DIGITIZED CHAOS: IS OUR MILITARY DECISION MAKING PROCESS READY FOR THE INFORMATION AGE?

A MONOGRAPH
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First Term AY 97-98

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	18 December 1997	MONOGRAPH

4. TITLE AND SUBTITLE

DIGITIZED CHAOS: IS OUR MILITARY DECISION MAKING PROCESS READY FOR THE INFORMATION AGE?

5. FUNDING NUMBERS

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

SCHOOL OF ADVANCED MILITARY STUDIES
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

COMMAND AND GENERAL STAFF COLLEGE
FORT LEAVENWORTH, KANSAS 66027

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

DISTRIBUTION UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

SEE ATTACHED

14. SUBJECT TERMS

DECISION MAKING, BATTLE COMMAND, FORCE XXI, ADVANCED WARFIGHTER EXPERIMENTS, PLANNING, COGNITIVE THEORY, INFORMATION SYSTEMS, COMMANDER'S INTENT, BATTLE STAFF, DIGITIZATION

15. NUMBER OF PAGES

70

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSFIED	UNCLASSIFIED	UNLIMITED

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18 298-102

USAPPC V1.00

Abstract

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The integration of new technologies has always been important to the military. The longbow, rifled muskets, and armored fighting vehicles are all examples of technological innovations that found their way into the military. However, history has proven that new technology alone seldom has dramatic effects on battlefield effectiveness. Changes in doctrine, organization, and training must accompany the new technology in order to exploit its full capabilities. Today the Army is looking at ways to integrate information age, or digital technologies into our fighting force. In particular, the area of battle command is seen as holding great promise for digitization. Unfortunately, the Army is implementing its new battle command technology without considering changes to its planning and decision making doctrine.

This monograph addresses the compatibility of the Army's Military Decision Making Process (MDMP) with information age technology. The analysis focuses on decision making theory, current digitization concepts and projects, and performance feedback from the field. The overall conclusions of this analysis are that the Army should upgrade certain portions of its decision making process to make it more compatible with digital information systems and contemporary decision making theory.

This upgraded MDMP focuses on the commander's vision and uses it as a controlling idea to guide the planning process. This controlling idea along with a modified Commander's Critical Information Requirements (CCIR) clearly defines the commander's implicit and explicit information needs and sets the conditions for staff and subordinate initiative. The upgraded MDMP requires the commander to develop a course of action early in the planning process and use digital technology to collaborate with higher headquarters and subordinates. Finally, the upgraded MDMP relies on adaptive instead of predictive planning to deal with the complexity of the battlefield.

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MONOGRAPH APPROVAL

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Title of Monograph: *Digitized Chaos: Is Our Military Decision Making Process Ready for the Information Age?*

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Accepted this 18th Day of December 1997

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Glossary

Note: Definitions in this glossary taken from Army or Joint Manuals are direct quotes or nearly direct quotes. The normal formatting with quotation marks and/or italics has been omitted for legibility.

After Action Review (AAR). A method of providing feedback to units by involving participants in the training diagnostic process in order to increase and reinforce learning. The AAR leader guides participants in identifying deficiencies and seeking solutions. The Army Combat Training Centers (CTCs) place great emphasis on the AAR as a vehicle for helping rotational units identify strengths and areas that need improvement. The AAR focuses on individual, collective, and leader performance measured against Army doctrine.[1]

Army Battle Command System (ABCS). A system envisioned in TRADOC Pamphlet 525-5 that will merge digital signals from sources within and beyond the battlefield to provide commanders at every level a common, relevant picture. This common, relevant picture will give commanders the "means to visualize how they will execute in harmony, integrated by a shared vision of the battlespace."[2] The ABCS concept today is manifested in the Army Tactical Command and Control System and the Force XXI Battle Command, Brigade and Below (BCB2) system. These two systems together comprise the Command, Control, Communications, Computers, and Intelligence (C4I) architecture employed by the AWE units.[3]

Advanced Field Artillery Tactical Data System (AFATDS). AFATDS is a multi-service automated command and control system of mobile, multi-functional nodes providing automated planning and execution capabilities to various fire support elements. AFATDS is compatible with and capable of interacting with the Army Tactical Command and Control System (ATCCS), the Maneuver Control System/Phoenix (MCS/P), and the All Source Analysis System (ASAS).[4]

All-Source Analysis System (ASAS). The All Source Analysis System (ASAS) is the Army's only intelligence fusion system. Through the use of automation, the intelligence community is able to process, correlate, and fuse hundreds of reports an hour, providing a clearer, more accurate, up to date view of the enemy for dissemination.[5]

Advanced Warfighting Experiment (AWE). The AWE's are a critical portion of the Army's Joint Venture Campaign designed to test and implement new technologies, organizations, and doctrines in accordance with the Force XXI concepts. There are three AWEs: **Task Force (TF) XXI, Division XXI**, and Corps XXI. The TF XXI program involved digitization of a modified battalion task force from the 4th Infantry Division (Mechanized). This AWE culminated in a National Training Center Rotation in March 1997. The Division AWE focuses on digitizing and modifying the entire 4th ID (M) staff. That AWE will conclude with a Battle Command Training Program rotation in November 1997.[6]

Battle Command. The art of battle decision making and leading. It includes controlling operations and motivating soldiers and their organizations into action to accomplish missions. Battle command includes visualizing the current state and a future state, then formulating concepts of operations to get from one to the other at least cost.[7]

Battle Command Battle Lab (BCBL). Part of TRADOC's Battle Lab program initiated in 1992 to address battlefield dynamics and streamline the process of identifying concepts and requirements for new doctrine, training, leader development, organizations, material and soldier systems (DTLOMS). There are three BCBLs: one at Fort Leavenworth, KS, one at Fort Gordon, GA and one at Fort Huachuca, AZ. These battle labs focus on DTLOMS relating to battle command.[8]

Battlefield Functional Area Command and Control System (BFACS). The BFACS is a "system of systems" that consists of the Maneuver Control System/Phoenix **(MCS/P)**, the Forward Air Defense Command and Control Intelligence System **(FAADC2I)**, the All Source Analysis System **(ASAS)**, the Advanced Field Artillery Tactical Data System **(AFATDS)**, and the Combat Service Support Control System **(CSSCS)**. Together these systems are designed to provide situational awareness and decision support to commanders and staff in the execution of tactical operations.[9]

Combat Training Center (CTC) Program. An Army program established to provide realistic joint service and combined arms training in accordance with Army doctrine. It is designed to provide training units opportunities to increase collective proficiency on the most realistic battlefield available during peacetime. The four components of the CTC program are: (1) the National Training Center (NTC), (2) the Combat Maneuver Training Center (CMTC), (3) the Joint Readiness Training Center (JRTC), (4) the Battle Command Training Program (BCTP).[10]

Commander's Critical Information Requirements (CCIR). Information required by the commander that directly affects his decisions and dictates the successful execution of operational or tactical operations. CCIR normally result in the generation of three types of information requirements: priority intelligence requirements (PIR), essential elements of friendly information (EEFI), and friendly force information requirements (FFIR).[11]

Course of Action (COA). A plan that would accomplish, or is related to, the accomplishment of a mission. Each course of action developed during the MDMP should meet the criteria of suitability, feasibility, acceptability, and distinguishability.[12]

Complexity Theory. A theory of social science formalized by a multi-disciplined group of scholars in the late 1980s. Complexity theory disagrees with more classical theories of aggregate behavior like rational expectation decision theory. Complexity theory is founded on the idea that man is an adaptive agent interacting with other adaptive agents in a dynamic environment. This interaction creates a condition of co-evolution whereby the behavior of the agents adapt to each other and to their environment. The environment shifts between moments of chaos and order based on self-emerging order created within the environment. Aggregate behavior in this type of environment is very difficult to predict based on the complex interactions and co-evolution that takes place between agents.[13]

Combat Service Support Control System (CSSCS). A component of the Maneuver Control System/Phoenix that support combat service support planning and control. This automated system links logistics nodes on the battlefield together to provide improved logistics visibility and support.[14]

Data Warehouse. A data warehouse takes data from one or more operational systems and restructures it into a decision support system. Data warehouses aggregate enterprise-wide data to support informational, analytical processing over a long historical period. Unlike typical relational databases, data warehouses specialize in the proper aggregation of data to support decision making.[15]

Drill-Down. A computer industry term pertaining to an information system's ability to allow the user to gain more detailed information on a given subject. The user typically begins a query using aggregated information on the topic. If the user needs more detailed information on the subject, the information systems allows he/she the ability to refine the query based on the level of detail needed. This ability to aggregate large amounts of data from various systems and then support detailed queries is one of the primary benefits of data warehouse technology. Drill-down queries are related to the commander's "tree" information processing mode described in the 1989 RAND study on the commander's information needs.[16]

Essential Elements of Friendly Information (EEFI). Key questions likely to be asked by adversary officials and intelligence systems about specific friendly intentions, capabilities, and activities so they can obtain answers critical to their operational effectiveness.[17]

Forward Air Defense Command and Control Intelligence System (FAADC2I). A sub-component of the Battlefield Function Area Command and Control System (BFACS) that automates many of the air defense early warning and control procedures. The FAADC2I system is designed to improve Army airspace command and control, air defense control measures, and early warning/defense against enemy air threats.[18]

Friendly Force Information Requirements (FFIR). Information the commander and staff need about forces available for the operation. This includes personnel, maintenance, supply, ammunition and petroleum, oils and lubricants (POL) status. FFIR can also include details on unit experience, morale and leadership capabilities.[19]

Force XXI Operations. The US Army's Training and Doctrine Command's evolving vision of future joint military operations. Force XXI is the future Army prepared to face a broad spectrum of operational environments. Force XXI is defined by five characteristics: doctrinal flexibility, strategic mobility, tailorability and modularity, joint and multinational connectivity, and the versatility to function in War and Operations Other Than War (OOTW). Force XXI relies heavily on information dominance and digitization in dealing with the complexity of future conflicts.[20]

High-Payoff Targets (HPT)/High-Value Targets (HVT). A high-payoff target is a target whose loss will contribute to the success of the friendly course of action. High-value targets are assets that the threat commander requires for the successful completion of a specific course of action.[21]

Independent Motorized Rifle Brigade (IMRB). A generic threat force used in Army simulations and based on Soviet doctrine and training. An IMRB is a large, mobile force organic to a Combined Arms Army or Tank Army. The IMRB's primary weapon systems include 168 BMP-2 infantry fighting vehicles, 51 T-80 tanks, and 18 2S3 152mm self-propelled howitzers. Typically, this force is used in a reserve capacity or as a counter-attack force due to its mobility and lethality.[22]

JANUS: A battle command computer simulation system used by Army units conducting staff training exercises at the platoon through division level. JANUS provides staffs a means of testing their operational plans against Opposing Force (OPFOR) computer operators and receive feedback on combat engagements, unit movements, battlefield synchronization, and decision making.

Joint Surveillance and Target Attack Radar System (J-STARS). An airborne (Boeing 707-based) radar imagery system also capable of detecting moving targets. Joint requests for J-STARS surveillance support is sent through military intelligence channels in the form of a Radar Service Request (RSR).[23] Since its successful introduction to combat during Operation Desert Storm, J-STARS has played an increasing role in U.S. military operations.

