davenport and Nicholas Negroponte contend that if the information needs of the organization are not clearly articulated, the system will not provide the right information product. As such they would include the CCIR development as a central starting point in the information management process. Commercial information management also involves actively or passively capturing information and its measured use. This model, (figure 19) is meant to be generic for all information operations in the commercial sense.

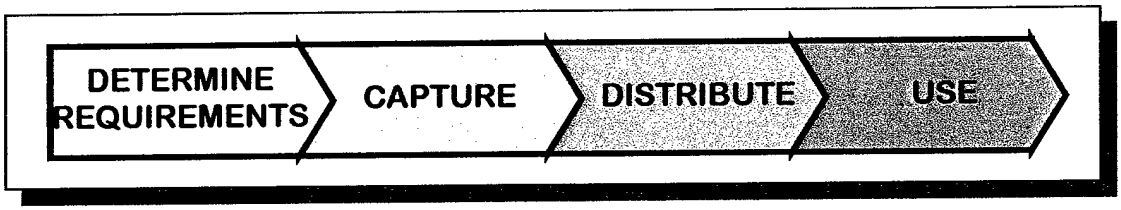

Figure 19. Commercial Information Management Process

In commercial systems, information capture involves the sub functions of scanning to identify potential sources of the needed knowledge, designing systems to capture information, categorization of the information per function. Information is packaged into forms which conform to user expectations and needs, such as websites, MS Office files, SOPs, matrices, overlays, written reports, operations logs, and orders. Where information is managed through several stove-piped systems as it is through ABCS, these functions occur separately, causing problems in distribution as well as straining the information pipes due to excessive transactions in capture sub functions

from remote locations. In the digitized force, each staff section currently captures and categorizes their needed information but the formatting and packaging is also done independently, denying the commander a single, integrated system for all relevant information.

Information distribution is an acute problem for tactical units because security boundaries, limited transmission pipes, and noninteroperable formats all impede the optimum distribution of a unit's information. In the digitized force, since the current systems do not share basic data formats and since different sections and units have different suites of systems, distribution of common documents is not normally done through digitized tools. Units from the battalion task force to JTF level overcome this by creating ad hoc distribution systems from common tools. Organizational intranets and web sites, electronic mail, and file folder systems are all common, easy-to-implement and maintain systems currently employed by units to allow for the effective distribution of critical information.

Information use, a key to the entire processes to professional information managers, is the measurement of information access and it enables an organization to adjust the information requirements, capture, processing, packaging, formatting, and distribution of information to meet user needs. While operational orders and overlays certainly remain critical, other accessed information within the digitized force, left unmeasured, contributes to information overload problems and conceals relevant information in the mass of available datum.

Information Access

The ability to get at the relevant information is another critical issue. Commercial corporations spend millions of dollars designing and testing user friendly graphic user interfaces (GUI's in computer jargon), and databases to ease the timely access to relevant information. Modern techniques such as intelligent agent systems and smart search engines are changing the way users access information. For military users, there are four main issues which govern access to the needed info: security, storage and search, presentation, and, transmission. Security is self explanatory. Storage involves categorizing the most relevant information in the proper, local and redundant disk, computer, and database. Search engines or file systems provide users with access to the categorized storage bins or folder. Presentation, or how information is couched for ease of understanding, is discussed in both FM 6-0 and MCDP 6 under graphic theory. The bottom line is that presenting information in graphic form speeds cognition because people think in picture form. Since the digitization systems all vary in computer screen desktop presentation, information management procedures may be employed to standardize the look of the information on the systems to the maximum degree possible. This may be as simple as prohibiting unit crests from Power Point slides to reduce the size of files in transmission or standardizing the location, size, and color of "red/amber/green" status markers.

Information Flows

Knowing how best to move certain types and categories of information is another key to managing its access and use, especially in an environment of multiple but limited transmission media. RAND's study, *Understanding Commander's Information Needs*

identified three information flow methods: pipeline, alarm, and tree. Pipeline generally relates to the downward flow of plans, guidance, and orders. Pipeline also includes regular reports from lower echelons. Alarm refers to any information of immediate value, usually from the lower echelons to the higher. Tree is a more demand-pull system and relates to a decision tree in which information is requested and searched for.[48]

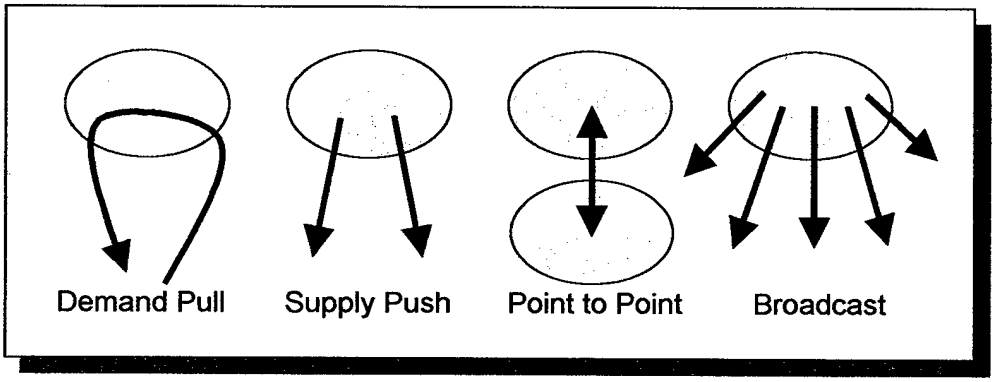

Figure 20. Information Flows in Operations

The Marine Corps Doctrinal Publication (MCDP) 6, *Command and Control*, specifies four primary ways of managing the movement of information. Demand-pull flow is when the user finds and pulls specific information from a source, such as a request for information (RFI). Supply push is when a need is anticipated and the source sends the information automatically to a specified audience. Point to point is the simple transmission of a message from the sender to a receiver. Broadcast is sending the same information to all potential receivers, such as a widely distributed policy message.[49]

Regulating information flow reduces the static encountered by users sifting for relevant items. For instance, maximizing demand-pull and point-to-point systems conserves limited bandwidth and storage space on computers. Minimizing supply-push

and especially broadcast flows ensures extraneous information is not needlessly duplicated on every computer across the unit. Regulating flows is usually accomplished through unit intranet web sites for demand-pull flows and electronic mail for supply-push, point-to-point, and broadcast flows. Again, the use of commercially available, fully interoperable, easy-to-employ and use systems provides needed services now, rather than as part of a larger, stove-piped system which takes years to build and deploy.

Information Precedence

The old Army precedence system ordered messages for transmission over various communications systems of varying speed and capacity. This system was devised when less capable communications and transmission means necessitated the prioritizing of messages by the importance of their information and grade of its users. Routine messages were to be received in the destination message center within six hours. Priority had a time limit of three hours, immediate thirty minutes, and flash as soon as possible. Special precedences such as flash override were provided to general officers and local commanders to ensure their messages got through.

This system is outdated in a world of the Internet because of the near instantaneous speed of transmission of information. Yet the concept of prioritizing information is used in commercial firms to assist in information capture, storage, and distribution. On a digitized staff, for instance, CCIR items would automatically be assigned the highest precedence while reports are assigned the lowest precedence. If all information entering a TOC were assigned precedences, staff officers could save time scanning the most pressing information while delegating or postponing other items.

Information Control

The largest data source in the world, the Internet, is accessed by millions daily to obtain relevant, well presented and easily transmitted information. The Internet successfully combines all the information management flow and activity procedures in an easy to use system. Building a web page is a skill which can be adequately taught in a couple of hours using modern technology. The graphic display nature of the information allows a precedence of information as the user sees it. Accessing a web page moves the page to a server closer to the user for speedy access while retaining the original file at the source. Electronic mail provides flexible information management because address lists and priority flags enable point-to-point, supply-push, and broadcast transmission and local storage of messages by category and importance. The military uses the Internet and its protocols thousands of times per day with tremendous effect, all at a research and development cost of next to nothing to the Department of Defense. As such, the Internet is a model of effective, efficient, and cost effective information control, which is why so many commercial firms base their information management systems on this tried and true "system of systems."

A typical commercial information management system consists of tools which are commonly available, easy to use, and extremely effective. Common databases to which any employee might be able to input items of interest would capture information. Operating logs, information requests, directives, meeting minutes, messages, and coordination notes are all examples of information input types which capture, categorize, and store information. Standard forms and data formats are employed as part of the information capture procedure. Shared file folder systems for each category are

commonly used to house the data on intranet LANs. To increase access, smart search engines which can traverse all databases are built on the most basic Internet tools. High priority items are highlighted on graphically displayed web pages. Commonly understood information categories can be accessed and the results displayed by subject, date recorded, key words, submitter, or relevance. Simple counting software scripts enable access and compile statistics which are employed to enhance the system for increased ease of use in commonly accessed subject areas. Users either compile information from various sources into a new document (also captured for future common use) or use the available information as is. Most use some form of information management and information control techniques to attack overload. This adaptation of existing systems, while sometimes haphazard, represents effective methods to address this issue with tools the Army already possesses.

Micromanagement

Imposing order and discipline in the fog of war is an activity which military leaders have striven towards since the days of Frederick the Great. Admiral Cebrowski of the Naval War College observed, "Commanders tend to provide top down, command directed synchronization of complex warfare activities."[50] From the experiences of commanders in digitized NTC rotations it is clear that digitization has not led to micromanagement, in part, due to the overwhelming amount of information available to the commander and the learning curve involved with commanding via new tools has, to date, precluded the oversupervision that many have supposed would be inevitable with the transition to digitized operations.

Yet senior commanders from the days of Napoleon to Vietnam have always felt the temptation to control the battle to a greater degree. "Invariably, whenever senior commanders have access to the same or more information than subordinate commanders do, they tend to exercise centralized control."[51] There is an impulsive, almost irresistible urge in some military officers to exert as much control on the battlefield as they possibly can. That this condition is due to some previous subordinate going off the deep end in the middle of a confusing and stressful operation is a distinct possibility, which is an advantage of the COP. As the Army deals more effectively with the problems which cause information overload commanders, and especially staffs who also micromanage in less obvious ways, will have more time to do what they do best. That is, they will decide things. Since higher level commanders will have the information upon which to base decisions, and the centralized assets (such as precision stand-off weapons) to act, the question of digitization's contribution to the potential for micromanagement is a valid concern.

Given the same digitized tools, C2 procedures can be designed to gage the amount of direct supervision at each tactical echelon. For starters, micromanagement often has its seeds in the planning phase of operations when uncertainty is high, but stress is lower than in execution, micromanagement which has been planned into an operation comes to fruition. Plans can constrain lower level initiative through an excess of staff initiated control measures, limitations, constraints, or excessive details on the "how" to get things done. Poorly written commander's intent can also be a primary cause of micromanagement, especially when the planning process fails to accurately identify key tasks or the described end state adds unnecessary constraints. In execution, the

micromanagement built into the plan becomes a reality when the plan changes but the constraints and controls do not. This type of passive micromanagement, usually perpetuated by staffs, is often more a factor of established organizational structures and procedures rather than of command style. Yet commanders may revert to forms of micromanagement for a variety of other real or perceived reasons such as the presence of media personnel or an environment rated as "high risk."

Mission-Type Orders and Mission Command

FM 100-5 of 1993 reflected the need for mission type orders when it recognized that the, "need for flexibility in command is greatest for the committed maneuver commander. He can neither cope with constant direction from above nor can he constantly provide detailed direction to his staff and subordinate commanders."[52] Significantly, there is no specific echelon to which this passage is aimed.

Like *Abischt* and *Auftragstaktik,* mission type orders and mission command assume that the battlefield retains its natural fog. Rather than try to impose order on this battlefield, these concepts use initiative within the framework of commander's intent to achieve their objectives. With enhanced situational awareness (SA), commanders have the tools to allow their subordinates more latitude in operations in part because commanders can monitor operations and intervene only when necessary. SA also provides the commander the ability to maneuver a larger number of subordinate units, effectively creating a flatter organization. COP enables decentralized synchronization of specialized battlefield assets such as artillery and engineers. The methods of powering down authority, thereby increasing initiative require trust and cohesion in the chain of

command, which is achieved through shared experiences, unit rehearsals, fact-to-face coordination, and effective leadership.

Another possible method of avoiding micromanagement, thus ensuring mission command is limiting the information available at different echelons. Digitized systems allow staffs to limit their COP to the appropriate echelons, such as two up and two down. Focus is maintained on the proper level of supervision through the use and maintenance of information filters at each level of command. Commanders who personally visit subordinates also limit micromanagement by building trust across the unit and by challenging their own mobile, less capable communications systems to deliver only the most pertinent information. In sum, commanders should continue to strive for close relationships with their subordinates, because that closeness will build trust and probably enable the commander to discern when and if to micromanage if he decides it is necessary. The procedures of mission command and mission orders afford measured instances of authority to encourage growth and leadership in the chain of command in peacetime, and efficiency and effectiveness in conflict. Staffs in general, however, should be procedurally barred from exerting control beyond what is approved by the chain of command in the execution of their duties. COP can help commanders, but constricting procedures reside in doctrine, SOPs, and TTPs.

Conclusions

The Army mission analysis and decision procedures, encapsulated in the MDMP, were built in an age of information dearth, when communications systems struggled to provide simple voice and data traffic across local areas. In this system, all analysis is centrally focused and managed around the optimum course of action based on

information on hand and predictions of enemy courses of action. All instructions for execution are centrally pooled into the operations order. No commercial enterprise would do business this way. The Army must consider decentralizing information and enhancing command and control processes around flexibility-providing products and tools for the commander using enhanced communications means that digitization provides.

Emerging C2 trends can address the shortcomings of existing C2 procedures while a holistic review would be the most effective way to optimize the entire system. Digitization adds capability to this existing system in numerous ways. While the mastery of these new tools is not perfect, the tools themselves, most notably the common operational picture, undoubtedly enhance operational effectiveness and synchronization. The OODA cycle and Plan-Prepare-Execute both reflect the emphasis on the commander's visualization, which is enhanced graphic nature of the COP. Yet there are issues which threaten to negate the advantages of digitization. New doctrine adds useful, nonautomated C2 procedures worth retaining. FM 6-0 and MCDP-6 both suggest three nontechnical C2 procedures to minimize the continuing frictions of conflict. First, commanders could employ a directed telescope, or special information gathering procedure to ensure understanding of critical events or aspects of the situation. Secondly, implicit communications typical of close knit teams, speeds communications and understanding across organizations. Third, decentralized decision making remains the way to ensure that the individual with the best knowledge of the situation to make the decision on the spot. While it is unlikely that a commander will have a group of directed telescopes readily available, readiness in implicit communications and capability to

operate in a decentralized manner are both training and leadership issues, which depend on personnel, time and resources. These are implemented through careful organizational structures which operate according to positively designed C2 procedures.

Information overload is a natural consequence of the fragmented and uncoordinated introduction of information technology into any organization. While the common operational picture is a vast improvement in battlefield synchronization, the systems which provide it also inject vast amounts of information into the command group's decision and execution cycles. The complete answer to this current problem with digitization will probably not involve further proliferation of automated systems, especially in the current period in which units are struggling to master the tools they already have. History shows that the solution can be arrived at via a broad selection of procedures and organizational techniques arrived at through objective and determined trial and error. Commerce has had success in focusing on information through knowledge management and simple information management procedures. Dedicated organizational cells to install, customize, and maintain information systems, to include managing the information on them are also required in every major staff element and unit.

Given the new capability of commanders to focus on micro-details of subordinate units, micromanagement is potentially a greater problem in future. The emphasis on mission orders, mission command, and commander's intent is helpful, but probably not enough to prevent counterproductive micromanagement. While information is ubiquitous on the digitized battlefield and trust in subordinate units is (in part) a factor of leadership,

the ability to synchronize through COP represents a double-edged sword because it enables either micromanagement or decentralized operations.

While these are negative, reactionary issues the larger question remains of how to move forward to a new C2 system through digitization. Observer of the DAWE, Colonel Garrett, noted that

> Synchronizing BOS functions necessarily becomes a more prescient, nearly instinctive, interactive command process of changing the existing battlespace picture into what must be accomplished, anticipating rather than seeing the battle. Unquestionably, this expeditious decision-making synchronization process remains a key C2 procedure in battlefield success and a complement to situational awareness.[53]

It is nearly impossible to describe this "nearly instinctive, interactive command process" result of COP. To digress to a sports analogy, pitchers might call it "being in the zone." It is an objective state of a cohesive, competent team. Digitization enhances the ability of leaders across units to get to this state as a team.

In future, there may yet be an Army C2 system which reduces uncertainty and improves synchronization to such a degree that it enables commanders to execute operations with three or four current tactical courses of action possible simultaneously. Staffers who are less engaged in situation updates due to the COP are currently involved with managing and running ABCS systems. These soldiers might be provided with information management training and tools to better manage friendly force information along the existing lines of the intelligence cycle. An MDMP which is less focused on the perfect, all inclusive plan and more focused on enabling lower level initiative to expose opportunities is far more conceivable with COP because the shared picture of the battlefield provides the necessary intelligence and the combined arms synchronization

tool. While executing a plan where there is no single friendly course of action planned past the first encounter with the enemy is unthinkable at the NTC, it was once common and very effective. This level of flexibility may be possible as a result of new tools such as the digitized COP, coupled with intelligent application of enhanced C2 procedures.

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[1]Training and Doctrine Command Pamphlet 525-5, *Force XXI Operations* (Fort Monroe, Virginia: TRADOC, 1995).

[2]Colonel John R. Boyd, "Destruction and Creation" (presentation given to the Command and Control Systems Course, Marine Corps University, Quantico, Virginia, 1997). Colonel Boyd published the original paper "Construction and Destruction" in 1976. Upon his death in 1998 the Marine Corps University obtained his papers and effects, including the OODA loop papers and briefings, which he presented at the Command and Control Systems School in 1996 and 1997. The OODA diagram and much of the information related to it is from the author's notes prepared for a class at Command and Control Systems Course on the subject of the OODA loop given in 1999, which was derived from the originals left by Colonel Boyd.

[3]Clausewitz, *On War,* 84-85.

[4]Department of the Army, Field Manual 6-0 (draft) *Command and Control* (Washington, D.C.: Department of the Army, 2000) 1-7, 6-2, 6-3, and Appendix A.

[5]Field Manual 101-5, *Staff Organization and Operations*, 1984 version, 5-5.

[6]Ibid., 5-1.

[7]Ibid., xi.

[8]Dr. Dennis K. Leedom, et. al., *Cognitive Engineering of the Human-Computer Interface for ABCS* (Aberdeen Proving Grounds, Maryland: Army Research Laboratory, 1998), 12.

[9]Field Manual 101-5, *Staff Organization and Operations,* 1997 version, 5-27.

[10]Ibid., 2-5.

[11]Ibid., xii.

[12]Field Manual 101-5, *Staff Organization and Operations*, 1997 version, 5-6.

[13]Department of the Army, Command and General Staff College, Student Text 3-0, *Operations* (Fort Leavenworth, Kansas: Combined Arms Center, 2000), 11-12.

[14]Field Manual 6-0, *Command and Control*, 4-8.

[15]Training and Doctrine Command Pamphlet 525-70, *Battlefield Visualization Concept* (Fort Monroe, VA: Headquarters, United States Army Training and Doctrine Command, 1995), 4-5.

[16]Student Text 3-0, *Operations,* 11-12.

[17]Field Manual 6-0, *Command and Control*, 3-11.

[18]Colonel Stephen F. Garrett, "Evolving Information-Age Battle Staffs," *Military Review* vol. 78, no. 2 (March-April 1998).

[19]Ibid., 11-12.

[20]Field Manual 101-5, *Staff Organization and Operations*, 1997 version, H-1 through H-3.

[21]Field Manual 101-5, *Staff Organization and Operations*, 1984 version, Annex G.

[22]Field Manual 6-0, *Command and Control*, 5-20.

[23]Ibid., 48.

[24]Ibid., xiv.

[25]Ibid.

[26]Field Manual 101-5, *Staff Organization and Operations*, 1997 version, 6-4 and 6-5.

[27]Army Research Institute, *Assessing Battle Command Information Requirements and the Military Decision Making Process in a Concept Experiment Program* (Alexandria, Virginia: Army Research Institute, 1998), vii.

[28]Harris, "To Fight Digitized or Analog."

[29]Army Research Institute Study, *Assessing Battle Command Information Requirements,* 37.

[30]Leedom, et. al., *Cognitive Engineering for ABCS*, 4-6.

[31]Lieutenant Colonel James E. Harris III, "To Fight Digitized or Analog," *Military Review* vol. 79, no. 6 (November-December 1999), 23.

[32]Harris, "To Fight Digitized or Analog."

[33]Stephen F. Garrett, "Evolving Information-Age Battle Staffs."

[34]TRADOC Pamphlet 525-70, *Battlefield Visualization Concept,* 3.

[35]Student Text 3-0, *Operations*, 11-14.

[36]Field Manual 6-0, 4-3.

[37]Department of the Navy, United States Marine Corps. Marine Corps Doctrinal Publication (MCDP) 6, *Command and Control* (Washington, D.C.: Department of the Navy, 1996), 74.

[38]Field Manual 6-0, *Command and Control,* G-3.

[39]Snyder, *Command and Control,* 74.

[40]MCDP 6, *Command and Control,* 72-76.

[41]Ibid., 7.

[42]Student Text 3-0, *Operations,* 5-1.

[43]Thomas Davenport. *Information Ecology: Mastering the Information and Knowledge Environment* (New York: Oxford University Press, 1997), 28-33.

[44]Stephen F. Garrett, "Evolving Information-Age Battle Staffs."

[45]Field Manual 6-0, *Command and Control*, 3-10.

[46]Ibid., G-6.

[47]Ibid., 5-17 through 5-20.