Limited and Pure Rational Expectation Theory. The difference between this theory and pure rational expectation theory is that individuals seek to "satisfice" the expected outcome of their decision in the former and maximize the expected value of their decision in the latter. Pure rational expectation theory requires the rational comparison of several alternatives against pre-determined decision rules followed by a choice that will lead to an optimum outcome. The Army's MDMP is based largely on the pure rational expectation decision making model. Limited rational expectation theory is based on the idea that individuals make choices using heuristic methods. Instead of using pure rational expectation decision theory's multi-attribute analysis and comparison methods, limited rationality suggests that people rely on their past experiences, intuition, judgment and expertise. A type of limited rational expectation theory is the **Recognition-Primed Decision (RPD) model.**[24]

Maneuver Control System/Phoenix (MCS/P). The MCS/P is an automated planning and battle tracking system currently undergoing testing and evaluation as part of the Army's AWEs. The MCS/P provides digital transmission of mission information such as graphics, orders, resource coordination, etc. Commanders and staff can adjust the MCS/P so it filters battlefield information according to their individual requirements.[25]

MDMP: Military Decision Making Process. The MDMP is a seven-step process (receipt of mission, mission analysis, course of action development, course of action analysis, course of action comparison, course of action approval, orders preparation) used by the US Army to plan operations. The MDMP can be a very time-consuming process depending on the complexity and/or difficulty of the operation. In a time-constrained environment, the commander can make the decision to shorten or omit some of the steps of the MDMP.[26]

MPRTS/3-D Visualization System. The MPRTS/3-D Visualization System provides state-of-the-art 3-D and virtual reality terrain representation for use in military planning. This system allows commanders and staffs to realistically visualize the battlefield and gain a better appreciation for the terrain than would normally be provided by a two-dimensional map. This "virtual terrain model" enhances planning activities such as course of action development, wargaming, and rehearsals.[27]

Operations Other Than War (OOTW). Military activities during peacetime and conflict that do not necessarily involve armed clashes between two organized forces.[28] Joint definition for Military Operations Other than War (MOOTW): encompasses the use of military capabilities across the range of military operations short of war. These military actions can be applied to complement any combination of the other instruments of national power and occur before, during, and after war.[29]

Priority Intelligence Requirements (PIR). Those intelligence requirements for which a commander has an anticipated and stated priority in his task of planning and decision making. PIR should be associated with a decision that will affect the complete the success of the commander's mission. As such, it asks only one question, focuses on a specific fact, event, or activity, and provides intelligence to support a single decision.[30]

Tactical Operations Center (TOC). A physical grouping of those elements of an Army general and special staff concerned with the current tactical operations and the tactical support thereof.[31]

Training and Doctrine Command (TRADOC). The United States Army Training and Doctrine Command is located at Fort Monroe, VA. As its name implies, this command has responsibility over all Army training and doctrine encompassing technology, organizations, and materiel. TRADOC generates operational concepts, articulates materiel requirements and develops the force design structures which enhance the ability of soldiers and units to accomplish their missions.[32] TRADOC is directly involved in, and oversees the Army's Advanced Warfighting Experiments (AWEs).

Unmanned Aerial Vehicle (UAV). A small, remotely piloted airborne collection system.[33] UAVs are playing a greater role in the US military's intelligence collection effort due to advances in sensors and digital communications technology. UAVs now have a long-endurance capability which allows more complete coverage of the objective area.[34]

The Army and Technology

...war is completely permeated by technology and governed by it.

Martin van Creveld[35]

Historical Perspectives

The Army has a long history of trying to integrate new technologies into its force structure and doctrine. Usually, the initial results of that integration are less than spectacular. An example from history of this phenomenon is the introduction of the tank in warfare. The tank received its baptism by fire with the Allies during World War I at Caporetto, Cambrai, and with the Germans during their offensives in the summer of 1918. Using the tank as cover from enemy fire and as a means of breaching enemy fortifications, infantry formations were able to overcome the stalemate that had predominated the war.[36]

Despite its initial success on the battlefield, the allies saw only limited utility in this new weapon. Although there were a growing number of mechanized warfare advocates, most military leaders viewed tanks and armored infantry vehicles only as "useful adjuncts to existing tactics, to be acquired in reasonable numbers and employed when opportune in conjunction with the existing arms, primarily the infantry and the artillery."[37] Employed in this manner, mechanized weapon systems failed to significantly enhance the warfighting capabilities of the allies as they entered World War II.

Germany, on the other hand, took great interest in developing new and innovative ways of employing mechanized forces in combat. Based on the German principle of schwerpunkt (center of gravity) they created their blitzkrieg doctrine which fully exploited the advantages of mass, speed, and shock offered by mechanized forces.[38] The French felt the devastating effectiveness of new technology combined with innovations in doctrine and organization in May of 1940. Germany's Heinz Guderian slammed three panzer divisions and a reinforced infantry regiment supported by almost 1500 Stuka dive bombers into the French 55th Division near Sedan.[39] The German attack crushed the French division in three hours and clearly demonstrated the decisive effects that can be achieved when new technology is integrated with equally new and innovative organizations and doctrine.

The development of mechanized warfare in World War II is an example of how integrating new technology with old organizations and doctrine seldom produces dramatic results. When the organization and doctrine are changed to maximize the capabilities of the new technologies (e.g. the German Panzer division and the doctrine of Blitzkrieg) the result is dramatic increases in capabilities.

Technology and Today's Army

Today the Army is faced with the same challenge that confronted military leaders following World War I: how to best integrate new technology into the current force structure. However, instead of new mechanized weapon systems (which are still very much a part of defense modernization efforts) the focus now is on information-age technologies. The Army has formalized its emphasis on information technology with the publishing of Training and Doctrine Command (TRADOC) Pam. 525-5 (Force XXI Operations), the Army Digitization Master Plan (ADMP) and the upcoming revision of FM 100-5 (Operations).

TRADOC Pam. 525-5 recognizes that success on the battlefield takes more than the application of new technology.

> *...future technology will require the Army to reassess time-honored means of battle command-to recognize that in the future, military operations will involve the coexistence of both hierarchical and internetted, nonhierarchical processes.*

Order will be less physically imposed than knowledge-imposed. Combinations of centralized and decentralized means will result in military units being able to decide and act at a tempo enemies simply cannot equal.[40]

Leaders within the private sector also recognize the importance of changing business practices to exploit new technologies.

Expertise has shown that the biggest gains from systems that involve users are made through changes in the way people work, not simply through the installation of technology...[41]

Battle command is one area of concentration within the Army's overall digitization effort. Unfortunately, the Army is implementing its battle command digitization plan without analyzing the current Military Decision Making Process (MDMP) to see if it fully exploits the new technologies. As a result, we may be ignoring the warnings provided by experienced leaders in the military and private industry as we try to automate an old, perhaps outdated, decision-making process. Ironically, we may actually *degrade* battle command effectiveness and tactical agility due to information overload and mismanagement.

This monograph addresses these concerns and will focus on the current MDMP's compatibility with emerging decision-making technologies and theories. The basis for the analysis will be research in decision-making theory, current Army digitization programs and Army battle command training trends. The monograph's conclusions will classify our MDMP in terms of commonly accepted decision-making theory and identify those areas within the process which could be improved to fully exploit information age technology. Finally, this monograph will provide suggestions for further battle command research and possible modifications to the MDMP that could enhance its utility to the Force XXI Army. However, before addressing these issues, this monograph will examine the theoretical influences on the MDMP.

Military Decision Making: From Theory to Application

> *The challenge is for commanders and staffs to develop skills in information management, such as knowing who needs the information, what information they should have and when they will need it, in order to take advantage of these revolutionary capabilities.*
>
> *Major General Wallace C. Arnold*[42]

Decision Making Theory

Decision theory is a widely studied subject. It has attracted scholars from a variety of disciplines such as psychology, sociology, biology, mathematics, economics, and managerial science. At the heart of all this research is an attempt to classify how people and groups make decisions and possibly determine ways to create better outcomes from given decision processes. There are many different "shades" of decision theory but for the purpose of analyzing the Army's MDMP, this monograph will aggregate these theories into one of four general categories: rational expectation, limited rationality, rule-following and complexity theory.

Rational Expectation Theory

The rational expectation theory is one of the most enduring and widely applied set of principles on how individuals and groups make decisions. It is frequently used to explain social behavior in a variety of disciplines such as politics, education, social sciences, economics, and warfare.[43]

The rational expectation theory involves procedures that pursue a logic of consequence. Individuals or groups evaluate the expected consequences of their decisions beforehand in terms of personal preferences. The decision maker(s) then make "rational" choices that will lead to the most favorable outcome.[44]

This consequence-based theory seeks to answer four questions:[45]

1. What are the available alternatives? This is a search for and development of actions that may lead to a favorable outcome.
2. What are the expectations of each alternative? This question seeks to determine the likelihood of the consequences of each alternative.
3. What are the decision maker's preferences? This question attaches value to the consequences associated with each outcome.
4. What are the decision rules? These are the criteria for choosing among the various alternatives.

Rational expectation decision theory is often described as a "decision-making loop." This loop begins when an individual or group becomes conscious of a problem or action. This awareness is followed by problem recognition and definition. The decision maker(s) then analyze potential alternatives and their associated consequences. A solution is then selected and implemented as the preferred course of action. The final stage of the decision loop involves feedback on the outcome of the decision. At this point, the process starts all over again with the recognition of new problems or actions.[46]

The validity of the rational expectation theory is based on three key assumptions. The first is that the decision maker has perfect knowledge of all alternatives. The second assumption is that the decision maker has perfect knowledge of the consequences of each alternative. The third key assumption is that the decision maker is aware of the decision rules that actually affect the selection process.[47] This prescriptive approach implies a "best" way to make a decision and is thus a popular method.[48]

Pure rational expectation theory has proven to be a poor predictor of aggregate behavior because these assumptions are rarely valid. Decision makers often cannot predict the long term consequences of their decisions and sometimes make choices based on rules that do not appear to maximize expected outcomes. These problems led to the development of the bounded or limited rationality theory of decision making.[49]

Limited Rationality

The bounded/limited expectation theory states that decision makers are inherently rational but instead of making decisions based on *maximizing* expected returns, they decide based on the concept of satisficing. Satisficing involves choosing an alternative that exceeds some criterion or target instead of choosing the best alternative as in pure rational expectation theory.[50] Limited rationality decision makers rely on experience, pattern recognition, and intuition to help them deal with complex situations. They do not calculate the endless possibilities and associated consequences to determine the *absolutely best* outcome but rely on heuristic pattern recognition to help them select a *satisfactory* alternative.[51]

An example of the limited rationality decision theory is the Recognition-Primed Decision (RPD) Model (Figure 1). RPD decision makers do not undertake a time-consuming search for the best option but instead use their expertise and experience to quickly find one that works. The RPD researchers found that "even with nonroutine incidents, experienced decision makers handle approximately fifty to eighty percent of decisions using recognitional strategies without any effort to contrast two or more options".[52]

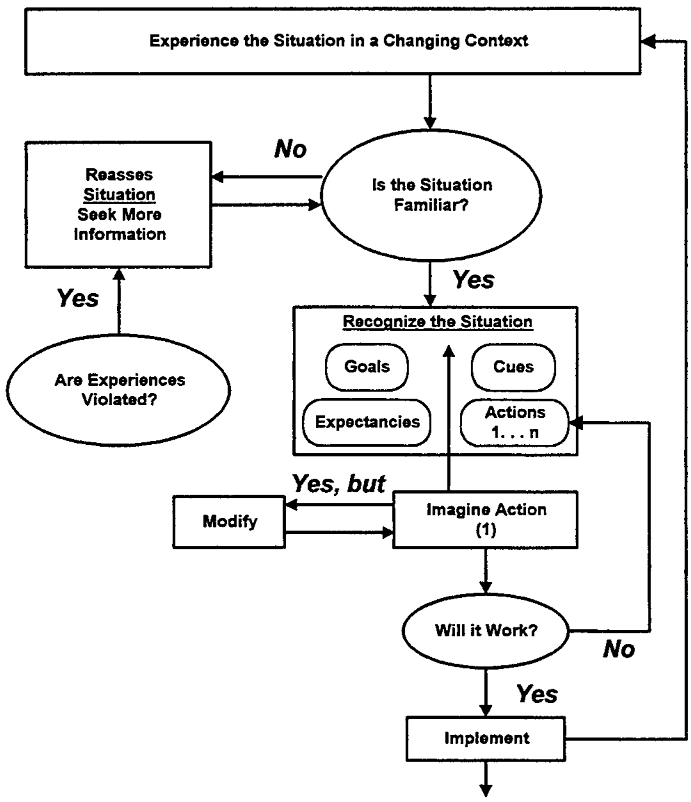

Figure 1: Recognition Primed Decision (RPD) Model[53]

The RPD theory focuses on situation assessment and the commander's imagination to select and subsequently improve choices. In a dynamic environment that provides little time to ponder which alternative is best, RPD provides experienced and competent decision makers with a quick and adequate choice.[54]

Rule-Based Decision Making

At the other end of the decision making theory spectrum is rule-following. This theory takes the approach that people make decisions based on learned rules. It uses a logic of appropriateness rather than a logic of rational expectation. It is a reasoning process that establishes identities and matches rules to recognized situations.[55]

Rule-based decision makers ask only three questions:

1. What kind of situation is this? This question seeks to clarify the decision-making environment.
2. What kind of person am I or what kind of organization is this? This question helps establish the role the decision maker in the social environment.
3. What are the rules that will influence the decision making process? This question defines the decision criteria.[56]

Experience, education, and the socialization process of the decision maker are core components in rule-based decision making. This theory recognizes the uncertainty and risk associated with decision making but does not necessarily make it any easier to predict individual or aggregate behavior. The situations, identities, and rules influencing a decision can be very ambiguous.[57] Determining which alternative is the most "appropriate" is often harder to quantify than determining which one is most "rational."