[48]James P. Kahan, D. Robert Worley, and Cathleen Stasz, *Understanding the Commanders' Information Needs* (Santa Monica, CA: RAND, 1989).

[49]MCDP 6, *Command and Control,* 96-100.

[50]Major Anthony R. Garrett, "Information Superiority and the Future of Mission Orders," *Military Review* vol. 79, no. 6 (November-December 1999).

[51]Stephen F. Garrett, "Evolving Information-Age Battle Staffs."

[52]Field Manual 100-5, *Operations,* 2-15.

[53]Stephen F. Garrett, "Evolving Information-Age Battle Staffs."

PART IV: COMMAND AND CONTROL COMMUNICATIONS

> What we must remember is that this new information technology is only the pipeline and storage system for knowledge exchange. It does not create knowledge and cannot guarantee or even promote knowledge generation or knowledge sharing in a corporate culture that doesn't favor those activities. The proverbial phrase "if we build it, they will come" does not apply to information technology [*emphasis mine*].[1]
>
> Thomas Davenport and Laurence Prusak, *Working Knowledge*

Modern communications networks are changing how in commerce and the military alike achieve their goals and objectives. Communications, or the meaningful movement of information, has traditionally defined the limits of military operations in terms of force size, dispersion, speed, and complexity. Modern RMA theorists see these limitations disappearing as communications capabilities advance exponentially. Indeed, for the first time in history military communications, like telecommunications in general, has the potential to move more information more freely over a wider area than can be processed and used. Communications system can now be built which can accommodate nearly any need, process, range, or requirement. Yet military communications are still limited by a number of important factors such as physics, security, and cost. The high cost of these highly technical, rapidly changing, and maintenance-intensive systems makes the investment a matter of tremendous importance. The relevant issue for investment in communications is less a question of what can be accomplished, but increasingly one of what is desirable and affordable. The implications on organizations and procedures are profound, and probably not fully understood by most commercial and military leaders because of the recent, rapid change in information technology systems.

This chapter begins with a general review of some of the basic communications systems components which affect the how the system works. Digitization parameters and considerations which impact planning and execution are identified and analyzed in the study, and these are compared to current commercial trends and considerations in communications. This chapter concludes with a forecast for the future of military communications.

Military Communications Baselines

Like most complex systems, communications systems can be broken down into a set of a few distinct components. While the sum total of all communications would include simple written messages and conversations, the technological components of modern, worldwide telecommunications networks are also understandable in terms of the services they provide and how they fit into the overall system of operations. While there are complex ways of breaking down these systems such as the seven-layer model, this study groups communications in terms of their forms of transmission, information flows, and linked locations or activities. The technical components are divided into three categories of switches, transmission systems, and interfaces.

Perhaps the key to determining communications systems' attributes is finding out how the user community optimally accomplishes its goals or functions. Major variables in communications systems design include the types or forms of communications needed, the locations or nodes which need that information, and the optimum flows needed such as broadcast or point to point.

Communications Types

Looking at current Army tactical communications in terms of what, where, and how much information a single unit headquarters moves would include myriad formats, linkages, contents, and purposes. While the various means a commander and staff employ to plan, direct, coordinate, and control operations have proliferated in recent years, the basic types of communications have not changed. These include one or more of the six types of communications: voice, text, graphic, liaison, interpersonal, and implicit. Voice includes any audio transmission and is the fastest type of communications and is most prevalent at lower echelons. Text and graphic are the most formal forms and include reports, electronic mail, orders, overlays, maps, sketches, and images. These two forms are most often combined, such as when diagrams are added to text in this work, or when text added to graphics, such as map legends. Liaison is the successor to messenger service and is most often employed to clarify and amplify the other forms between organizations which are not familiar with each other and engage in temporary, mission-oriented relationships. Interpersonal, or face-to-face contact is often the most effective, most common, and often the most informal form. It includes visits, meetings, and, briefings. Implicit communications involves a level of trust and common understanding built upon shared experience. Implicit communications involve personal relationships and are often nonverbal, intangible, and informal.

The six basic types of communications often overlap. For example, data and graphics are often combined, especially in the case of orders. Whiteboard and VTC are themselves combinations of voice and graphics. General relationships between the forms are also discernable. For instance, implicit communications and liaison communications

normally have an inverse relationship because liaisons are most often employed when units lack cohesion built over time. The level of overall implicit communications is also directly related to less formal types of communications such as voice, implicit, and interpersonal.

Table 3. Communications System Requirements Menu

Command Functions	Info Flows	Commo Types
Leading Planning Coordinating Controlling	Point-to-Point Demand-Pull Supply-Push Broadcast	Voice Data Graphics Liaison Interpersonal Implicit

Communications Spheres

The list of locations or nodes to which a typical headquarters must communicate is a fixed number of "spheres" which represent groupings of requirements. These four basic spheres involve communications with higher headquarters, with lateral and supporting units, internally between nodes, and with subordinate units. This model as a standard raises a few issues at the outset. Obviously, across each of the spheres there are significant duplication and overlap of communications capabilities, needs, and linkages. This simplified model focuses the differences of the major bundles of requirements from a single headquarters' point of view. Conversely, exceptional types of ongoing communications exist in every organization, such as a directed telescope employed to supersede communications norms.

Unit communications to higher headquarters is the starting point for the unit's subsequent, mission-related C2. Units normally maintain immediate, mobile, and near constant communications with higher headquarters to receive direction and obtain information while sending reports and requests. Therefore higher echelon communications usually utilize point-to-point (to receive direction and send reports) and demand-pull (to obtain information) information flows. These interactions further imply a heavy traffic with higher in data, and graphic communications. Use of interpersonal communications is often a factor of unit locations and time in this sphere.

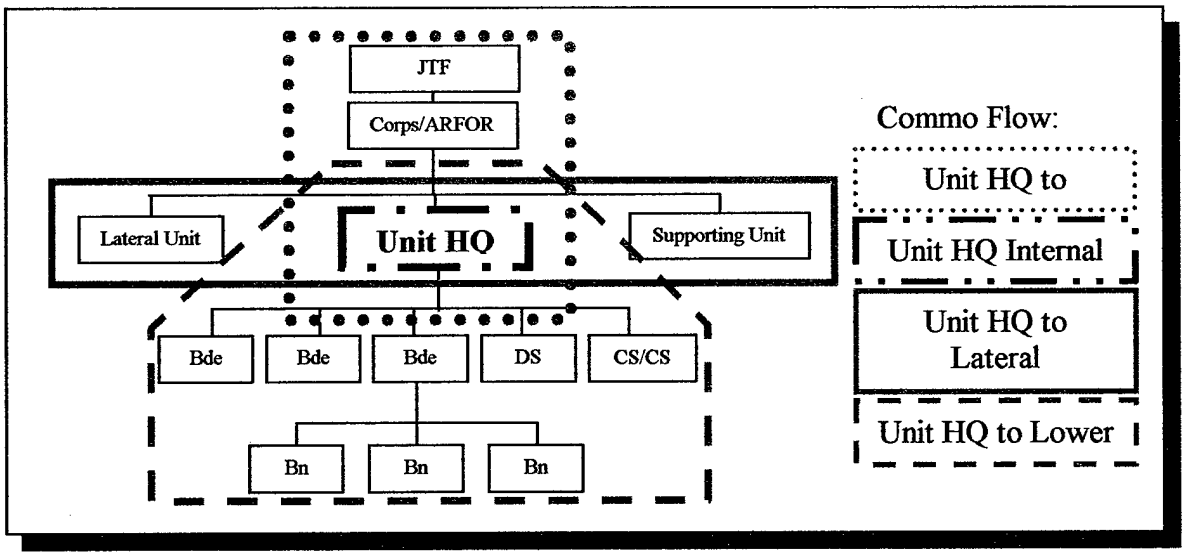

Figure 21. Spheres of Operational Communications

Communications with lateral units involve the functions of coordination, control, and some planning. Since lateral units have the requirement to monitor each other's ongoing activities by the exchange of status, requests, and control measures. The propensity of these communications is supply-push to send coordinating measures and information and demand-pull to obtain information and status. The likely types of lateral

communications often include voice and implicit at lower echelons and often add liaisons at higher echelons. Communications to supporting units, some of which may be outside the unit's normal organization or service, often imply some sort of temporary relationship. The command function of planning and coordinating with supporting units requires the ability to exchange text (orders, requests), graphics (maps, overlays, control measures), and, of course, liaisons.

The requirement to communicate from higher to lower primarily involves the functions of planning and coordinating at the beginning of operations, followed by directing and controlling. The commander requires near instantaneous, mobile contact between these echelons for point-to-point and demand-pull information movement. Supply-push of orders and information is also critical to both higher and lower. To meet these requirements, links using all types of communications are employed with the possible exception of liaison. There are other differences depending on echelon, for instance voice is more prevalent at company to platoon, and data and/or graphics more prevalent at corps to division. Likewise, while all commanders will require a degree of interpersonal communications, at higher levels these will be less prevalent due to larger spans of control, longer distance, and more capable alternatives such as VTC. The last but perhaps most common type of higher to lower communications is implicit, which depends on the cohesion and length of tenure of the leadership of a unit.

Within a single headquarters, internal communications revolve around linking a commander and staff dispersed between up to three remote locations. The primary internal functions for a headquarters are planning and coordinating, then leading and controlling in order. Unit commanders require demand-pull and supply-push links to and

from the staff for the ongoing exchange of information, intelligence, and direction. Of course, interpersonal contact and implicit communications play a large role in these efforts, reducing the need for formal text but raising the level of voice transmission. Text, and graphic links play a lesser role in the production of policy, as well as updating the commander on status of ongoing operations. Graphic communications in particular focuses the commander and staff on the key depiction of the battlefield, the situation map.

The broadcast information flow lies outside the model because, by definition, it traverses all spheres. Broadcast, the automatic transmission of information to all possible receivers, is used primarily in conjunction with critical information such as the answers to the questions: Where am I?; Where are my buddies?; and Where is the enemy? The sparing use of broadcast is necessary because, like "spam" electronic mail, it can clog transmission pipes, switches, and interface systems.

Communications Systems Components

The actual components of a communications networks can be divided into three primary components: switches, transmissions systems, and interfaces. Since systems development of complete communications systems usually involves teams of experts months of work and is far beyond the scope of this study.

Switches are the heart of any communications network. Traditionally, they provide the carrier signal which the actual communications "rides" from one place to another. Switches are also equipped with the mechanisms which determine how a message moves from point to point. Switches often serve an additional functions when they break up messages or transmissions into bits, called packets, which may be sent over

numerous paths to the distant end, where another, similar process reassembles it and sends the message to the receiver. Switches have certain capacity for doing all these things, making them limiting factors in any network. Modern switches include routers which identify electronic addressees embedded in messages and gateways which include some protection and security screening within and between large bodies of users. More traditional military switches include the small extension node, which connects local area users with each other and the larger network. All these machines identify the address, search for a path to the destination, and then send the message, all nearly instantaneously.

Transmission systems are the "pipes" through which messages, data, graphics, or voices are sent. Generally, these pipes are established over the air or through cables and are relatively static, since it is up to the switches to control how the pipes are used. Transmissions links can be established over various media, such as radio links over the air and through space, or digital data links over wires and cables.

While there are dozens of types of interfaces in telecommunications systems, for this study interfaces are software programs which enable users to convert meaningful data and information into forms which can be stored and transmitted. For telephones or radios, the interface is the acoustic "reader" which converts voice sounds into either radio waves or data bits. For computers, software converts user input into bits and bytes. Software has two major branches: user applications and operating systems. User applications such as Microsoft Office enable the user to form and save data and information. Operating systems such as Windows NT or UNIX are the brains of the computer and they run all the transparent but essential machine functions of the system which enable user applications to run. Protocols are sets of rules which link switches,

transmission pipes, and interfaces together, enabling the movement of information across networks.

Commercial IT Trends

Commercial users of advanced communications systems are changing the way business is done. Market forces and trends reflect the advance of telecommunications systems in the information age. These trends largely define the limits of interoperability and communications capability available to military and commercial users.

The Internet Protocols

The Internet is swiftly creating a standard set of information movement protocols worldwide. As commerce and the armed forces become more dependent on this information source and communications network military communications systems are adhering more closely to Internet standards. Beginning with the Global Command and Control System (GCCS) set of standards, military systems are using the Internet as a model for interoperability, flexibility, and transmit-ability. GCCS is a key military C2 system because it was designed in part to establish and field an official standard of interoperability for Department of Defense information systems. To date millions of dollars have been spent in all the services on information systems, software programs, and communications means which do not work together.

The current Internet protocols provide a baseline set of tools from which organizations can and do build adaptive, dynamic information systems. This packet-based Transmission Control Protocol/Internet Protocol (TCP/IP) set of protocols allows organizations to move information on flexible, expandable, and graphically oriented websites. Hypertext transfer protocol and file transfer protocol (FTP) are the

transmission standards for transmitting websites and files respectively in an effective, bandwidth conservative way. Electronic mail via Simple Mail Transfer Protocol (SMTP), builds on TCP/IP to offer another set of ubiquitous, easy to use information movement standards. Organizations can enhance the basic website with advanced software tools through add on capabilities such as dynamic web page markup languages, database interface languages such as PERL and MS Access. Further applications enable enhanced information movement applications via the web such as interactive chat, sound and video streaming, and telephony. These applications, commonly available, build on the common Internet protocol standards to provide multi-media communications worldwide.

For example, Sun's Java software is but one add-on application built to leverage the existing TCP/IP network to create a variety of interactive tools. Java uses TCP/IP to create active web pages which have the capability of updating themselves automatically to ensure users have the latest information displayed each time they access their web browser. Java is the enabling technology which allows mobile users to access their standard information suite from any type of computer from UNIX to Windows.

Wireless Mobility

As commercial firms expand globally via the World Wide Web, executives travel to meetings and briefings at an increasing rate. As they travel, executives have come to expect access to communications which replicate the capabilities of their offices. This has fueled the wireless boom in not only voice cellular telephones, but in the exchange of critical data and graphic information over long distances.

There are two platforms for wireless communications: cellular phones and notebook PCs. Both of these small, light devices offer roaming connectedness via cellular line of sight microwave relay for voice communications and modem connections via cellular links for data exchange. The proliferation of connection locations (the expansion of the wireless coverage areas) enables electronic mail, document transfer, and limited web browsing. The traditional personal organizer, pager, and cellular phone have been combined and enhanced by the addition of position location information and document transfer capabilities. The leaders in this field such as Nokia, Ericsson, and Verizon are moving towards making the personal hand held device more like a full computer with voice recognition software and VTC. Other firms are developing lightweight, wearable computers which will approximate the clarity of a 19" monitor by use of a miniature eye screen. Wireless notebook PCs naturally provide more capability and ease of use than their hand held cousins. Most notebooks come with either wireless LAN or dial up connectivity through common data communications types and office formats. While many of these advances are not ready for the open market, they illustrate the rapid miniaturization and mobility of an increasing array of computing applications through wireless communications.

Compatibility and Interoperability

The IBM compatible personal computer was the first mass-market, ad hoc IT standard. IBM defined the platform for computing which, in turn, drove how software and hardware were subsequently designed. Since the interconnectedness of IT is its defining advantage, no corporate entity is willingly stuck with dead end technology such as Betamax, ISDN, or Iridium. This is the reason why Microsoft has been so successful

in marketing its Windows and Office software systems. When the MS Office standard became ubiquitous, it drove what the industry defined as a standard. Multimate, Lotus 1-2-3, Harvard Graphics, and WordPerfect all declined, despite their superiority in some areas over Microsoft products.

Since the Internet defines ad hoc standard for intercommunications, all IT products which seek to be successful must have the capacity to work with or over the Internet. For this reason, the emerging standards of communications software and protocols are nearly all driven by the Internet's existing set of standards, primarily, TCP/IP. Yet wireless communications currently has three distinct sets of signaling, all of which provide some degree of web communications. The local network for wireless access often depends largely on which continent one is in at the time. The eventual market standard, if one ever emerges, will be the one which is able to provide the best services to as wide a coverage area as possible, and interface more fully with existing ad hoc standards such as the TCP/IP and MS Office.

One final point to consider in the commercial adaptation of information technology is the upgrade factor. While military systems can take up to ten years to develop and field, commerce has realized that IT system are continually upgraded and therefore require not only a common base of interoperable protocols, but an infrastructure to add capability in methodical, non-intrusive ways. The military outlook on IT systems mirrors that of weapons systems where the equipment is developed to the highest degree possible then fielded as a self-supporting package. In an age when the hard drive of a typical computer doubles in capacity every twelve to eighteen months, the military ten-year development, cycle which emphasized "field and forget" is no longer possible.

Ease of Use

The interface between information technology users and the highly technical systems often determines which products and systems succeed and which fail. When the Internet first evolved, users were limited to large corporations, universities, and government agencies because these organizations had the expert knowledge necessary to use and understand the rudimentary intercommunications protocols of the first Internet systems.

With the 1993 advent of Netscape Navigator, America Online, and Prodigy On Line, the World Wide Web was accessible through an easy to use graphic user interface (GUI) called the net browser. This caused the explosion of the Internet, which was sustained by the simplicity and flexibility of its protocols. GUI continues to be a critical issue for commercial IT users in a world where the digital tools of modern business grow in complexity yearly.

Advanced GUI programs are enabling new methods of information exchange. Optical Character Readers (OCR) enters text automatically into commonly used word processors. Voice recognition programs are enabling users to talk to their computers through a user-defined set of verbal keystrokes for enhanced ease of use in multiple applications. Also, object-oriented software and light pens enable users to draw directly onto screens to highlight, alter, or otherwise enhance the display.

Since more information can be moved, stored, and presented than humans can use, the commercial trend is to install collaborative subsets of the greater whole of available data and information on the Internet. Multifunctional work group technology such as Microsoft Outlook and Lotus Notes run on intranets to provide users with a single

point of entry to multiple applications and communications menus. Intranets, like protected harbors, shield these extensions of the available mass of data and allow users to focus their information according to their needs. Companies are, in effect, erecting barriers to the outside world of communications in order to secure and focus their information on their local systems to their specific needs. Knowledge management systems and collaborative environments concentrate on managing and enhancing the value of readily available, protected information which organizations share and use.

Technology on the Battlefield

While the Army attempts to field its common operational picture, the applications which make digitization so useful are being replicated in commerce. Trucking companies and commercial shipping firms already employ a version of GPS provided position location. Satellite imagery, downloadable to remote locations has become available to private firms. Cellular telephone networks provide voice and data communications over an increasing area of the globe. The Internet offers tremendous volumes of valuable open source information and serves as a psychological operations platform. Java enhanced web pages update themselves in minutes to distribute an information package which includes a version of a common operational picture, organizational status, and CCIR. The adaptation of these technologies can approximate a rudimentary but effective version of the latest military command and control system. Or, adversaries could take the easy way to COP, and simply capture one of ours. It is inconceivable that future enemies would not focus significant efforts on the capture of but one vehicle which provides them a relevant combat picture of not only where Army ground forces are, but a depiction of red forces as well. History has proven, again and

again, that purely technological advantages of an army are short lived. More lasting advantages are built in organizations and procedures, which take years to develop and employ.

Perhaps the most important issue to confront, and one which has received only passing attention in the digitized literature, is what to do when the lights go out. The 4th Infantry Division has experienced degrees of unreliability of ABCS in every AWE to date.[2] When the enemy captures one of our FBCB2 systems, the entire network may well have to be shut down before they corrupt our data beyond repair. Urban terrain, so successfully used against American forces in Somalia and Russians in Chechnya, restricts the line-of-sight radio links upon which COP depends. The fifty-year old answer is, of course, is maps and radios. History provides examples of effective systems which operate well when uncertainty at higher echelons, as would certainly be the case here, is acute. Decentralized operations, limited through redundant communications, and clear commander's intent all enable the continued effectiveness of lower echelon leadership when the lights go out.

The increase in the use of commercial systems by military organizations points to the continued applicability and effectiveness of commercial-off-the-shelf (COTS) products. The digitized division itself employs numerous operational websites, shared Windows folders, and MS Office tools to increase efficiency with little or no training or cost overhead. Since rest of the interconnected world, and especially joint forces, also rely on these tools, the lack of attention they have garnered in Army doctrine, training manuals, and procedures is unusual. While dozens of reports, manuals, and professional articles attempt to convey the positive aspects of digitization, the Army has a single

manual which provides guidance and options for leveraging various Internet technologies for operational needs. Although FM 101-4 *JTF-IM: Multiservice Procedures for Joint Task Force Information Management* was not written by the Army, it is an excellent guide on the effective use of operational websites, newsgroups, electronic mail, video teleconferencing, and other commercial technologies. This joint Air, Land, Sea Application (ALSA) Center's manual also outlines other information management issues such as meetings, standard reports, logs, and briefing formats.[3] Unfortunately, since the manual is geared to serve the Joint Task Force and was produced by a joint headquarters, FM 101-4 is currently not widely known or used in tactical Army units.

Army Battle Command Systems (ABCS)

ABCS is a family of tactical data information systems associated with battlefield functional areas (BFAs), created to enable planning, leading, coordinating, and controlling command functions in Army operations. Force XXI is the program to develop and field ABCS and its associated applications of over 100 tactical data systems which provide COP and assist with the development of the commander's situational awareness and situational understanding.

While the Army has information systems which relate to every conceivable function, specialty, element, and task, ABCS is generally recognized as the primary set of "digitization" operational systems. Because the actual definition of which systems comprise ABCS, this study adheres to the curriculum at the Command and General Staff College's (CGSC) Center for Army Tactics which includes in its definition the All-Source Analysis System (ASAS), Advanced Field Artillery Tactical Data System (AFATDS), Combat Service Support Control System (CSSCS), Air and Missile Defense

Work Station (AMDWS), and the Maneuver Control System (MCS). The main "associated" systems include the Future Battle Command Brigade and Below (FBCB2) and the Global Command and Control System-Army (GCCS-A) which are primarily maneuver control systems for echelons below and above division respectively.