Complexity Theory

In the late 1980s a diverse group of scholars developed concepts that invalidated many of the classic theories about individual and collective behavior. These concepts popularly became known as complexity theory. Complexity theory challenges the notion people can solve problems by simply applying a prescriptive process as if they were butterflies that could be pinned down on cardboard and analyzed.[58] This theory borrows heavily from biological and evolutionary science in describing how people interact and make decisions.

Complexity theory is founded on the idea that society is like a biological entity that is dynamic, adapts to its environment, and continues to evolve. Individuals, groups and societies are complex-adaptive systems that interact according to an ingrained set of rules.[59] In this way, it resembles rule-based decision theory and to some degree, limited rationality theory. However, complexity theory argues that the rules change along the way as agents adapt to their environment. As agents co-evolve based on interaction with other agents and their surroundings, this creates an environment where systems fluctuate between order and the forces of disorder...the edge of chaos. In this environment "you also find complexity: a class of behaviors in which the components never quite dissolve into turbulence...."[60]

Complexity theory fits nicely with Clausewitz's ideas on the nature of war. To Clausewitz, war produced a type of friction that makes the simplest things very difficult. It is a force that cannot be perceived but only experienced in combat. Friction cannot be prevented but can be overcome through the "Iron will-power of the commander."[61] As battlefield activities shift between order and chaos, and hundreds of complex situations emerge, Clausewitz saw the commander's will as the force that kept war on the edge of chaos.[62]

At this point, the obvious question is: which general theory on decision making is correct? Unfortunately, there is no definitive answer. Even decision theorists avoid absolute rigidity in their acceptance of one "pure" theory of decision making. While most theorists will usually argue in favor of a preferred decision theory (especially if it is their own), they generally recognize the validity and applicability of all of these theories.[63]

The next question might then be: if no one theory is correct, what utility do decision making theories provide us? Their greatest utility is in providing an insight into how individuals and groups solve problems. Having a good understanding of how people solve problems, we can then develop standard procedures for solving problems in organizations. These standard procedures or doctrines provide a common framework that guides the efforts of the organization toward solving a particular problem. For the United Stated Army, that framework is the Military Decision Making Process (MDMP).

From Theory to Warfighting: The MDMP

Historical Perspective

The Army's decision making process has changed very little in the last several decades. First described in the 1932 version of FM 101-5 (Staff Officers' Field Manual, Part 1) as the "Estimate of the Situation", it contained the following four paragraphs: [64]

1. Mission: that mission assigned by higher headquarters
2. Opposing Forces: the disposition and relative combat strength of the enemy
3. Enemy Situation: analysis of the enemy's probable intentions
4. Own Situation: analysis of the available friendly courses of action
5. Decision: states what is to be accomplished, when, where, and why.

The estimate of the situation remained virtually unchanged until the 1982 version of FM 101-5 when it was augmented with the Military Decision Making Process. This manual formalized the concept of mission analysis as a "means through which the commander obtains an understanding of the mission."[65] The "new" FM 101-5 also attempted to link the MDMP with various actions performed by the commander and staff.

The current MDMP (Figure 2) follows the same basic steps that began as the estimate of the situation almost seventy years ago. Like its predecessors, it is a sequential and prescriptive in nature.

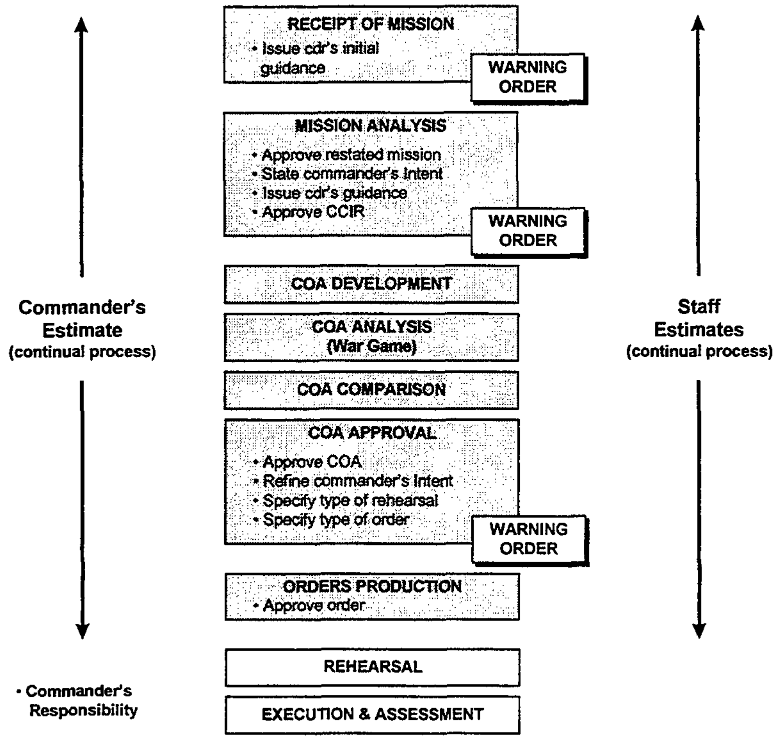

Figure 2: The Current MDMP[66]

Theoretical Influences

The influence of pure rational expectation decision theory is readily apparent in the Army's MDMP. The 1950 Version of FM 101-5 discloses this relationship between rational expectation theory and the MDMP when it states that it (the estimate process) "is a logical and orderly examination of all the factors affecting the accomplishment of the mission to determine the *most suitable* [author's italics] course of action."[67]

The mission analysis phase has a particularly heavy reliance on the logic of consequence. During this phase, the intelligence officer tries to identify enemy courses of action based on analysis of enemy doctrine, disposition, strength, and capabilities. Factoring in terrain, weather, movement rates, and vegetation, the intelligence officer aims to identify the enemy's most probable course of action. He considers intangibles like the enemy commander's personality and the moral of the troops but his analysis primarily is based on quantifiable facts like doctrinal frontages, movement rates, bridge classifications, etc. In so doing, the intelligence officer role-plays the enemy commander and creates a plan based on expectations of what will be most successful given the situation at hand. The intelligence officer also identifies other possible enemy courses of action but the most probable one is used as a basis for developing the best friendly course of action. All of these activities fit nicely into the pure rational expectation theory's logic of consequence.

Wargaming is another example of the dominant influence of rational expectation theory in the MDMP. Wargaming, or course of action analysis, "identifies which COA accomplishes the mission with the minimum casualties while best positioning the force to retain the initiative for future operations."[68] In other words, wargaming seeks to create a plan that maximizes the expected outcome of an engagement. The staff uses tools developed in the mission analysis phase such as enemy event templates, relative combat power ratios, and staff estimates to help them wargame friendly courses of action. This phase can be very time consuming since the staff should wargame each friendly course of action against each enemy course of action.

The limited rationality decision theory works its way to into the MDMP as well. The commander develops his intent not through a detailed analysis of expected outcomes but more likely by relying on his experience, training and intuition. During the COA approval phase the staff will present recommendations based on rational expectation theory summarized in a decision matrix. However, the commander will probably make his decision again based on experience, judgment, and training more so than his staff's quantitative analysis.

Rule based decision theory is not a formal part of the MDMP but it also manifests itself in military planning. For instance, the planners often develop courses of action that "follow the rules" expected military planners in their organization. Their plans are compatible with the commander's ideas on warfighting, follow generally-accepted tactical rules, and conform to the organization's standard operating procedures (SOPs). The planners can develop unique "out-of-the-box" solutions only if they are the "school-approved" out-of-the-box solutions.

In summary, the MDMP's theoretical foundation is based largely on the pure rational expectation model with the other decision theories making only guest appearances. The reliance on the pure rational expectation theory means that the MDMP also inherits all of that theory's limitations and weaknesses. The next section focuses on how the negative influences of the pure rational expectation theory on the MDMP may actually be degrading unit performance.

Pre-Digitization Performance Trends

RAND Study

In 1989 the RAND Corporation Arroyo Center conducted an in-depth analysis of how units plan for operations and what are the information needs of the commander during planning, preparation, and execution of military operations. That study found that commanders typically formulate an image or vision of how the battle will be fought early in the planning process. They often do this with the help of some key advisors or subordinates. For the commander, the MDMP briefings served not as a forum for making decisions but as an opportunity to test the organization's understanding of his vision.[69] The RAND study concluded that while ostensibly the MDMP is a decision making process, the main purpose of communication during planning is to facilitate understanding and share images.[70] Commander's test their staff's and subordinate's understanding of their image through question-and-answer sessions during briefings and leader backbriefs.

According to the RAND study, commanders process information in one of three modes: pipelined, alarm, or tree. Pipelined information is the routine information that is necessary for the commander to maintain his image of the battlefield. It includes data such as status reports, unit locations, actions of adjacent units, and expected enemy actions. If an event occurs that does not fit the commander's image of the battle, that information is sent as an alarm. It tells the commander that something is occurring which will seriously disrupt his image of the battle. An example would be a report of an enemy attack into the flank of the friendly main effort. Once the commander is alerted to the alarm condition, he searches for detailed information so he can take action to reestablish the course of action or create a new one.[71]

The study concluded that in order to be effective, a military information system must be able to enhance the sharing of the commander's image and support the three types of information processing modes. This would call for a planning process that clearly establishes and disseminates the commander's images through formal briefbacks and question-and-answer sessions. Additionally, the ideal process would greatly facilitate the sharing of information and would define the type and amount of information needed by the commander.[72]

The 1994 RAND Study

The RAND Corporation followed up their 1989 research with another study in 1994 that focused specifically on battalion-level command and control, decision making, and planning. The analysts reviewed four years of NTC take-home packets, conducted on-site research, and compiled volumes of data from NTC observer/controllers. Their conclusions were that Army Battalion Task Forces frequently are unable to develop adequate battle plans. As a result, they are only able to stop the Opposing Forces (OPFOR) and successfully complete their missions about sixty-five percent of the time.[73]

The problem with the units at the NTC was not that they didn't know or understand the Army's planning process. Their biggest problems were in the area of poor staff cohesion and communication. The staff planning did not seem to have focus and follow a common direction. Individual staff members and sections usually produced good products but they were often produced in isolation and too late to contribute to mission success.[74]

The RAND study also showed that commanders and staff do not manage information well. Reports that had a significant influence on the battle (or battle preparation) frequently would come into the Tactical Operations Center (TOC) and remain unnoticed by staff officers. Despite the fact that the reports were readily available, staffs often failed to recognize their importance and take timely action. This problem was exacerbated by poor articulation of the commander's information needs.[75]

Combat Training Center Training Trends

Three years after the RAND study units are still struggling with the planning process and decision making. In addition to the already identified problems with staff integration and poor communication, units also show need for improvement in the areas of course of action development, wargaming, and development of the commander's intent and planning guidance.[76]

Commanders and staffs have difficulty developing flexible, adaptive plans. They tend to fixate on one course of action aimed at defeating the "most probable" enemy course of action.[77] The sayings "the enemy gets a vote" and "fight the enemy, not the plan" are often heard in CTC After Action Reviews (AARs) because units fail to adapt to changes on the battlefield. They become reactive and lose the ability to gain or maintain the initiative during the fight.

Unsatisfactory commander's intent statements and poor planning guidance appear to be a major contributing factor to poor course of action development. The staff is presented with guidance that is either too vague, complex, or contradictory.[78] This sets the staff up for failure from the beginning and creates an atmosphere of confusion. This has a ripple effect as subordinate units become confused and hesitant as they plan and prepare for the upcoming mission. The confusion typically comes to a head during the unit rehearsal when the commander realizes that his staff has developed a plan that doesn't fit his true intent for the operation.[79] Precious rehearsal time is then wasted as the commander tries to clarify his ideas in the minds of his staff and subordinate commanders.

Wargaming is another significant problem area for staffs. Although wargaming is considered the most valuable step in the staff's course of action analysis[80], it often becomes a tedious and time consuming event that degrades rather than enhances the decision making process.[81] Vague commander's intent statements and planning guidance exacerbates the problem by not highlighting the decisive points and critical events the staff should wargame and synchronize. This lack of analytical focus creates a "paralysis by analysis" whereby planners attempt to predict multiple enemy actions instead of synchronizing battlefield functions.[82] As a result, the plans usually require significant modification once the unit makes contact with the enemy.