The ABCS themselves are actually sets of software applications and communications programs which help format any input data, processes it in the context of some initial set of parameters, and communicate it with other, distant computer terminals. The systems were designed to automate the planning, monitoring, and executing of basic BFA-specific tasks for increased efficiency. Since most of the ABCS were designed as communications platforms as well as planning and information systems, they were all originally built using the UNIX operating system. UNIX is the flexible but technologically intensive set of software tools used for multiple, simultaneous users which runs most Internet servers. Two major issues with UNIX have affected the ABCS. First, UNIX comes in a number of "flavors" which are not necessarily completely interoperable with each other. Secondly, UNIX normally runs intricate, high level programs which require significant computing power, far beyond the capacity of the standard desktop personal computer.

Force XXI Battle Command Brigade and Battalion (FBCB2)

FBCB2 uses Global Positioning System (GPS) receivers and Enhanced Position Location Reporting System (EPLRS) digital radios links to compile and broadcast the tactical COP consisting of an automatic portrayal of friendly force units and their status. The FBCB2 system also can portray enemy locations based on user input and add them to the computerized picture of friendly forces. Other capabilities include the display of

planning and control overlays, and logistics status. The friendly relevant operating picture is created and distributed automatically via EPLRS and SINCGARS radio links (together called the tactical internet or TI) from remote, vehicle-mounted terminals using a Netscape browser across the battlefield. Users can submit reports and requests for medical, NBC, logistics, and intelligence via standard formats. The system also assists with order and overlay production and distribution for planning, command, control, and coordination.

All-Source Analysis System (ASAS)

ASAS is the intelligence and electronic warfare component of ABCS which provides the graphic enemy situation for the COP on MCS. ASAS is built to accept data from multiple sources including Joint Surveillance and Target Attack Radar Systems (JSTARS), standardized reports (SALUTE), UAVs, and national strategic assets. ASAS performs tasks relating to targeting, geodesy, threat database, messaging, collection management, and situation analysis. ASAS has been fielded in both "heavy" and "light" versions. The heavy version is normally fielded at corps through division and is a high capacity, UNIX system on a Common Hardware System terminal. The Remote Work Station (RWS) is the light, Windows NT version and is specially configured to incorporate intelligence and information products from the heavy ASAS version and distribute them across other ABCS at echelons below division.

Maneuver Control System (MCS)

MCS is the maneuver-oriented program planned and designed to fuse several ABCS systems' information onto a single computer screen, providing the commander with the friendly and enemy COP. MCS automatically fuses friendly force location and

status information from FBCB2 with enemy location and status information from ASAS. The COP itself has been described as the answers to the three critical questions of Where am I?; Where are my buddies?; and Where is the enemy? MCS also includes map and overlay production and communications tools such as file and message transfer, and on-line chat. There are also two versions of MCS. MCS heavy provides the relevant common operational picture via its UNIX Common Hardware System (CHS) workstation. MCS heavy also is the system which compiles the overall COP using input from other ABCS systems. MCS light is run on a standard PC using the Windows NT operating system and enables planning and orders preparation.

Combat Service Support Control System (CSSCS)

CSSCS provides the logistics planner and operator a means to track and coordinate CS and CSS assets on the digital battlefield. It features automatic logistic monitoring and tracking, requests, supply, maintenance, medical, field services, and movement status, data, and communications. CSSCS runs on a UNIX system and uses the CHS II heavy workstation and operations.

Advanced Field Artillery Tactical Data System (AFATDS)

Like most ABCS, AFATDS is actually a family of software and networked workstations connected via radio links to automatically communicate battlefield information about fire support from artillery unit location and ammunition storage sites to fire support control measures. AFATDS enables tasks to be automated and information shared among fire support staffers and units. The Fire Direction System (FDS) is a primary AFATDS application designed to receive information provided by ASAS or from forward observers and process fire support requests automatically to a firing battery.

AFATDS manages and tracks fire support assets from mortars, MLRS, attack aviation, naval gunfire, and offensive electronic warfare. AFATDS also features a set of planning tools to assist with the targeting and fire support tasks of the MDMP. All AFATDS applications run on UNIX based computer workstations.

Air and Missile Defense Work Station (AMDWS)

The AMDWS is a comprehensive air defense planning and airspace situational awareness tool for use at the air defense battery to theater air defense commands. The AMDWS program includes the Air Defense Systems Integrator (ADSI) which provides connectivity to multiple joint air defense and control systems such as the TADIL family of data links; and the Forward Area Air Defense Command, Control and Intelligence (FAADC2I) system which is designed to provide near real time airspace and air defense graphic displays. AMDWS is a UNIX system which uses its own heavy workstation.

Global Command and Control System-Army (GCCS-A)

GCCS-A is the Army's component of joint GCCS family of C2 systems. GCCS-A was designed to include a suite of tracking and COP systems for force management at division, corps, and army level. Its primary purpose is to allow the ARFOR or Land Component Commander (LCC) to interface with joint GCCS and its service level components for joint force coordination and visibility. GCCS-A is a UNIX system which uses Sun Sparc Common Hardware Systems II heavy workstation.

ABCS Interoperability

The individual ABCS were initially designed and built by and for separate user communities for different purposes and command functions. Individual Army branches originally paid for the design and construction of their BFA specific ABCS. Since

interoperability was not a primary concern, it was not incorporated into the basic data and intercommunications format of the systems' operating software. Furthermore the user communities of the individual ABCS, and the contractors who developed them were largely senior and retired military personnel interested in enhancing the operations of their BFA. This led to a conceptual limitation in the design of the systems where legacy processes and products were automated for limited user groups. Rather than develop a system of systems for a new operational paradigm, the ABCS were initially created to pave cow paths which ran parallel to each other, never intersecting. The stovepiped origin of the individual ABCS has lead to continued problems with interoperability. Differing data formats, GUIs, and communications protocols has created significant fielding issues for units attempting to implement these systems in an integrated way.

There are currently four methods of sending data between the ABCS: File Transfer Protocol (FTP), Local Area Network (LAN), Wide Area Network (WAN), and MTF. FTP is used when the data are readable equally by both systems because FTP does not alter data in transmission. LAN interoperability requires both systems to be able to access the same database and display the same relevant data. Both LAN and WAN information exchanges in digitized units often rely on Internet browsers such as Netscape and simple electronic mail to achieve a commonality of software GUI. ABCS via WANs is transmitted over tactical radio links. Larger, multichannel links enable a greater number of applications and data transfers. Single channel links limit ABCS connectivity. For instance, when the FBCB2 updates automatically the location of all units for the friendly force COP, the radio net is rendered useless for a short period due to the congestion of automatic location and status data transmissions.

The primary medium for the exchange of information between ABCS is the MTF system of messaging, which is a joint standard, text-based set of preformatted messages. These formats are automatically filled with data and transferred over existing communications links or over LANs from one ABCS to another. For example, the MTF message type 507 (Unit Location) features standard information fields for friendly unit location. This information is transmitted from MCS to the other ABCS which automatically read the information and places unit icons on the appropriate overlay or graphic. This system has two drawbacks. First, the overlay or map used must be capable of receiving the information from the message, which means that the data formats must be identical on both ends. But, like any system which converts graphics to data then back again, the transfer of unit location information is problematic when one or more preset parameters on either end are not synchronized. Also, since it is a text-based system, MTF represents the absolute minimum interoperability between systems. Several simpler commercially available collaborative systems are able to exchange and read graphic information in the original format directly via object-oriented capabilities or simply by using the standard underlying data formats and protocols. For instance, common image data formats such as JPEG or GIF are easily transferable from a web page to a Power Point presentation with no unintended alteration or loss of information.

While MTF moves more raw data than any previous tactical communications system, interoperability problems with the data often make it less valuable. This has led to the biggest challenge of the ABCS family of systems, namely to create a common operational picture which automatically integrates both the updated friendly and enemy situations. Currently, the standard method of transferring enemy situation information

from ASAS to friendly situation displays on MCS is via MTF standard messages and FTP overlays which, as is common in add on capabilities, often produces imperfect COP products. For instance, since one system may use the term "location" and the other "position" the data is either ignored by the receiver, or it is altered, creating an incomplete or imperfect product.

Also, some systems have more refined overlay creation tools than others. While both conform to current Army and Joint standards, they are not fully interoperable because the data inserted on the more precise overlay is not readable by the less capable system. While the contracting community is working to address these issues each upgrade in software which is fielded by each ABCS requires the rebuilding of interoperability software, especially between old and new versions of ABCS. The underlying interoperability problem with the current ABCS is the various incompatible versions of UNIX used to build the original BFA versions of each system.
Light versions of ABCS have been used to enhance the interoperability of ABCS and windows computers and to increase the mobility of some systems. Windows NT versions of ABCS enables the use of common applications in the MS Windows and TCP/IP environments such as PowerPoint, Excel, MS Word, electronic mail, net meeting, FTP, web applications, and desktop VTC programs. Yet, the need to create additional versions of the same systems such as MCS and MCS Light and ASAS and ASAS RWS also creates interoperability issues where different versions of the heavy and light systems cannot seamlessly communicate.

The proliferation of systems is an additional concern during the period when the basic interoperability issues with the five main ABCS systems are being addressed and

rectified. Yet, the various development and maneuver communities of ABCS (five distinct organizations as of this study) often address shortcomings in ABCS through the development and fielding of entirely new systems. BPV, for instance, was fully developed over the last two years and added to ABCS to overcome the planning shortfalls of MCS. The lack of sensor to shooter seamless interoperability between ASAS and AFATDS led to the development of add on software applications called TIDAT (Targeting DATa), and TCRIT (Targeting CRITeria). In effect, the Army is "building bridges to legacy systems"[4] according to one former digitized brigade commander.

It is the using unit which experiences the impacts of these interoperability constraints most acutely. Staffs in the two digitized TOCs of the 4th Infantry Division must monitor up to seven different screens to display the fragmented parts of the current common operational picture.[5] Also, the commander's situational awareness is restricted when he is away from the TOC because of the limited portability of ABCS applications over small radio links to remote locations over a larger operational area.

Joint and strategic systems enjoy a far less cohesive community of stakeholders and technicians than Army information systems developed largely in the 1980s and 90s. The Joint systems have been under development since the 1950s and are perhaps further on the road to interoperability than ABCS. The example provided by the slow, problematic integration of joint systems into a single GCCS standard is one which can be learned from to avoid the same mistakes. It took the Y2K crisis for the joint community to finally retire many legacy systems with proprietary technology and incompatible protocols, operating systems, and data formats. The elimination of systems to create

more interoperable joint C2 communications systems is an example for Army systems development of future C2 communications systems.

ABCS Implementation

The way ABCS was constructed and the capabilities it brings to the command make it more capable in certain communications types, spheres, and flows. In communications types, ABCS is clearly a text and graphic set of systems. Yet ABCS can be applied to interpersonal, implicit, and liaison communications as well, particularly through the use of its embedded video teleconferencing (VTC) tools. Since implicit communications are generally nonverbal, the COP can approximate this communications medium.

In information flows, ABCS is primarily a supply-push set of systems, especially in its primary information exchange method of automatic Message Text Format (MTF) messaging which presets the automatic transmission of information between terminals. There are limited demand-pull flow capabilities of the ABCS, but normally between systems of like types. For instance, an ASAS-RWS at brigade may pull down imagery from a heavy ASAS at division, but an AFATDS or AMDWS generally cannot. This supply-push nature of ABCS increases the amount of moving data because rather than choosing the necessary pieces of information needed from a remote system, MTF messaging automatically fills dozens of obscure input windows in each message and is sent at set time intervals (usually every fifteen minutes in the case of the COP). Unlike modern Internet systems which can detect and send only data which has changed from a previous transmission, MTF sends all data entries, every time. Since every ABCS

computer is a provider of data or information as well as a consumer, MTF messaging can flood tactical communications with data.

ABCS can engage in other information flows as well. In point-to-point communications, the ABCS provide numerous methods of transferring data and information, such as free text MTF messages, file transfer protocol (FTP), electronic mail, and limited VTC and chat functions. Broadcasting in ABCS is rare, and unlikely with the requirement for close attention to systems settings for proper rendering of received information. The COP is broadcast in a limited way, but the supplier of the picture must manually add each recipient to his distribution table. If the distant end is not programmed into the sender's system, he is unreachable via direct broadcast.

ABCS in Planning

Since the MDMP was one of the original design parameters of many of the ABCS, many of these applications were built to assist specific staff sections and specialized support units in mission planning. The three major goals of the ABCS with regards to the MDMP were to provide the necessary information input for options and decisions, to speed the planning of the commander and staff through the MDMP analysis process, and to enable the construction and distribution of orders.

The MDMP steps specifically involving communications during planning are listed below with their flows, types, and spheres. A plus sign (+) indicates an enhanced capability through ABCS.

Step 1: Receipt of Mission

+*Receive Order*-point to point text and graphic communications with higher.

+*Issue Warning Order 1*- supply-push text and graphics to lower and supporting units.

Step 2: Mission Analysis

+*IPB*- demand-pull reception of text, graphics from both higher and lower echelons' and text demand pull internally (from staff).

+*Staff Estimates*- demand-pull text and graphic information from lower echelons and point-to-point collaborative text and graphics internally shared.

+*Commander's Intent/Planning Guidance*- supply-push interpersonal and text shared internally shared.

+*Preliminary Movement and Recon*- point-to-point text or voice to lower units.

Mission Analysis Briefing- various interpersonal communications internally shared.

+*Issue Warning Order 2*- supply-push text and graphics to lower and supporting units.

Step 3: COA Development

+*Staff Estimates/Products/Enemy COA*- point to point (collate) text and graphics internally.

+*COA Statements and Sketches*- supply-push text and graphics internally.

Step 4: COA Analysis

War Game- various interpersonal (text, graphic, voice) communications internally.

+*Task Organization*- supply-push text internally.

+*CCIR*- supply-push text to lower and adjacent units.

Step 5: COA Comparison

Brief Results- various interpersonal (text, graphic, voice) communications internally.

Step 6: COA Approval

COA Approval Briefing- various interpersonal (text, graphic, voice) communications internally.

Step 7: Orders Production

+*Prepare Orders*- point to point text and graphic internally.

+*Transmit Orders*- supply-push text and graphics to lower and supporting units.

Since ABCS is primarily a text and graphic, point to point and supply push, internal system, it has the capability to speed many of these MDMP communications steps and tasks in planning, especially the numerous requirements to move and share information internally within a headquarters. A key factor in the use of ABCS is the ways in which it allows the commander and staff to employ efficiencies in the planning process. ABCS allows remote, collaborative planning in many steps of the MDMP, saving time at multiple echelons. Also, while ABCS lacks voice communications,

telephone links are often added to ABCS collaboration type tools such as white board VTC enabling remote participation in key MDMP steps such as commander's guidance, decision briefings, and especially wargaming. This enables commanders across the unit to attain a higher degree of operational cohesion and visualization earlier in the MDMP process.

ABCS systems cannot; however, fix a faulty MDMP process. Based on the AWEs and reflected in other evaluations of digitized systems, ABCS in its current state probably does not speed the MDMP.[6] In most cases, ABCS did not save enough time to prevent the staffs in these studies from planning in variance to the doctrinal MDMP. Another reason why ABCS does not significantly enhance planning processes is the aforementioned information overload. While ABCS provides plenty of raw information, processing software, and storage space, it is not typically used for information collaboration and distribution. In fact, digitized forces typically use simple web sites and electronic mail to distribute documents and graphics. This is because ABCS boxes are distributed only within BFA staff sections. For instance, since each staff section has a different ABCS system they generally cannot easily share data and graphics horizontally across a headquarters.

The shortfalls in planning with the ABCS led to the development of the Battlefield Planning and Visualization (BPV) system which allows users to move unit icons on three dimensional terrain models and maps enhanced with battlefield geography, conditions, routes, and effects. BPV's design enables it to graphically display the commander's key tasks and end state, providing a graphic intent. Perhaps most importantly, it saves and plays back multiple COAs for the development of branches and

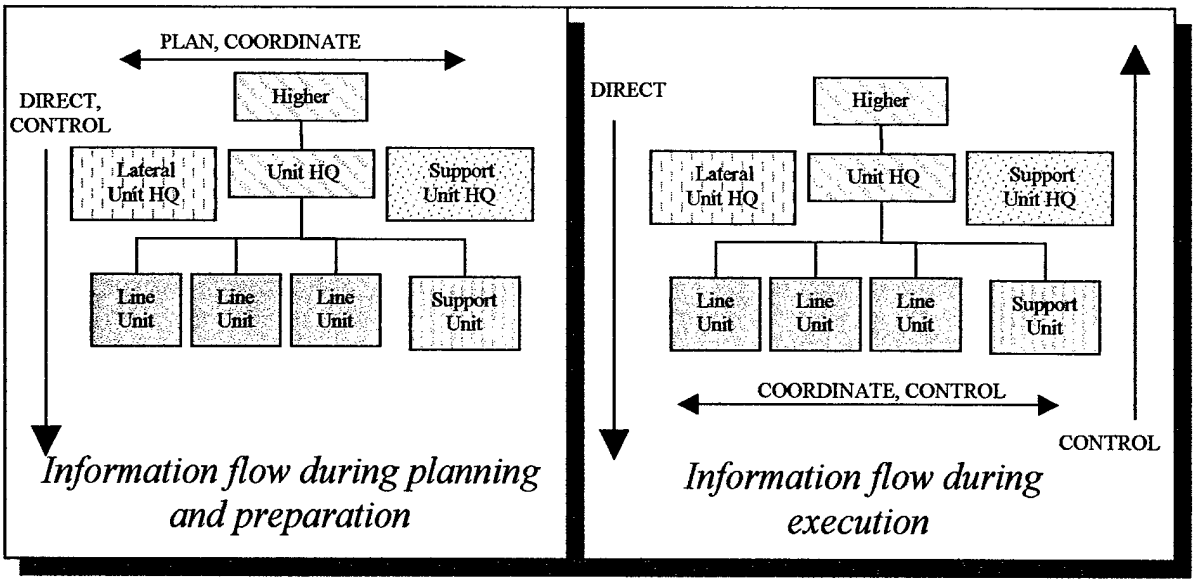

Figure 22. Information Flows Before and During Operations

sequels. Yet BPV cannot generate interoperability and, therefore represents an additional computer system which the staff must learn and integrate for planning.

ABCS in Execution

As the operation transitions from the planning and preparation phases to execution, the primary information flows and communications types are transformed to concentrate on and support lower echelons in the fight. During planning, the bulk of direction and information flows down through the hierarchy and across supporting and supporting units (figure 22). Planning and coordination functions move information laterally at higher echelons, especially between supporting and supported units. Also, a high degree of text and graphic communications between echelons supports multiple planning processes simultaneously.

Once an operation begins, controlling and coordinating information is exchanged horizontally across units conducting the operation. Controlling information also flows up

from the commander in charge of the operation to supporting and higher levels as assets are requested and status is provided. Compressed decision cycles also cause a sharp increase in voice and implicit communications versus text and graphic information.

Recon and Security

+*Issue R+S Plan*- point-to-point text and graphics or voice to lower units.

+*Receive Recon Information*- point-to-point text and graphics or voice to lower units.

Coordination with Supporting/Adjacent

+*Send Support Requests*- liaison and/or point-to-point text, graphic, or voice to supporting units.

+*Coordinate Battlefield Geometry/Linkups* - liaison and/or point-to-point text, graphic, or voice to lateral units.

+*Coordinate Phase Changes*- liaison and/or point-to-point text, graphic, or voice to lateral units.

Rehearsal

Conduct COMMEX- various interpersonal (text, graphic, voice) communications to lower units and internally.

Conduct Rehearsal- various interpersonal (text, graphic, voice) communications to lower units and internally.

Pre-Combat Checks

+*Receive PCI Results*- point-to-point text communications to lower

+*Coordinate CS/CSS Immediate Requirements*- point to point text internally and to lower level units.

Execution

+Monitor Status- demand-pull text and/or graphic, voice, interpersonal from lower units.

+Issue FRAGO- supply-push text and/or graphic to lower and supporting units

The central function of the ABCS, the creation and dissemination of the COP is a demand-pull and supply-push operation. The COP is filtered at each level to provide the commander with the appropriate granularity of detail on friendly and enemy unit status. In pushing the graphics to higher headquarters through MCS, some detail is filtered out. To add enemy situational graphics, brigades and divisions ASAS systems pull enemy situational overlays from lower level ASAS boxes. At division the enemy graphics are fused into one overlay and sent to MCS, which consolidates the two products into a COP.

MCS-Light is used to push the completed COP out to users across the division working on standard windows computers.

The overall impact of ABCS on communications in execution is to reduce the less formal forms of point-to-point communications as more formal text and especially graphic forms of supply-push transmission rise. The prevalence of text and graphic information moved through the ABCS greatly reduces voice transmissions because up to sixty percent of all voice traffic is queries on location and status of friendly and enemy units. Furthermore, since EPLRS typically outrange line of sight FM radios, short text and position location data transmissions increase where no voice is possible.

With COP, these radio and telephone connections are no longer necessary because not only is the information readily available and relatively accurate, a record of the battlefield situation can be saved distribution, reference, and after action reviews. Interpersonal and implicit communications also decline, especially since ABCS contains a number of collaborative tools such as VTC and whiteboard for enhanced, long-distance collaborative communications between commanders. The digitized 4th Infantry Division, for instance, conducts VTCs every two hours for the exchange of battlefield information and uses this system for every division level battle update briefing.[7]

There are negative aspects of this development. When commanders spend more time in TOCs, poring over video screen data opportunities for the leadership aspects of interpersonal communications are lost. Also, the potential for micromanagement in these situations increases as the commander attempts to more decisively project his visualization onto the battlefield without direct, on the spot evaluations of the situation or voice, real-time exchanges of information with the commander on the spot.