Conclusions

Theoretical and Practical Limitations of the MDMP

The Army blames these battle command shortcomings on poor individual and unit training, a lack of sound standard operating procedures and a misunderstanding of battle command doctrine. However, many of these problems can also be traced to theoretical weaknesses within the MDMP. The inflexibility and "paralysis by analysis" can be attributed to the MDMP's foundation in rational expectation decision theory. This type of analysis is very time consuming and has often failed as a predictor of aggregate behavior. Wargaming becomes a quest to predict every action the enemy could take during the battle and develop the optimum counter-reaction. The focus shifts from synchronizing the friendly plan to reacting to predictions of enemy behavior. This happens not because the planners are incompetent but because the process sets them up for failure from the beginning. Instead of trying to predict and maximize the expected outcome of critical events, planners should develop flexible, adaptable plans that can be modified easily based on feedback from the environment. The decision making process should focus on adaptation and less on prediction.

Supporters of Recognition-Primed or limited rationality decision theory would likely place the course of action development phase into the hands of the commander on the grounds that his experience and expertise will yield an adequate (and probably better) decision much faster than a comparison of several options. The 1989 RAND study seems to validate the RPD theory as the method commander's rely on when actually conducting operations. As previously mentioned, the "decision" briefings are primarily vehicles for the commander to test his subordinates' understanding of his concept.[83] The staff's rational expectation-based analysis may give the commander some new ideas but are probably not worth the extra time and confusion they brought to the planning process.

The complexity theorists would likely criticize the MDMP as a decision making process because of its over reliance on rational expectation theory. Their contention would be that enemy and friendly units, acting as complex and adaptive interacting agents, would tend to invalidate many of the rational expectations developed during the MDMP's COA analysis phase. The result would be a battle being fought on the edge of chaos based on a static and inflexible plan. They would recommend attempting to identify possible long-range ramifications and side effects of the plan and build in adaptability. Complexity theorists might also expand the MDMP to include mission preparation and execution. In other words, the plan never really ends, it just keeps adapting and evolving. The commander and staff would continue to monitor the situation and make small changes to a plan based conceptually on the commander's vision for success.

In his research on the causes of failure in decision making, Dietrich Dörner highlights man's inherent weakness in considering long term repercussions and side effects of decisions and policies. People naturally "have great difficulty in evaluating exponentially developing processes." [84] As a result, they tend to implement decisions that lead to failure. In his experiments, Dörner found that the most successful decision makers were those that made more decisions and adapted their plan to fit the existing conditions.[85]

Dörner's findings compliment those of the complexity theorists and point to another conceptual weakness in the MDMP: its tendency to focus too narrowly on a specific friendly and enemy course of action. This myopic approach to decision making often leads to plans that are rigid rather than adaptive. Helmuth Von Moltke probably best described the limitations of plans based on rational expectations when he stated: "You will usually find that the enemy has three courses open to him, and of these he will adopt the fourth."[86]

Conceptually, the MDMP also falls short based on the findings of the 1989 RAND study on commander's information needs because it does not place enough emphasis on the development and dissemination of the commander's vision. It does not force the commander to formulate and articulate his vision until the COA approval phase. In the meantime, the staff is working off his initial intent and planning guidance. They may or may not be in synch with his mental image of the fight. The process also fails to focus the organization on one common goal because the commander and staff develop separate estimates that are not merged until late in the process. The MDMP is structured this way so that the staff and commander give maximum consideration to all available courses of action and receive input from multiple sources but it does so at the expense of organizational focus and synergy. The latest FM 101-5 attempts to alleviate this problem by emphasizing the importance of the commander's planning guidance.[87] However, the lack of organizational focus and synergy will likely continue as long as the commander and staff develop separate estimates and the propagation of the commander's vision falls toward the end of the planning process.

The MDMP also does not identify, facilitate or reinforce the three types of information processing modes. The Commander's Critical Information Requirements (CCIR) are developed by the staff and approved by the commander following mission analysis. While the staff is developing CCIR recommendations, the commander is formulating his initial intent. It is entirely possible that the staff and the commander completely disagree on what information will be critical for the operation. The commander may not even have a clear enough image of the battle to determine if the staff's CCIR recommendations are able to support his information needs. The CCIR is also developed before the commander knows what essential decisions he may have to make during the battle. Wargaming is supposed to identify critical decision points in the battle but if those decisions don't coincide with the commander's vision of the battle, they may end up being irrelevant. Therefore, any information connected with those decision points would be irrelevant also. The end result is that the CCIR fails to adequately reflect *all* of the commander's information requirements.

Digitization to the Rescue

Digitization is seen as the solution to most of the Army's decision making problems. There is a widely held belief in the Army that digitization will "assure C^2 decision-cycle superiority."[88] These sentiments seem to echo those of the military leaders of the early twentieth century who believed that armored forces would work just fine with existing doctrine and organizations. The assumption is that the new technology (information age technology in this case) is the key to fixing current battle command problems or enhancing the decision making processes. Before challenging this assumption, this monograph will examine the Army's concepts for integrating information age technologies, current digitization projects and feedback from the field on battle command digitization.

Decision Making and Technology

> *The Purpose of automation is to help man not only to act, but also to think, especially to make decisions.*
>
> *V.V. Druizhinin, D.S. Kontorov*[89]

Current Modernization Programs

The Army is again in the process of integrating new technologies into its force structure and doctrine. The focus now is not on new types of mechanized fighting machines but on information technology. The Army's senior leaders have witnessed the dramatic changes that information technology has brought to the private sector and are now looking for ways to exploit these technologies for military operations.

Despite the fact that the United States has the world's most technologically advanced military, it was the former Soviet Union that first seriously analyzed the profound impact that information technology would have on the military. In the early 1970s the Soviets were looking at how automation would effect warfare and battle command. The Soviets began by looking at how automation could enhance and support decision-making. They recognized that introducing automation systems in the battle command process would require a multidisciplined approach. They involved experts in the fields of philosophy, psychology, mathematics, computer science, communications, engineering psychophysiology, linguistics, etc.[90]

Soviet military researchers were convinced that computers would be necessary for future commanders to handle the complexity and high tempo of global operations:

> *The swiftness of military actions, enormous volume of information, colossal responsibility, which in many cases takes on a nationwide and even worldwide character, finally the need to have complete guarantee that a decision under all circumstances will be arrived at and implemented by a given period- all of these and many other factors determine the activity of the commander. It is widely*

known that effective management of armed forces under modern conditions is possible only with the aid of automation systems.[91]

The demise of the Soviet Union ended their efforts to blend automation and battle command. Two decades later, however, the U.S. Army appears ready to continue the journey in combining information technology and decision-making. Before looking at the digitization of the U.S. Army's battle command system, we need to briefly describe the Army's 'road to digitization'.

Force XXI

The Army is committed to matching the Soviet's passion for information technology. TRADOC PAM. 525-5 (Force XXI Operations) describes the dramatic effects that information technology will have on battle command. Advanced communication and information processing will force the Army to adjust its command information structures from hierarchical to non-hierarchical organizations.[92]

These "internetted" organizations will exploit information age technologies using the Army Battle Command System (ABCS). The ABCS will merge digital signals from sources within and beyond the battlefield to provide commanders at every level a common, relevant picture. This common, relevant picture will give commanders the "means to visualize how they will execute in harmony, integrated by a shared vision of the battlespace."[93]

The purpose of all these changes is to allow the Army to increase its tempo and effectiveness both in war and in Operations Other Than War (OOTW). Increased tempo will allow the Army to conduct lightning quick pulses of maneuver, logistics, and fires. By increasing its tempo and effectiveness using Information Age technologies, the Army will be able "to operate at levels most adversaries cannot match, while simultaneously protecting that capability."[94]

The Army Digitization Master Plan

The Army Digitization Master Plan (ADMP) is taking the innovative concepts contained in TRADOC PAM. 525-5 and translating them into an implementation plan that leverages "information technology to rapidly mass the effects of dispersed firepower, rather than relying exclusively on the physical massing of weapons and forces that was the primary method of the past."[95]

The ADMP sees digitization as being the specific technology that will allow the Army to fully exploit information technology on the battlefield. Specifically, the ADMP sees battlefield digitization as providing the following: [96]

- A common picture of the battlespace in near-real time (situational awareness).
- Shared data among and between battlefield operating systems.
- The ability to more effectively and decisively concentrate combat power.
- High speed exchange of data.
- Fusion and display of intelligence information to commanders at all levels.
- Rapid exchange of targeting data from sensor to shooter.

The Advanced Warfighting Experiments

A major part of the Army's Force XXI campaign plan is the Advanced Warfighting Experiments (AWE). These experiments are where the digital rubber meets the road. The experiments take the digitization plan outlined in the ADMP and translate it into reality through a series of tests and exercises designed to provide feedback on Force XXI operational and organizational concepts.[97]

The recently completed Task Force XXI AWE focused on brigade-level organization and operations and culminated in a full-scale National Training Center (NTC) rotation in March 1997. During this exercise, seventy-one prototype digital systems were tested during realistic force-on-force scenarios. The Army has not yet published official reports from the TF XXI AWE but General Hartzog, the Army's Training and Doctrine Command (TRADOC) commanding general, was satisfied with the results of the exercise. Interestingly, two of the systems that failed to perform as well as expected were in the battle command arena. The Tactical Internet system lacked efficiency and the digitized mapping system was difficult to work with.[98]

The next phase of the Army Warfighting Experiments will be to test the Division XXI organization and equipment. The purpose of the experiment is "to validate the design for the digital division, the combat service support (CSS) concept, the Force XXI Battle Command and Information Operations requirement, and the operational concept for Division XXI operations."[99] Division XXI will use and refine many of the systems first tested in the Task Force XXI AWE.

Battle Command Digitization Efforts

Battle Command and Data Warehouse Technology

Data warehouses have become one of the fastest growing technologies in the information systems industry. Private sector research indicates that the percentage of companies implementing data warehouses has grown from ten percent in 1993 to ninety percent in 1994.[100] A recent study of forty-five major companies revealed just how important data warehouse technology is to private industry. The average return on investment for these data warehouse systems was over four hundred percent.[101]

A data warehouse takes data from one or more operational systems and restructures it into a decision support system. Data warehouses aggregate enterprise-wide data to support informational and analytical processing over a long historical period.[102] Unlike typical relational databases, data warehouses specialize in the proper aggregation of data to support decision making.

Data warehouse technology supports the commander's need for pipelined information by presenting key information in aggregate form appropriate to the decision maker's level of detail. Key resource reports, unit locations, obstacle completion, and the identification of enemy units are examples of pipelined information requirements for commander's and staffs that data warehouses could provide.

Data warehousing also supports the need for "tree" information where a commander is trying to reconstruct his vision of the battle or modify it to accommodate significant changes in the situation. Data warehouses support this requirement through the use of "drill-down" analysis. Acting as an electronic "directed telescope", drill-down analysis would give commanders and staff officers the ability seek detailed answers to questions that cannot be satisfied through normal pipelined information modes. For example, if an alarm report came in based on an enemy chemical attack, the commander and staff could drill-down and retrieve detailed information that would support timely and effective decision making.

The Army already has a mini data warehouse or "data mart": the All Source Analysis System (ASAS). The Army intelligence community uses the ASAS to satisfy all three information modes (pipelined, alarm, and tree). The ASAS satisfies pipeline information requirements by fusing and presenting intelligence obtained through interfaces with Army, joint, national, and allied intelligence and electronic warfare systems. This aggregated information taken from operational systems used by staff analysts to support situation development. It filters message traffic based on user-selected criteria but fully supports "tree" information requirements by allowing complete access to message traffic, imagery, and other intelligence databases. Finally, ASAS supports "alarm" information requirements by allowing users to establish immediate High Value Target/High Payoff Target (HPT/HVT) alarms.[103]

The Army as a whole is following the Intelligence community's lead and developing an "enterprise-wide" data warehouse called the Battlefield Functional Area Command and Control System (BFACS). This system feeds off smaller data marts like ASAS and operational systems from various functional areas. The information is then aggregated and displayed using Appliqué technology to the user. Figure 3 depicts how BFACS aggregates and presents battlefield information to support situational awareness and decision support.

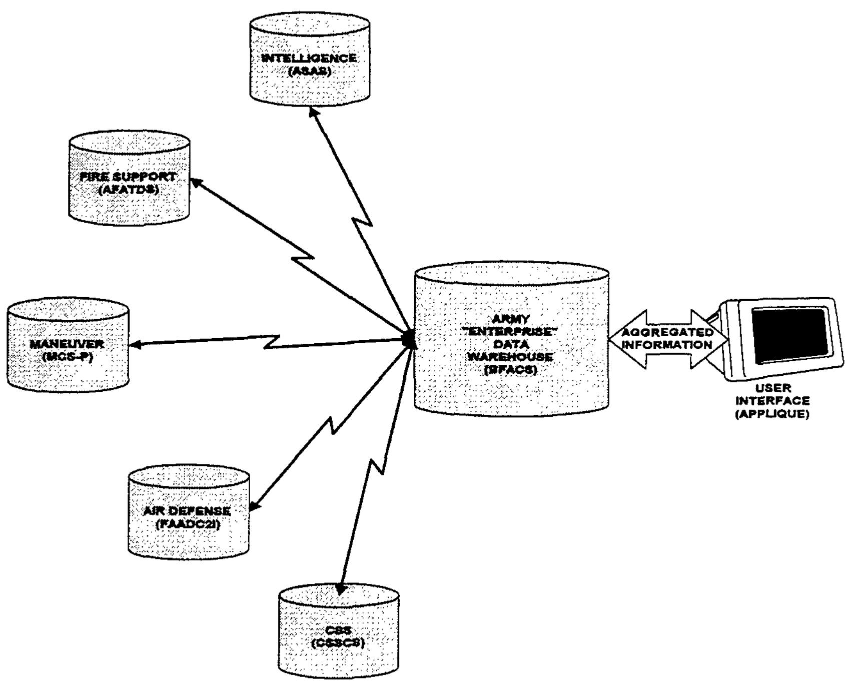

Figure 3: The Battlefield Functional Area Command and Control System

Maneuver Control System/PHOENIX

The Army's digitization effort also applies to specific battle command functions. The Maneuver Control System/PHEONIX (MCS/P) is the program that guides the development of each subordinate battle command system.[104] Within the MCS/P program are several smaller systems designed to enhance or completely automate certain battle command tasks.

One of MCS/P's goals is to improve battle command by providing decision support tools such as the JANUS simulation system. The Army has been using JANUS in training environments to teach leaders the fundamentals of battle command for quite some time. Now, MCS/P wants to move JANUS into the operational environment.[105] The concept behind this initiative is to give commanders and their staffs tools that help them test their plans in a sophisticated simulation environment before they actually execute them. JANUS creates a simulated battlefield where digital forces fight according to the friendly and enemy courses of action developed by the staff. The results of these digital engagements helps the staff identify weakness in their plan and take the appropriate corrective action.

Complimenting the JANUS system is the Course of Action (COA) analysis tool. This system quickly calculates correlation-of-forces ratios to help planners determine if they have distributed combat power correctly. Once the planners have developed their course of action, the COA analysis tool generates briefing slides for use in wargaming and decision briefs.[106] This initiative converts a lot of "stubby pencil" work into "point-and-click" operations that save planners time.

Once the planners have developed their courses of action, automated synchronization tools assist them during the wargaming process. This system links together several related planning tools such as the decision-support template, enemy event template, attack guidance matrix, reconnaissance and surveillance plan, and intelligence collection plan.[107] As the planners synchronize critical events during the wargaming process, the results are automatically posted to the appropriate planning tool. This helps quickly capture and disseminate the results of the wargaming process.

The MCS/P also emphasizes display technologies as part of the effort to digitize battle command. Common scaleable map displays present a digital representation of all Defense Mapping Agency map products and multi-spectral imagery for use by commanders and their staffs.[108] These digital map products allow organizations to relay battlefield information internally and externally with great speed. No longer do couriers need to physically distribute graphic overlays to subordinate command posts. They are now digitized and electronically passed over military communication networks. Friendly and enemy positions are also digitized greatly simplifying the process of battle tracking.

Even more sophisticated than digital map displays is the MPRTS/3-D Visualization system. This system provides a three dimensional virtual representation of the battlefield. Commanders and staffs can move through this virtual environment and *see* the terrain they will fight in a way that no two-dimensional map product could provide. Using this "21st century sand table", commanders could conduct distributed rehearsals of upcoming operations.[109] This will be particularly useful when units are separated by great distances and there is not enough time to conduct a live rehearsal.

Decision Making Performance Trends: Post-digitization

Feedback from the Field

Despite these efforts to integrate information-age technology into the battle command process, the Army appears to be suffering from the same growing pains that have plagued militaries trying to integrate new technology in the past. Initial reports from the AWE indicate success in several areas such as counter-reconnaissance but also point out some emerging problems in the area of battle command. In recent command post training exercises, the Fourth Infantry Division (the Division experimental force) experienced problems with information overload, overemphasis on irrelevant information, technology limitations, and usability problems.[110]

The impressive capabilities of systems such as J-STARS and UAVs actually degraded staff performance and decision making in some cases due to their ability to overload the command post with information. During one wargaming session, the division planners were presented with very detailed information on friendly and enemy dispositions. Because they could "see" so much battlefield detail they began to envision numerous enemy courses of action that might adversely effect the friendly plan. They laboriously wargamed each anticipated enemy action and developed a complete plan to deal with that particular threat. This process went on for hours and consumed the attention of several key staff officers. In the end, the enemy reacted differently than any of the wargamed scenarios. A senior battle command observer controller accurately summed up their efforts as "more information, more options, and more work that goes nowhere."[111]

The plethora of battlefield data has also caused Division XXI staff officers to become fixated on irrelevant information. An example of this "common irrelevant picture" occurred during a recent Division AWE exercise as a simulated enemy Independent Motorized Rifle Brigade (IMRB) entered the division's area of operations. The division's Unmanned Aerial Vehicles (UAVs) faithfully captured this event with real-time video feeds into the division's command posts. Staff reactions were immediate as attention was focused on the IMRB and resources diverted to deal with this sudden intrusion into the division battlespace.

Ironically, the IMRB's actions posed no real threat to the division's original plan. The staff was focusing its attention and the division's scarce resources on an irrelevant battlefield event. Only after sustained prodding by the exercise observer controllers did the staff realize they had lost their focus. It was a case where excellent situational awareness actually degraded planning and decision making.[112]

The AWE unit performance is also frequently hampered by technology limitations and system usability problems. Staff officers in Task Force and Division XXI use digital maps displayed on high-resolution personal computer monitors. While this system offers high resolution and the ability to "zoom in" on particular sections of terrain, only one or two people can view the display at one time. This limitation degrades collaborative planning and limits staff integration. The larger monitors used for briefings support staff collaboration but their poor resolution make them unsuitable for detailed analysis. As a result, staff officers use back-up paper maps for terrain analysis and battle tracking.[113] While these technical limitations will probably be overcome in the near future, at the present time they hinder rather than enhance decision making and planning.

Conclusions

Blending the Old With the New

In summary, the Army is committed to equipping is battle command process with information age technologies yet the Army's AWE units have had significant problems along the way. The promise of decision making Nirvana through digitization remains unfulfilled. This is because the technology tends to magnify the theoretical and practical limitations of the MDMP. It makes bad things worse instead of better. The MDMP lacks compatibility with current information age technology primarily because it presents the commander and staff with huge amounts of irrelevant information and because it exaggerates the limitations of rational expectation theories.

The digitized MDMP can overwhelm the commander and staff with potentially irrelevant information. Because the commander's vision is not solidified early in the decision making process (if at all) the flow of information throughout the organization lacks focus and relevance. A clearly developed vision will help define the commander's information needs in terms of pipeline, alarm, and tree processing modes. It does this implicitly. Since it describes what is important in achieving success on the battlefield, it also helps define what information is important to realizing that vision.

The commander's explicit information requirements are supposed to be provided for by the CCIR. The Army defines the CCIR as:

> *"information required by the commander that directly affects his decisions and dictates the successful execution of operational or tactical operations. CCIR normally result in the generation of three types of information requirements: priority intelligence requirements, essential elements of information, and friendly force information requirements"*[114]

Doctrinally, the CCIR is designed to meet all the commander's explicit information requirements and drive information collection and sharing. Together, the operational vision and the CCIR should define all of the commander's implicit and explicit information requirements and determine what information is actually relevant to the organization.

Where this breaks down is in the linkage between the commander's vision and the CCIR. The staff recommends CCIR to the commander early in the MDMP but it is more likely linked to the staff's analytical process than to the commander's vision of success. As a result, the CCIR usually does a poor job of articulating the commander's total information needs during the battle. When this flaw is automated, the commander and staff get more information that is not necessarily relevant to the commander's image of the battle. Information flows into the command post very quickly but it is often irrelevant causing information needs to go unmet.

Another source of irrelevant information is the MDMP's course of action development phase. The commander does not actually develop the course of action but gives guidance to his staff to assist them in developing a COA that fits his intent. As pointed out in the CTC training trends, it is sometimes not until the unit rehearsal that the commander realizes that his staff has developed a COA that really does not fit his intent. This miscommunication leads to poorly defined pipelined, alarm and tree information requirements… another source of irrelevant information waiting to be exaggerated by automation.

As the section on decision theory pointed out, the MDMP is heavily reliant on the rational expectation decision theory. Synchronization matrices, event templates, decision matrices, and relative combat power tables are all tools designed around the logic of consequence. As such, they inherit all of the rational expectation decision theory's limitations and even tend to magnify them. This is demonstrated by the propensity for commanders and staffs to focus too much on fighting their synch matrix instead of fighting the enemy. Fighting the synch matrix would be fine if it were a good predictor of what will happen on the battlefield but as the elder Moltke reminded us, it rarely is. It is just too difficult to develop a single, best solution to a complex problem such as warfare. Since these tools magnify the limitations of rational expectation theory, then automating them has a compounding effect. As these decision tools are digitized and broadcast across the organization, they tend to capture everyone's attention at the expense of what is really happening on the battlefield. This propagates the "fighting the plan" syndrome where the plan and not the enemy becomes the focus of attention.

The Beginning of Digitized Chaos

The Army's optimistic assumptions concerning the digitization of the MDMP appear to be invalid based on analysis of decision making theory and feedback on the digitization of battle command. The Army has remained faithful to the MDMP despite the warning signs that it is in need of a good overhaul. Digitization seems to have only magnified its flaws and will continue to do so until the Army decides to follow the guidance of TRADOC Pam. 525-5 (Force XXI Operations) and remain willing to change its doctrine to fully exploit new technologies.[115] The final section of this monograph suggests some modifications to the MDMP that might fulfill that guidance.

The Future of Battle Command

> *It is not enough that a leader should have the ability to decide rightly; his subordinates must seize at once the full meaning of his decision and be able to express it with certainty in well-adjusted action...his words must have the same meaning for all.*
>
> *Julian Corbett*[116]

Upgrading the MDMP

Despite the seemingly poor performance report on the MDMP and the efforts to digitize it, the process should not be totally scrapped in favor of a "new and improved" decision making process. All that is needed is a moderate upgrade to bring it in line with more current research on decision making and the information needs of military units. In some cases, only shifting of emphasis and attitude should be enough to bring about dramatic improvements. The three general characteristics of the upgraded MDMP are:

1. It Defines and supports all of the commander's information needs
2. It emphasizes the experience and the expertise of the commander
3. It focuses on being adaptive in a complex environment.

The last section of this monograph explains how these modifications will enhance the utility of the MDMP and make it more compatible with information-age technology.

The Commander's Vision, Complexity and Emerging Order

One key to bringing battle command and the decision making process into the twenty-first century is to emphasize the commander's vision as a framework for establishing order in the complex environment of combat. The complexity of even a small battle is astounding yet order usually seems to emerge out of this chaos. Military theorists have understood this phenomenon for centuries:

In the tumult and uproar the battle seems chaotic, but there is no disorder; the troops appear to be milling about in circles but cannot be defeated.[117]

Complexity theorists maintain that this phenomenon occurs when ever complex situations arise where order sways toward chaos and then back again toward order. It is a unique situation that develops in complex environments. Military professionals credit this self-emerging order to small-unit leadership and initiative and understand that it happens naturally in battle. The German army sought to exploit this tendency in World War II with their concept of Auftragstaktik which stresses small unit initiative and adaptability. This concept was integral to their doctrine of Blitzkrieg and was instrumental to their stunning attack against France in 1940.[118] This idea is also integral to Force XXI's concept of knowledge-imposed order.[119] However, self-emerging order is not total independence from any type of overall control. Heinz Guderian was exercising initiative *within* the broad vision developed by the German General Staff. He understood what success was supposed to look like and therefore recognized an opportunity to exploit a penetration of the French defenses. Without the commander's overall vision of success, self-emerging order on the battlefield can be counterproductive.