While the creation and distribution of the COP is a significant enhancement to battlefield synchronization, there are drawbacks to fighting on a video screen. Of course, any number of interruptions such as electromagnetic pulse can neutralize ABCS and effectively blind the chain of command. Furthermore, since ABCS uses nineteen-inch screens rather than maps, haphazardly drawn control measures and unit boundaries at higher headquarters' can cause problems when the subordinate unit takes a closer look. Also, the traditional tabletop or wall-mounted map offers a view of the area of interest which a computer screen cannot duplicate, altering how commanders see the battle in depth. Finally, COP is leading to the demise of the terrain model, which also offered an effective view of the terrain and area of operations in three dimensions.

On balance, the use of ABCS enhances operational effectiveness of communications in execution especially through the commander's ability to monitor and then affect the situation through COP. Yet information overload, partially due to the automated forwarding of MTF messages and micromanagement as a result of (in part) a loss of interpersonal communications are potential detractors from the effectiveness ABCS brings to the fight.

Communications

In an age when the capacity of the computer hard drive doubles every twelve to fifteen months, the Army's six or seven year development cycle cannot hope to field the latest communications technology.[8] Advances across all parts of communications systems: switches, transmission means, and especially software has led to uneven incorporation in the various Army communications systems, leading to additional interoperability issues. At the same time, ABCS has been a primary factor in the

exponential expansion in communications requirements on the battlefield. The Army's communications systems are changing in two ways in order to keep up with the demands of the user community. First, incremental improvements in individual systems and communications components are constantly designed and fielded. Second, the Army's longer term future communications system will adhere more closely to current commercial standards and therefore more easily reap the advances sown by the private sector.

Multichannel Common User Systems

The current set of tactical vans, truck, antennae, and generators used to form the tactical communications network is called the Army Common User System (ACUS) which consists of the legacy Tri-service Tactical (TRI-TAC) systems for echelons above corps and Mobile Subscriber Equipment (MSE) for corps and below. Both these systems were developed over the 1980s primarily to support the Airland Battle doctrine with voice and limited data transmissions and switching. While most home computer modems now accommodate 28 or 56 Kilobits of data per second (Kbps), TRI-TAC requires two vehicle mounted shelters of radio and switching gear to provide a local area telephone and data network system for 26 phones with an aggregate of 256 or 512Kbps (about four home PC modems). TRI-TAC can provide limited service up to commercial T-1 bandwidth (1.544Kbps) to stationary subscribers near a switching node. MSE is used at corps and below to provide a version of mobile telephone service over transmission paths which feature bandwidth formerly limited to 16Kbps per channel to both stationary and mobile subscribers. Each MSE Radio Access Unit can handle up to eight calls simultaneously over a circular area of 15 kilometers.

Both MSE and TRI-TAC rely on relatively immobile node switching centers and multichannel line of sight microwave radio and satellite vans. Most of these systems have been upgraded in recent years with enhanced transmission and switching components for increased bandwidth capacity. The Tactical Packet Network (TPN) is but one example of how the Army has adapted existing systems to provide enhanced service. TPN uses excess transmissions capacity to transmit packetized data over radio links in much the same way as the Internet uses telephone lines to move data and graphics over primarily voice lines. Another, more recent upgrade is the introduction of the Near Term Digital Radio (NTDR) which increases the ability of MSE systems to transmit large bandwidth data to stationary subscribers, usually located at division, brigade, and battalion command centers. This upgrade in particular is useful in that it allows the transmission of the larger ABCS files and documents via TRI-TAC and MSE networks to lower echelon units.

Single Channel

The EPLRS is a combination of Global Positioning System (GPS) location and line-of-sight single channel radio links. It is the user terminal which automatically updates friendly force position location and relays that information to the collating system to produce a single, graphic COP. EPLRS radios can transmit and receive data messages at 1.2Kbps. This is the backbone of friendly forces automated situational awareness via FBCB2 and other systems. AFATDS, AMDWS, and CSSCS are all designed to be transmittable via EPLRS radio links but with severely restricted functionality due to the bandwidth constraints.

Combat Net Radio (CNR) is the set of current Army single channel radio systems. It includes Single Channel Ground and Airborne Radio System (SINCGARS), tactical satellite (TACSAT) radios, and high frequency (HF) radios which enable one user to contact another over a single communications link or to a broadcast to multiple users over a radio net. AFATDS, AMDWS, and ASAS RWS (light version) also use SINCGARS links for data exchange, again with restricted functionality.

Future Communications

Warrior Information Network-Tactical (WIN-T) is the developing set of future communications systems designed to provide more robust, flexible, and mobile communications to commanders at all tactical echelons. A central project of WIN-T is the mobile terminal for commanders, which approximate cellular and notebook commercial wireless communications devices. The notebook version will incorporate Internet, Secret Internet Protocol Routing Network (SIPRNET, or secret military intranet), voice, and VTC communications. The handheld version is designed to enable voice, electronic mail, whiteboard, and limited data communications.

The Army is also working on other communications transmission initiatives to extend the range of its radios and reduce their weight for deployment. The Joint Tactical Radio System (JTRS) is the future joint single channel tactical man pack and vehicle-mounted radio set. It will replace many of the currently thirty tactical radios currently used by all services in operations. What is new about the JTRS is that it will incorporate software operating systems, enabling easy upgrades and flexible application. Aerostats, or balloons with relays and retransmission systems offer a possibility for extending the range of current Army line of sight communications systems. UAVs have already been

adapted to conduct FM retransmissions in a like manner. The need for weight reductions in communications systems has accelerated since the inauguration of the current Army transformation initiative. This problem is acute, as was demonstrated as recently as 2000 when it took thirteen C-5A cargo planeloads to move a single Army contingency signal company to East Timor. Modularized packaging of capabilities, commercial transmission and switching systems, and a greater reliance on satellite communications are all potential solutions to increase communications mobility which the Army is investigating.

Commercial firms have a different outlook on communications systems upgrades. Typically, private firms assume that upgrades are continuous and build their systems to account for this. Their networks are built on interoperable switching, transmissions, and software components which can be upgraded individually to ensure currency and continuous interoperability. This concept was the impetus behind the Navy's decision in 2001 to transition all their communications systems to a common Windows NT, TCP/IP, and Java set of baseline protocols and operating systems in their IT-21 program. The current incremental upgrades of Army switching and transmission systems reflect this method. Yet where military systems are built on noninteroperable operating systems and protocols they will continue to require complete fielding and add-on software. Some WIN-T systems have already been fielded in transmission and switching modules with COTS "plug and play" components.

The Army is investing significantly in not only COTS hardware systems, but also in commercial telecommunications contracting services and satellite access. The new family of tactical satellite terminals was built to utilize commercial telecommunications

satellites, continuing a trend towards increasing purchases of commercial bandwidth for military operations. Commercial firms provide a wide range of communications services, especially at higher-level echelons where the communications requirements are generally higher and the risk factor lower.

Other significant commercial concepts the Army is considering include "dumb terminal" systems where the remote workstation downloads the applications with the files to be used. Dumb terminals (also known as thin clients) have little of no application software stored on its hard drive, allowing the network to maximize drive space and simplify upgrades because all the large programs are loaded onto one, network application server which distributes only the necessary software to read or alter downloaded files. Java is a related concept where the application resides on a web server and uses an extension of itself, called an applet, to run specific applications on the client's distant computer. While thin clients are still not proven computing methods, Java is a common, interoperable Internet application which joint military organizations are using to manage information on operational intranets.

The future of communications, regardless of the ultimate program or platform, will almost certainly retain some commonality with commercial standards due to the requirement to use and exploit the existing, largely commercial global information grid. The increasing reliance on COTS technology, while not always the optimum solution for military systems, does ensure a longer utility of telecommunications system when these systems are built on currently ubiquitous protocols and changeable components. Because communications systems derive a large part of their value from their ability to communicate across systems, and where many of these systems are likely to incorporate

some COTS near term upgrades, the continued use of commercial data formats, Internet protocols, interoperable operating systems, and components are perhaps the most important factors for future communications development.

Finally, communications will continue to increase in speed, capacity, and flexibility (table 4). Future communications will continue to replace more personal types by replicating interpersonal communications through VTC and the attainment of sharpened information flows. Voice recognition, object-oriented programming (objects which have meaning), virtual reality, and mobility will continue to proliferate and enable command and control communications.

Table 4. Communications Speed, Flexibility, and Capabilities

Media	**Speed (Rate)**	**Flexibility (Info Flows)**	**Commo Types**
Messenger	paper (7-12	Point-to-Point	Text
Telegraph	mph)	Point-to-Point	Text
Telephone	30-60wpm	Point-to-Point	Voice
Radio	100wpm	Broadcast	Voice
Teletype Radio	80wpm	Point to Point,	Voice, Text
EPLRS	150-300bps	Broadcast	Voice, Text
ABCS (via	1.2Kbps	Point to Point,	Text, Graphics
LAN) Internet (remote modem)	10Mbps 28.8Kbps thru 1.544Mbps	Broadcast Demand-Pull, Point to Point, Supply-	Text, Graphics, Voice (telephony over IP)
WIN-T	25Mbps-155Mbps (ATM)	Push Point-to-Point, Demand-Pull.	Text, Graphics, Voice

Conclusions

The movement of Army communications systems to more mobile, smaller, more commercially standardized hardware, especially in transmission and switching systems is

a positive sign. The interoperability problem is in the operating software and protocols which ride the pipes to the user where the ABCS information is often incompatible, requiring intricate, expensive, and complicated integration fixes.

The ABCS family of systems undoubtedly enhances the ability of commanders to direct, plan, coordinate, and control operations. The provision of the COP allows the commander to instantly concentrate on the actual operation in as much detail as he requires. Upgrades to current transmission systems enable the movement of information in graphic form which is easy to absorb across the expanded digitized battlespace. This enables more rapid and complete cognition of the situation, improving the ability of the users to assess and predict the outcome of the current and potential courses of action. The COP provided by ABCS is a quantum leap in the information provided to the commander, enabling him to update his orientation and arrive at decisions within the cycle of most adversaries in the confusion of complex future battlefields.

With ABCS, the staff has the challenge of coordinating, controlling, and planning operations on systems which currently require significant amounts of attention to operate and maintain. Noninteroperable ABCS constitutes a "paving of the cow paths" while processes and procedures are advanced only locally in fragmented ways. Furthermore, the staff must be ready to conduct operations when the lights go out, as they often have with the current set of ABCS systems during the series of AWEs. Without an increase in systems administrators in uniform, the learning curve for integrating the expanding number of ABCS systems may impede the ability of the staff to concentrate on planning and operations. Both digitized and nondigitized units have adapted commonly available, easy to use, easy to maintain, and cost effective solutions to overcome the complicated

problems associated with ABCS. For instance, shared file systems, web pages, and electronic mail are currently used to share and distribute information; leaving some ABCS capabilities idle due to their complexity or limited interoperability. Overall, the provision of measurable, specific, documented, and proven procedures to leverage the ABCS for the staff in the planning and controlling of operations has been impeded by the unnecessary complexity of the systems, the fragmented development and integration communities and lack of interest in comprehensively leveraging existing technologies by the training and doctrine commands.