Narrowly centralizing control over a military operation tends to stifle self-emerging control and often serves as a mechanism for increasing friction. This is because centralized battle command systems monopolize information and the decision making process in order to maximize certainty at the higher levels of command. The more detailed the plan, the more information is required to monitor its execution. However, instead of maximizing certainty, the system becomes overwhelmed by the influx of information and actually expands uncertainty.[120] Some call this type of friction "information overload" or "paralysis by analysis." Regardless of what name it's given, it is an undesirable byproduct of overlaying centralized battle command systems on complex situations.

By clearly stating his vision for success during an operation, a commander is in effect decentralizing his command system. Decentralized command systems distribute the uncertainty of combat throughout the organization. In so doing, they begin to resemble self-organizing dissipative structures that create order out of chaos.[121] Small unit leaders adapt to complex situations on the battlefield and exercise initiative within the commander's vision. They are less worried about fulfilling their obligation to a detailed plan and concentrate on adapting to the situation at hand. The plans developed in this distributed battle command system are simple and flexible. They provide order without creating friction or stifling initiative.

Given the complex nature of the battlefield the battle command process should emphasize the commander's vision and stress adaptability at the lowest levels. The commander's vision provides the necessary framework that allows subordinate leaders to generate order within the chaos of combat. It is the description of success that provides meaning to the common relevant picture.[122] Armed with an understanding of what success looks like, subordinate leaders can quickly adapt to complex situations and either exploit opportunities or overcome adversity.

The commander's vision is not linked to any particular course of action. If it were, it would provide too much centralized control and discourage self-emerging order or initiative. A course of action is one method for achieving the commander's vision of success, but not the only one. Because it is independent from any particular course of action, subordinates have the freedom to act on opportunities or prevent disasters that were not predicted or anticipated in the planning process.

Current Army doctrine has finally recognized the importance of the commander's vision with the lasted definition of commander's intent. The latest definition states:

> *A clear, concise statement of what the force must do to succeed with respect to the enemy and the terrain and to the desired end state. It provides a link between the mission and the concept of operations by stating the key tasks that along with the mission are the basis for subordinates to exercise initiative when unanticipated opportunities arise or when the original concept of operations no longer applies...*[123]

This definition breaks from past definitions by de-linking the commander's vision from a particular course of action and provides the controlling idea of success that allows for self-emerging order on the battlefield. Unfortunately, this new doctrinal focus is blurred by a decision making process that fails to place enough emphasis on the commander's vision of success. The MDMP has the commander's intent *evolve* throughout planning process and is not explicitly stated early in the process. The completed commander's intent is not stated until the last portion of the MDMP in the operations order. Until then, the staff is developing courses of action and coordinating with higher, adjacent, and subordinate elements without a clear understanding of what the commander sees as success on the battlefield. Subordinates are also effected by the delayed propagation of the commander's intent with the result being a general degradation of their planning and preparation efforts.

An improved MDMP would require the commander to solidify and disseminate his vision as soon as possible in the planning process. Since the commander's intent is no longer tied to a particular course of action, it need not be delayed until after a course of action is adopted. The commander has the necessary information to develop a good vision (intent statement) after receiving the mission analysis brief. At that point, the commander should formulate his vision, disseminate it throughout the command, and have key personnel demonstrate their understanding of that vision with a formal briefback to the commander.

Front-loading the commander's vision complements, and is improved by, information-age technologies. By focusing the organization on what the commander sees as success, it provides loose controls over the amount and type of information collected. This helps the staff tailor sensor collection efforts to support that vision and tells the organization in broad terms what information the commander thinks is important for mission success. Automation greatly supports moving the commander's intent statement up in the MDMP by providing a quick and efficient means of disseminating that information throughout the organization. Using the latest telecommunications and display technologies, commanders can conduct virtual intent briefings and briefbacks.

Another way to enhance the effectiveness of the MDMP in a complex and dynamic environment is to stress adaptation versus prediction in planning and execution. Napoleon was one of history's greatest adaptive planners. During his 1805 Ulm campaign, Napoleon arrayed his corps within forty-eight hours supporting distance of each other in order to mutually support each other and adapt to the situation in the face of uncertain Austrian intentions.[124] At Austerlitz, Napoleon established lines of operation to the west in Brünn and south in Vienna to lessen the effects of possible allied attacks to his rear.[125] Finally, in 1809 Napoleon displayed his genius for flexibility again by arranging his forces in a diamond formation so as to be in a position to envelop the Austrian army if they attacked north or south of the Danube River. This embedded adaptability allowed Napoleon to out-maneuver the Austrians once again and achieve a strategic victory against numerically superior forces.[126]

A good example of modern-day adaptive planning is the NTC OPFOR's decision-point tactics. The OPFOR defines decision-point tactics as:

> *the art and science of employing available means at a specific point in space and/or time where the commander anticipates making a decision concerning a specific friendly course of action. This decision is directly associated with threat force activity (action/reaction) and/or the battlefield environment.*[127]

Using decision-point tactics, the commander only chooses a particular COA once the conditions for meeting that COA have been met at a particular point on the ground. Those conditions are determined through reconnaissance, contact with the enemy, or some other form of intelligence. These conditions become part of the commander's CCIR and change from decision point to decision point. The staff doesn't come up with a single "recommended" COA but instead analyzes the situation and develops two or three options at each decision point (DP). The plan positions resources to execute more than one option at each COA (e.g. artillery is positioned to fire FASCAM on more than one mobility corridor).[128]

This type of planning tends to merge planning and execution into one continuous process. A single "plan" is not published, but rather a package of options based on the commander's concept of operation. Mission planning continues throughout the operation as the commander and staff analyze the situation at each decision point. This helps prevent the situation whereby "no plan survives first contact". It also prevents the "unit fighting the plan and not the enemy" syndrome. Finally, it may prevent the "paralysis by analysis" that comes with trying to create the perfect plan.

Decision-point tactics also recognizes the complex nature of warfighting. It goes outside the mental model of trying to develop a "recommended" plan based on an enemy's most probable COA. Instead, actions on the battlefield are determined based on conditions at each DP. This recognizes the fact that the battlefield is a complex environment with interacting agents adapting and changing along the way. Our current MDMP is like a roadmap that is designed to get you from point "A" to point "B". The problem with that is that the roads begin changing once you start your trip and your roadmap quickly loses its utility. Decision-point tactics gives you options to get you to the next intersection. Once you get to that intersection, it looks at the prevailing conditions, and offers solutions for getting to the next intersection. In that way, it is *evolutionary* and able to adapt to changing situations on the battlefield.

The Army could improve its ability to adapt to the complexity of the battlefield by integrating the concepts of decision point tactics into an its MDMP. This would entail developing a plan that *evolves* based on battlefield events. Although based on the commander's overall concept of operation, the plan remains adaptive as it follows a series of options planned around each decision point. These are more than branch plans; they are an integral part of the plan which allocates and positions resources so that any of the options can be executed.

Information age technologies can greatly enhance a planning process based on decision-point tactics. The unit can focus its collection efforts at the decision points and use digital communications to give the commander the situational awareness necessary to make a quick and informed decision. Like the commander's vision, decision-point tactics helps filter out irrelevant information. The information that comes to the commander is relevant to a decision that must be made and helps the organization adapt rather than react to situations on the battlefield. Digital communications and sophisticated sensors can also provide the commander with timely and accurate information at each decision point.

Integrating a clear, concise statement of the commander's vision with decision-point tactics in the MDMP provides the basis for successful military operations in complex environments. Flexibility and adaptation is built in explicitly with decision-point tactics and implicitly with the commander's vision. If subordinates cannot make any of the planned options work, turn to the commander's vision and use their initiative to attain success outside of the original course of action.

Experience and Expertise Versus Multiattribute Utility Analysis

The Army should adopt a recognition-primed decision making instead of a pure rational expectation model for developing courses of action. The former model is based on limited rationality theory that relies on heuristics instead of the multiattribute utility analysis currently embedded in the MDMP. Recognition-primed decision making makes use of the commander's expertise, experience, and intuition in developing satisfactory solutions in dynamic environments. [129]

The appropriateness of this decision making theory for military operations is reinforced by the 1989 RAND study on the commander's information needs. Since commanders typically develop their own concepts of operation, the staff drill of developing, analyzing, and comparing various courses of action is largely wasted time. The very idea of trying to maximize the expected value of a battlefield decision is invalidated by the uncertainty and friction of the battlefield. The perfect plan has never been developed and automation only adds to the illusion that it actually exists.

Given the complexity and dynamic nature of military operations, the MDMP should require the commander develop his course of action early in the process and use his staff to refine it using decision-point techniques. This eliminates the time wasted searching for the ultimate COA, exploits the expertise and experience of the commander, and provides the staff with more time for building adaptability into the plan. This would also eliminate much of the ambiguity that develops when commanders give inadequate planning guidance to the staff for COA development. The commander now has full ownership of the COA and the staff's responsibility is to make it more adaptable to changing battlefield conditions.

Technology can assist the commander greatly in developing a good course of action. The commander can collaborate with subordinates and trusted advisors when developing his COA using the same telecommunications and display technologies that helped him propagate his vision within the organization. Enhancing the ability of the commander to collaborate with subordinates recognizes the dynamic nature of modern military operations where plans sometimes develop from the bottom up.[130] At the same time, technology helps subordinates initiate parallel planning since they understand the commander's concept of the operation long before the formal publishing of the operation order.

Defining and Supporting all of the Commander's Information Needs

The one aspect of the MDMP that makes it least compatible with information-age technologies is its inability to properly manage large amounts of rapidly-transmitted information. The only mechanism for focusing and filtering information coming into the command post is the CCIR. Defined as "information required by the commander that directly affects his decisions and dictates the successful execution of operational and tactical operations"[131], the CCIR should provide for *all* the commander's information needs. As evidenced by reports from the field, the CCIR does not do a very good job of providing the commander relevant information during the battle. Without an effective means of filtering and managing information, Force XXI commanders and staff find themselves overwhelmed by irrelevant information.

The problem is not in how CCIR is defined in doctrine but rather in how its components are defined and understood by the Army's leadership. Army doctrine states that CCIR normally consists of the Priority Intelligence Requirements (PIR), Essential Elements of Friendly Information (EEFI), and Friendly Forces Information Requirements (FFIR).[132] The PIR and EEFI service the commander's need for alarm information regarding enemy and friendly forces and arguably receive the most attention during planning. The FFIR is the only part of the CCIR that deals with routine information. Typically, it contains Standard Operating Procedure (SOP) items such as personnel and maintenance status requirements.[133] Tremendously under-emphasized in doctrine and often ignored during planning or execution, the FFIR currently provides little utility in managing information flow into the command post.[134]

To better meet the commander's information needs in battle and harness the power of today's information systems, the FFIR should receive more emphasis as the description of the commander's pipeline information needs. Instead of SOP-type information that provides little useful information during the battle, it should contain general information that helps the commander see that his vision and course of action are being executed as intended. This type of information would include both friendly and enemy activities as well as information on terrain, weather, and any other factors that the commander thinks is relevant to monitoring the flow of the battle. With this in mind, a more appropriate name for this type of information might be General Information Requirements (GIR). Like the PIR, the GIR is tailored for specific events on the battlefield. For example, a brigade commander may only want to see on his appliqué display the center mass indicator of battalion-sized units as they conduct their approach march. As they close on their objectives, the commander may want to see individual companies within his main effort. He may only want to see that particular portion of the battle only hearing or seeing other parts of the battlefield if there is a serious problem in those areas. Simply adding emphasis to pipeline information in the form of General Information Requirements will go a long way in taming the tendency of our digital information systems to provide an abundance of irrelevant information.

The one type of information requirement not addressed in the CCIR is the tree information processing mode. However, given a clear understanding of the pipeline and alarm information requirements, the staff can better anticipate what the commander's tree information requirements will be. This is the hardest type of information requirement to forecast and requires flexible information systems that quickly and intuitively provide detailed "drill-down" information.

The commander should explicitly state his CCIR once development of the concept of the operation is complete. The staff and subordinates should brief the commander on their understanding of the CCIR as part of the commander's vision/intent briefback. Combined with flexible and intuitive information systems and a clearly stated commander's vision and concept of operation, this enhanced CCIR maximizes the capabilities of information-age technologies and improves the overall utility of the MDMP.

The three types of information processing compliment the commander's vision in providing focus for the collection and sharing of information throughout the organization. The vision provides the implicit relevance to battlefield information while the CCIR provides explicit relevance. Together this implicit and explicit control over information collection and sharing form the Common Relevant Picture (See Figure 4). This common relevant picture of the battlefield is provided by and enhanced through the use of information-age technologies. The common relevant picture provides the organization the information it needs to successfully prosecute the battle without increasing friction through information overload.

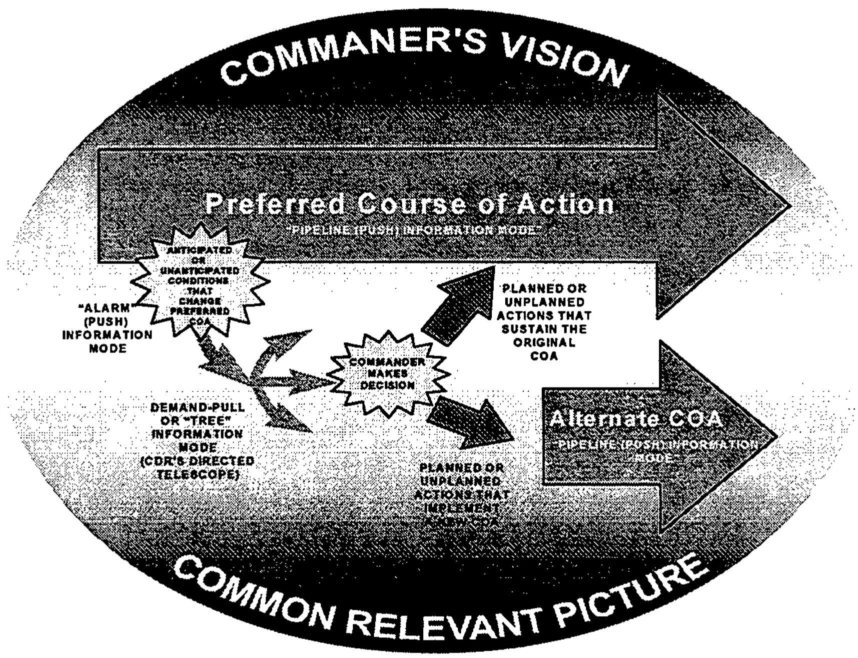

Figure 4: The Common Relevant Picture

A New Model For Decision Making

The following is a summary of the recommended modifications needed to make the MDMP more compatible with automation and contemporary research on decision making:

1. Have the commander clearly articulate his vision of success (commander's intent) early in the decision making process to focus the planning effort and establish broad filters for information collection and processing.
2. Have the commander personally develop a course of action based on his experience and expertise early in the decision making process. The staff then focuses on making it adaptable to changing conditions on the battlefield. Technology enhances this aspect of the decision

making process by allowing the commander to better collaborate with subordinates and provides those same subordinates with more time for parallel planning.

3. Have the commander define his information requirements early in the decision making process using a modified CCIR. The modified CCIR consists of alarm information such as PIR and EEFI as well as a new category called General Information Requirements (GIR). The GIR provides the commander with the necessary pipelined information to complete the common relevant picture. This modified CCIR harnesses the power of today's digital information systems and helps prevent information overload.
4. Have the staff concentrate on building adaptability into the commander's course of action using the methods of decision-point tactics. This will prevent the organization from fixating on one course of action and focus more on fighting the enemy. Technology helps this effort by providing sophisticated sensors and communications equipment that can monitor the situation at the decision points and quickly pass that information to the commander and staff.

The battle command process shown in Figure 5 is a graphic representation of the upgraded MDMP. While not dramatically different from the current MDMP, it integrates the qualitative adjustments mentioned above in an effort to improve the process' overall utility and make it more compatible with modern digital information systems. Unlike the current MDMP which separates planning from preparation and execution, this process blends these activities together along with the various concurrent activities that normally accompany the planning effort. This reflects the more dynamic nature of military operations and forces the plan to adapt to conditions on the battlefield rather than trying to precisely predict future events.

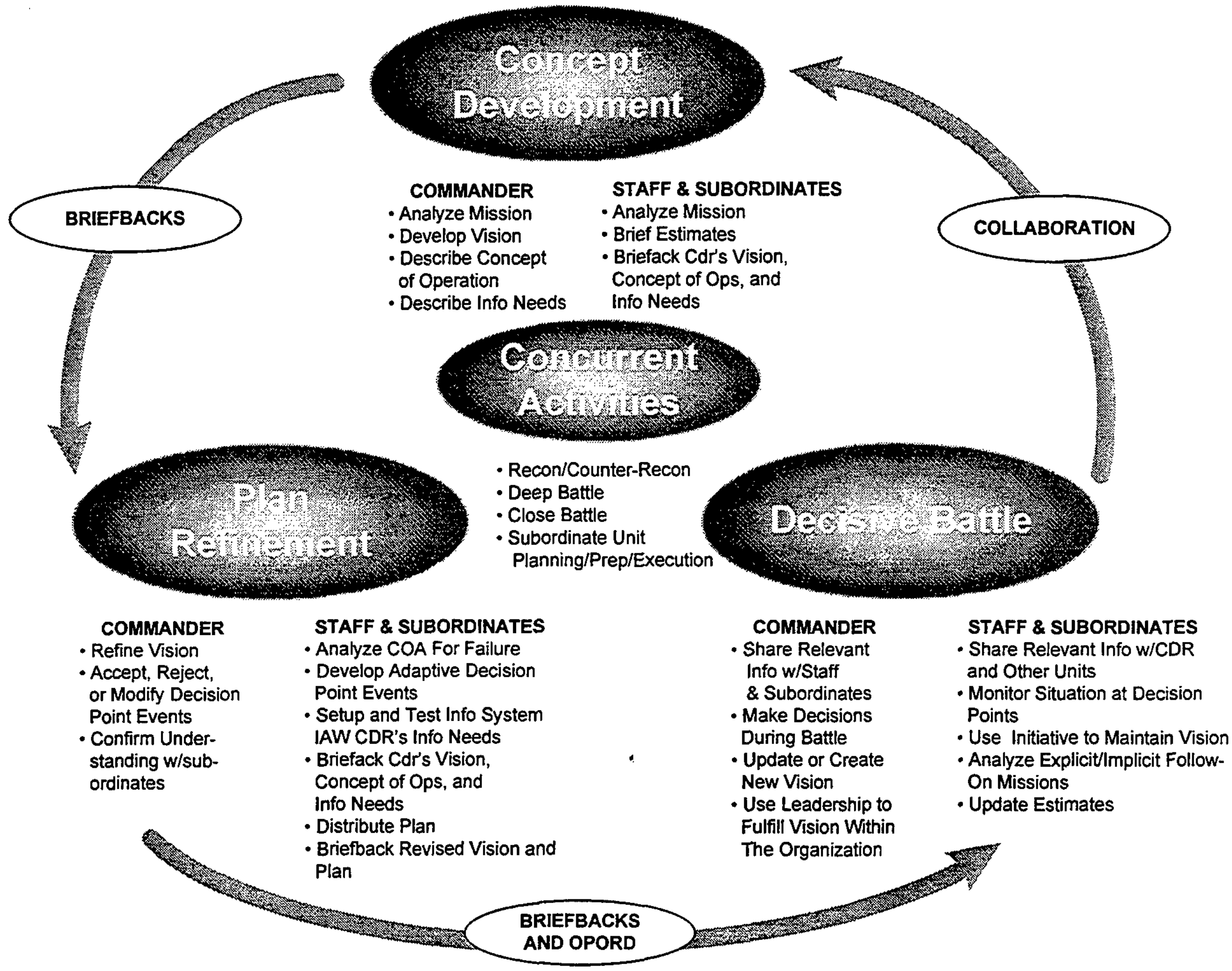

Figure 5: The Upgraded MDMP

The Oldest Paradigm

The Army is traditionally very resistant to change. In the past this tendency has caused a lag between the introduction new technology and improved doctrine designed to fully exploit the new capabilities. This resistance to change has perpetuated the existence of a sixty year old decision making process that is badly in need of an upgrade. If the Army intends to use information-age technology to take it into the twenty-first century it must first be willing to circumvent digitized chaos by taking a hard look at its battle command and decision making doctrine.

The analysis in this monograph was limited by the lack of official results from the Army's AWEs. Most of the information relating to AWE results is subjective and general in nature. The Army has not conducted a detailed objective comparison of battle command performance pre and post-digitization. This monograph intended to show that enough circumstantial evidence exists to indicate that the Army can improve its MDMP to take full advantage of current and emerging technologies. It is meant as a point of departure for more systematic and objective research in the area of battle command digitization.

In their book The Future of War, George and Meredith Friedman analyze weapon system life-cycles using a concept they call senility. A senile weapon system is one where the cost of keeping it survivable on modern battlefields begins to far exceed its utility. These systems are not obsolete. They can still accomplish their military task but it takes exponentially more of the nations resources to protect it from increasingly sophisticated countermeasures. Only when the countermeasures become so effective that it takes totally unreasonable expenditures to protect the system does it actually become obsolete.[135] This same concept could be applied to the MDMP. Although not necessarily obsolete, this aging decision making process could be showing signs of senility. As the amount of money being spent to digitize the MDMP continues to grow, the expected increases in battle command effectiveness and operational tempo continue to elude the Army. Despite the Army's love for its oldest paradigm, perhaps it is time to recognize the senility of the MDMP and finally upgrade our decision making process.

Notes

[1] FM 25-100, Training the Force: Soldiers, Units and Leaders, (Washington DC: Headquarters Department of the Army, November 1988), G-3.

[2] US Army Training and Doctrine Command Pamphlet 525-5: Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-first Century, (Fort Monroe, VA: Headquarters, US Army Training and Doctrine Command, 1 August 1994), 3-4.

[3] MAJ Arthur N. Tulak, "Command, Control, Communications and Intelligence (C3I) at the Advanced Warfighting Experiment (AWE), *US Army Center For Lessons Learned Web Site* (http://call.army.mil:1100/call/nftf/mayjun 97/c2iawe.htm., 22 Nov 97), p. 1.

[4] "Advanced Field Artillery Tactical Data System (AFATDS)", *Program Manager, Field Artillery Tactical Data Systems Home Page,* (http://www.exit109.com/~fatds/afatds.htm., 13 December 1996), 1.

[5] "TRADOC System Manager All Source Analysis System Home Page", *TSM ASAS Web Site* (http://www.tsmasas.army.mil., 22 November 1997), 1.

[6] "Force XXI Outbrief to the TRADOC Staff", *TRADOC Advanced Warfighting Experiment Web Site,* (http://www.monroe.army.mil/pao/tradoc., 20 November 1997), slides 1-27.

[7] FM 101-5-1: Operational Terms and Graphics, (Washington DC: Headquarters, Department of the Army, 1997), 1-16.

[8] COL Patrick Lamar, LTC Billy J. Mccollum, LTC John A. Collier Jr., MAJ Edwin J. Kuster Jr., "Battle Command Battle Laboratories: Where Tomorrow's Victories Begin", *Military Review*, May-June 1996, 54-55.

[9] Tulak, p. 1.

[10] FM 25-100, G3-G4

[11] FM 101-5-1, 1-34.

[12] Ibid., 1-41, and FM 101-5: Staff Organization and Operations, (Washington DC: Headquarters Department of the Army, May 1997), 5-11.

[13] This is a very superficial definition of complexity theory based on Mitchell Waldrop's book Complexity: The emerging Science at the Edge of Order and Chaos, (New York: Touchstone Books (Published by Simon and Schuster), 1992). Page 12 discusses the "edge of chaos" and page 147/148 is about adaptive agents.

[14] COL Patrick Lamar, LTC Billy J. McCollum, LTC John A. Collier Jr., MAJ Edwin J. Kuster Jr., "Battle Command Battle Laboratories: Where Tomorrow's Victories Begin", *Military Review*, May-June 1996, 59.

[15] W.H. Inmon, "Tech Topic: What is a Data Warehouse", *Prism Solutions, Inc. Web Site*, http://www.cait.wustl. edu/cait/papers/prism/vol1_no1, 1 April 1996, 1.

[16] For information on Data Warehouse capabilities see Jack McElreath, "Data Warehouses: An Architectural Perspective", *Computer Sciences Corp. Web Site*, http://www.csc.com/about/tech_dw_arch.html, 4 April 96, 1. For information on "tree information processing modes" see James P. Kahan, Robert Worley, and Cathleen Stasz, Understanding Commander's Information Needs, (Santa Monica, CA: The RAND Corporation Arroyo Center, June 1989), 43.