The Army is currently at a crossroads in the communications systems components which transport and exchange ABCS information across the battlefield. The continual upgrades of both the existing MSE, TRI-TAC, and ABCS is moving to a point where the original technology limits will impede continued improvement due to different data formats, protocols, and operating systems. Radically changing to a common system is vastly less expensive now than it would be if the Army continues to marginally upgrade software, supporting doctrine, training infrastructure, maintenance material, parts, and soldier training for legacy systems. In other words, it is still early enough to start over. [9]

The Army currently has an opportunity born of its foresight. The provision of the COP itself represents the tool necessary for continued advance towards new C2 paradigms. The units using digitization tools generally regard COP as indispensable. Yet at the same time, they construct ad hoc, inexpensive, workable methods of using existing but interoperable systems to create and share information. It is possible that the Army's decision makers and contractors, in their efforts to provide the best possible system and enhance efficiency, have negated the positive effects of their own creation by

its complexity. Refocusing on providing only the best COP, while leveraging present technology to help commanders and staffs to more effectively manage information, would ensure these communications systems were ready for the next add on technology from the industry, while the military conserves funds for the proper fielding of COP systems.

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[1]Thomas H. Davenport and Laurence Prusak, *Working Knowledge: How Organizations Manage What They Know* (Boston: Harvard Business School Press, 1998), 18.

[2]Dorothy L. Finley, "Handling Degraded Communications," *Military Review* 81 no. 2 (March-April 2001), 33.

[3]U.S. Department of the Army, Field Manual 101-4 *JTF-IM Multiservice Procedures for Joint Task Force Information Management* (Langley Air Force Base, Virginia: ALSA Center, 1999).

[4]Lieutenant Colonel John Lynch, "Lessons Learned Commanding a Digital Brigade" (presentation to the U.S. Army Command and General Staff Officer Course, Class A308, Fort Leavenworth, Kansas, November 2000).

[5] Ibid.

[6]Dennis K. Leedom, *Cognitive Engineering of the Human-Computer Interface for ABCS.* Army Research Laboratory final report #E-4419U (Aberdeen Proving Grounds, Maryland: Army Research Laboratory, 1998), 4-6.

[7]U.S. Department of the Army, *4th Infantry Division (Mechanized) Tactical SOP* (Draft) (Fort Hood, Texas: Headquarters, 4th Infantry Division (Mechanized), 2000).

[8] Gordon Moore, "On Moore's Law and Fishing: Gordon Moore Speaks Out," interviewed by Dori Jones Yang, in *U.S. News and World Report* (10 July 2000); available from http://www.usnews.com/ usnews/transcripts/moore.htm; internet; accessed on 25 April 2001. Moore originally stated in his 1965 briefing that the time period for the doubling of processor capacity was one year. In 1975 he revised this to two years.

CHAPTER 5

CONCLUSIONS

> In the 20's and 30's the major players had about the same technology, when war came, some militaries had created new operational concepts and new organizations. The guys who got it right just ran over the other guys. The French and British had more and better tanks than the Germans, but lost.[1]
>
> Dr. Andrew Marshall, Office of Net Assessment, "Profile: Pentagon Thinker"

Over the last two centuries, the major trends driving the evolution of command and control systems have been the increase in battlefield information and the rise in the complexity of warfare. These were the impetus for the development of intricate systems by which commanders made informed decisions about what to do, and saw that these decisions were carried out. To deal with increased complexity and information, Napoleon, von Moltke, and the Wehrmacht all developed organizational structures and operational procedures which leveraged existing communications capabilities. These developments relied not upon the technology alone, but upon experimentation, objective analysis, and ruthless change in organizations and procedures.

The resulting command and control systems relied on decentralization of decision, regulated information management, and specialized C2 organizations. Decentralization was means to overcome of the limitations of communications systems rather than an acknowledgement of friction of fog of warfare. The regular, simple, and structured movement of information was developed to maintain operational cohesion and a focus on the overall objective in decentralized armies. Knowing that the commander leading from the front had the best, most up-to-date information, past armies provided

these subordinate leaders with the organizational means to concentrate effects through the provision of combined arms. Trust was a necessity of decentralized decision making, but it was tempered by the provision of a directed telescope as a kind of deus-ex-machina through which superiors could observe and intervene when necessary.

Organizations rely on three principal variables which govern their interaction with the outside world in pursuit of their goals. Decentralization, span of control, and specialization define the degree to which a traditional hierarchy adapts itself to its internal and external environments. Recently, commerce has leveraged information technology through alternative organizational structures to enable the implementation of a degree of "flatness," increased networking, or matrixed organizational forms, resulting in gains in operational efficiency and effectiveness.

To deal with the military environment, with its higher relative complexity and dynamism, the baseline army organization of the division balances flexibility and structure through specialization, a low span of control, and centralized information and support structures. Division XXI, while it decentralizes some key specialized functions and provides ubiquitous operational information, retains the basic Army of Excellence structure and framework. While the brigade has proven to be the key echelon in the majority of recent operations, and Force XXI effectively decentralizes information through ABCS, the Force XXI division achieves no major efficiencies by decentralizing key functions to brigades because it retains its basic span of control and essential elements at the division level such as artillery, communications, and aviation.

Throughout history, many military organizations have retained a centralized structure while decentralizing through C2 procedures. The German notions of *Absicht*

and *Aufstragstaktik* enabled the Prussian Army of the nineteenth century and the Wehrmacht of the twentieth century to ensure initiative while retaining loose, high-level control despite centralizing organizational hierarchies and uneven distributions of relevant information.

The U.S. Army's basic command and control procedures for planning and operations reside in the MDMP. The system of analysis through the IPB process, and information focus through CCIR both form the information management effort of the Army organization. Information gained and developed is collected, and then distributed through the orders process. Commanders define situational decentralization through their commander's intent. While the MDMP provides C2 procedures for effective command and control, units in operational environments have consistently failed to implement the MDMP, or its doctrinally shortened versions, to standard, mostly due to its time-intensive nature. Also, during this planning phase, since the MDMP and the IPB were originally built to maximize the amount of information fused into single plan, information overload has resulted from the vast increase in data and information which new capabilities such as digitization, UAVs, and JSTARs provide.

In digitized execution, command and control procedures are significantly simplified through the provision of the COP which synchronizes battlefield coordination and control. Lower echelons can share information horizontally in digitized operations, enabling greater concentration of effects at decisive points. Higher echelons can act as information and strike asset providers to units maneuvering against an adversary, supporting and directing action only when necessary. With the stove-piped nature of the ABCS, the overall organization assumes a matrixed structure which can provide the best

aspects of both networked and hierarchical organizations. Yet the potential for micromanagement through ABCS, either by commanders or staffs, is exponentially higher with the fragmentation of digitized control systems and the increase in relevant information throughout the chain of command. While centralized command and control is, and should remain, a commander's option, digitized operations require decentralized C2 due to the increased capability of lower-level commanders to employ battlefield systems, the increased overall complexity of the battlefield as witnessed by digitization itself, and the need to continue operations when digitized systems fail.

In recent years, commerce has moved from implementing technology based on existing procedures to creating new, more effective and efficient procedures and processes through IT. For instance, Wal-Mart's centralized, just-in-time inventory system is not valuable because it moves information faster, but because it created a new, more efficient operational process which streamlined operations. Realizing the value of information, and the importance of its location, timing, and presentation, commercial firms have intensively studied and enhanced their information management organizations and procedures. Intensive lessons learned systems are one of the main information management elements in commerce which have not been adapted by the Army. Yet these systems offer a potential paradigm shift in C2 because they leverage technology to add value to the information available across an organization.

In military communications the historical trend has been to adapt existing forces to the limits of the latest technologic advances rather than develop technology for existing organizations and procedures. Part of the reason for this approach is that technological advantages have traditionally been short lived, especially in periods of

conflict. While the so-called "Information Age" promises systems which can be built to any C2 requirement, and thereby be based on capability rather than limitation, adversaries have successfully employed asymmetric counters to technology in each major era when the disparity of technology was insurmountable.

Since it is the increased range and flexibility of computer networks which gives them their great value, commerce generally adheres to the de-facto standards of Internet protocols, fully interoperable operating systems, and MS Office user formats for portability, systems interoperability, and upgrade-ability of component parts. In fact, while the military takes up to ten years to develop and field a complete, "one size fits all," and fully capable communications system, commerce has migrated to a system of continuous upgrades of components for significantly increased efficiency.

Military organizations at the lowest echelons utilize many of the standard tools which business has adapted for increased efficiency on an ad hoc basis. Shared Windows folders, Internet web sites, and email are all common in digitized and non-digitized operations for effective, flexible, inexpensive, and efficient communication of information. Yet the specific procedures to leverage these simple, easy to manipulate tools are nearly nonexistent in Army doctrine and discussion.

The ABCS as a communications platform, while a powerful and necessary evolution for COP, is troubled in important ways. Since the five main systems were developed and fielded individually, some over ten years ago, interoperability was and continues to be an impediment to an integrated system. This creates a strain on a staff struggling to keep the ABCS operational and relevant while adhering to doctrinal procedures mismatched to modern information systems and flows. The creation of the

COP has been a focus of effort in ABCS interoperability and rightly so, because it is this tool which makes ABCS most valuable from a communications standpoint. Yet COP, as a directed telescope, is a fixed system of computerized location, status, and information. When commanders realize that the living enemy lies beyond the perception on the screen, especially through their internal battlefield visualization, they maximize the information provided through ABCS.

The Army is moving forward with COP in important ways. The development of the IBCT represents a transition of focus from the division to the brigade as the key echelon of decision. The rise of battlefield visualization, as a derived, command-specific result of COP, retains the view of the fog and friction of warfare and stresses flexibility and adaptation. The investment of interoperable commercial components promises increased, and increasingly flexible communications systems.

Future operations may enable the rapid planning of multiple COAs based on real-time information provided by enhanced sensors. Decentralized, semi-independent combined arms units may synchronize operations with supporting arms and services as well as each other, based on emerging battlefield opportunities rather than a single COA developed at a point in the linear planning process when uncertainty is highest. Ubiquitous communications systems may yet be fielded which promise constant, flexible flows of relevant information. While these developments are likely, they are not a certainty. What is a certainty; however, is the need to match C2 organizational structures to new C2 procedures in order to leverage the power of the COP for commanders at all echelons.

A major change in the nature of warfare brought about by the innovative application of new technologies which combined with dramatic changes in the military doctrine and operational and organizational concepts, fundamentally alters the nature and the conduct of war.[2]

Michael Roberts, 1967 (the original definition of an RMA)

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[1]Hess, "Profile: Pentagon Thinker."

[2]Michael Roberts, *Essays on Swedish History* (London: Weidenfeld & Nicholson, 1967).

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