[17] FM 101-5-1, 1-62.

[18] For an example of FAADC2I capabilities see MAJ Arthur N. Tulak's "Command, Control, Communications and Intelligence (C3I) at the Advanced Warfighting Experiment (AWE), *US Army Center For Lessons Learned Web Site* (http://call.army.mil:1100/call/nftf/mayjun97/c2iawe.htm., 22 Nov 97), p. 8.

[19] Ibid., 1-72.

[20] US Army Training and Doctrine Command Pamphlet 525-5: Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-first Century, (Fort Monroe, VA: Headquarters, US Army Training and Doctrine Command, 1 August 1994). The forward gives a good overview of the basic concepts behind Force XXI. Chapter two discusses the environment of future conflicts and chapter three discusses the importance of information technology in future land operations.

[21] FM 34-2, Collection Management and Synchronization Planning, (Washington DC: Headquarters Department of the Army, March 1994), Glossary 6.

[22] Opposing Forces Battle Book, (Fort Leavenworth, KS: School for Command Preparation US Army Command and General Staff College, 1 January 1997), page STRAT-9.

[23] FM 34-2, Collection Management and Synchronization Planning, Glossary 6, 7.

[24] For an overview of pure and limited rational expectation theory see James G. March's A Primer on Decision Making: How Decisions Happen, (New York: The Free Press, 1994), pages 1-23. For an overview of the Recognition-Primed Decision Model see Gary A. Klein's "Strategies of Decision Making", *Military Review*, May 1989, 58-59.

[25] Tulak, 7.

[26] FM 101-5: Staff Organization and Operations, 5-3 and 5-27.

[27] COL Patrick Lamar et al., 60-61.

[28] FM 100-5: Operations, (Washington DC: Headquarters Department of the Army, June 1993), G-6.

[29] Joint Publication 3-07: Joint Doctrine for Military Operations Other Than War,(Washington DC: US Department of Defense, Joint Chiefs of Staff, 16 June 1995), GL-3.

[30] FM 101-5-1, 1-124. See also FM 34-2, pages G-6 and D1-D2.

[31] FM 101-5-1, 1-150.

[32] "1997 Strategic Plan", *US Army Training and Doctrine Command Web Site*, (http://www-tradoc.army.mil/cmdpubs/ 97strat/stratpln.htm.,3 June 1997), 1.

[33] FM 34-2: Collection Management and Synchronization Planning, Glossary 7.

[34] Clarence A. Robinson, "Unmanned Surveillance Vehicle Grabs Over-the-Horizon Imagery", *Signal*, September 1995, 15.

[35] Martin van Creveld, Technology and War: From 2000 BC to the Present, (New York, NY: The Free Press, 1989), 1.

[36] Ibid., 178.

[37] Ibid.

[38] James J. Schneider and Lawrence L. Izzo, "Clausewitz's Elusive Center of Gravity", *Parameters*, September 1987, 50.

[39] Ibid., 54.

[40] TRADOC Pamphlet 525-5, 1-5.

[41] Art Caston and Don Tapscott, "Stage IV Report: The Integration of Data, Text, Voice and Image, (Toronto: DMR Group Inc., 1987) in Paradigm Shift, Caston and Tapscott, 38.

[42] Major General Wallace C. Arnold, "MANPRINT: Battle Command and Digitization", *Military Review,* May-June 1995, 49.

[43] James G. March, A Primer on Decision Making, (New York: The Free Press, 1994), 9.

[44] Ibid., 2.

[45] March, A Primer on Decision Making, 2.

[46] Paul E. Moody, Decision Making: Proven Methods for Better Decisions, (New York: McGraw Hill Book Company, 1983), 1.

[47] Ibid., 4

[48] Donald G. Ellis and B. Aubrey Fisher, Small Group Decision Making: Communication and the Group Process, Fourth Edition, (McGraw-Hill, Inc.: New York, 1994), 143.

[49] Ibid., 5.

[50] March, A Primer on Decision Making, 18.

[51] Ibid., 14.

[52]Gary A. Klein, "Strategies of Decision Making", *Military Review*, May 1989, 59.

[53] Ibid., 58.

[54] Ibid. 61.

[55] March, A Primer on Decision Making, 58.

[56] Ibid.

[57] Ibid., 61.

[58] M. Mitchell Waldrop, Complexity: The Emerging Science at the Edge of Order and Chaos, (New York: Simon and Schuster, 1992), 225.

[59] Ibid., 281.

[60] Ibid., 293.

[61] Carl Von Clausewitz, On War, translated and edited by Michael Howard and Peter Paret, (Princeton, New Jersey: Princeton University Press, 1976), 119.

[62] Clausewitz appears to understand the effects of complexity but has a slightly different attitude about how to deal with it than the complexity theorists. Clausewitz sees the willpower of the commander as key in overcoming complexity and chaos on the battlefield. The complexity theorists maintain that a self-emerging order develops in complex situations that tends to keep things on the "edge of chaos". They discounted the effectiveness of overly-centralized control over complex situations due to the nature of this self-emerging order. Nevertheless, Clausewitz appears to understand the importance of at least a degree of centralized control in military operations and therefore makes the battle against fog and friction a key task for the commander.

[63] Moody, Decision Making: Proven Methods for Better Decisions, 222.

[64] FM 101-5: Staff Officer's Field Manual, Part 1, (Washington DC: US War Department, 1932), 44-46.

[65] FM 101-5: Staff Organization and Operation, (Washington DC: Headquarters, Department of the Army, May 1982),5-11.

[66] Ibid., 5-2.

[67] FM 101-5, Staff Officers' Field Manual: Staff Organization and Procedure, (Washington DC, Department of the Army, July 1950), 59.

[68] FM 101-5: Staff Organization and Operations, (Washington DC: Headquarters Department of the Army, May 1997), 5-16.

[69] James P. Kahan, Robert Worley, and Cathleen Stasz, Understanding Commander's Information Needs, (Santa Monica, CA: The RAND Corporation Arroyo Center, June 1989), 20. The RAND researchers discuss how commanders often use abstractions such as anecdotes and analogies to better communicate their ideas to subordinates and staff officers. They also ask questions not for their own edification but to test the knowledge of the staff officer and increase the general understanding among the group.

[70] Ibid., 17.

[71] Ibid., 36-46.

[72] Ibid., 71-78.

[73] Jon Grossman, Battalion-Level Command and Control at the National Training Center, (Sanata Monica, CA: The RAND Corporation Arroyo Center, 1994), xii.

[74] Ibid., xiii.

[75] Ibid., 21.

[76] See "BCTP Training Program Perceptions, Corps and Division Level, FY 95" *U.S. Army Center For Lessons Learned (CALL) Web site, http://call.army.mil/call/ ctc_bull/bctp1/sec2ta4.htm*; "NTC Training Trends, 1st & 2nd Quarter FY 97", *CALL Web Site, http://call.army.mil/call/ctc_bull/97-16/ta4pl.htm#10.*; "JRTC Training Trends, 4th Quarter FY 96 & 1st Quarter FY 97", *CALL Web Site, http://call.army.mil/call/ctc_bull/97-6jrtc/sec2ta4a. htm#27.*

[77] "BCTP Training Program Perceptions, Corps and Division Level, FY 95" *U.S. Army Center For Lessons Learned (CALL) Web site, http://call.army.mil/call/ ctc_bull/bctp1/sec2ta4.htm,* 1.

[78] "NTC Training Trends, 1st & 2nd Quarter FY 97", *CALL Web Site, http://call.army.mil/call/ctc_bull/97-16/ta4pl.htm#10.* (Trend 23, p.2).

[79] Ibid.

[80] FM 101-5, Staff Organization and Operations, 31 May 1997, 5-16. It could be argued that wargaming *is the only* course of action analysis. The Army's efforts to improve military decision making focus on the wargaming process as a way of synchronizing battlefield functions like maneuver, fire support, and logistics. The outputs of wargaming like the synchronization matrix and decision support template are examples of how the wargaming process has grown in sophistication.

[81] "NTC Training Trends, 1st & 2nd Quarter FY 97", *CALL Web Site, http://call.army.mil/call/ctc_bull/97-16/ta4pl.htm#10.* (Trend 27, p.4).

[82] "BCTP Training Program Perceptions, Corps and Division Level, FY 95" *U.S. Army Center For Lessons Learned (CALL) Web site, http://call.army.mil/call/ ctc_bull/bctp1/sec2ta4.htm,* 5.

[83] 1989 RAND Study, 20.

[84] Dietrich Dörner, The Logic of Failure, (New York: Metropolitan Books, 1989), 34-35.

[85] Ibid., 21.

[86] Justin Wintle, The Dictionary of War Quotations, (New York: The Free Press, 1989), 85 (First quoted in Robert Debs Heinl Jr., Dictionary of Military and Naval Quotations, 1966).

[87] FM 101-5: Staff Organization and Operations, May 97, 5-10.

[88] Major Mark D. Calvo, "Digitizing the Force XXI Battlefield", *Military Review*, May-June 1996, 68.

[89] Druzhinin, V.V.; Kontorov, D.S., Decision Making and Automation: Concept, Algorithm, Decision (A Soviet View), (Moscow: Military Publishing House of the Ministry of Defense or the USSR, 1972), Translated and Published under the auspices of the U.S. Air Force, Available through the U.S. GPO (Stock # 008-070-00344-9/ Catalog # D 301.79:6), 18.

[90] Ibid., 4.

[91] Ibid., 6.

[92] TRADOC PAM. 525-5 (Force XXI Operations), 2-8.

[93] Ibid., 3-4.

[94] Ibid., 1-5.

[95] The Army Digitization Master Plan Executive Summary (Coordinating Draft), (Fort Monroe, VA: U.S. Army Training and Doctrine Command, November 1995), 1.

[96] Ibid., 4.

[97] Colonel Thomas R. Goedkoop, "Task Force XXI: An Overview", Military Review, March-April 1997, 71.

[98] Jim Caldwell, "TRADOC Commander Reveals Some Results of Force XXI AWE", *TRADOC News Service Press Release,* (Fort Monroe, VA: U.S. Army Training and Doctrine Command, 22 April 1997), 1. General Hartzog

admitted that TRADOC had not completed formal analysis of the exercise but his initial impressions were good. Although some systems fell short of expectations or failed completely, 85 percent performed to requirements. The most promising systems fell into the recon/counter-recon category. The Joint Surveillance Target Attack Radar System (J-STARS) and the Unmanned Aerial Vehicles (UAVs) were both star performers. Weapons systems such as the Javelin Anti-armor system and the Apache Longbow were also winners.

99 Colonel Albert F. Turner, Jr., "Division XXI Advanced Warfighting Experiment Directive", (Fort Monroe, VA: U.S. Army Training and Doctrine Command, February 1997), 1-1.

100 Jack McElreath, "Data Warehouses: An Architectural Perspective", *Computer Sciences Corp. Web Site,* http://www.csc.com/about/tech_dw_arch.html, 4 April 96, 1.

101 Lawrence Fisher, "Along the Infobahn: Data Warehouses", *Booz, Alen & Hamilton Web Site* (http://www.strategy-business.com/technology/96308/ page2html.) 11 Oct 97, 2.

102 W.H. Inmon, "Tech Topic: What is a Data Warehouse", Prism Solutions, Inc. Web Site, http://www.cait.wustl.edu/cait/papers/prism/vol1_no1, 1 April 1996, 1.

103 "All Source Analysis System (ASAS) System Summary", *United States Army Intelligence Center and Fort Huachuca, Director of Combat Developments Web Site* (http://huachuca-dcd.army.mil/IEWSYS/asas.htm), 25 Oct 97, 1.

104 COL Patrick Lamar, LTC Billy J. Mccollum, LTC John A. Collier Jr., MAJ Edwin J. Kuster Jr., "Battle Command Battle Laboratories: Where Tomorrow's Victories Begin", *Military Review,* May-June 1996, 58.

105 Ibid., 60.

106 Ibid.

107 Ibid.

108 Ibid.

109 Ibid., 61.

110 Interview with LTC Rivera, U.S. Army Battle Command Training Program Senior Battle Staff Observer/Controller, 8 October 1997. The author had to rely heavily on LTC Rivera's observations of the 4th ID's experiences with digital battle command since the Army has yet to publish official reports concerning the March 1997 Task Force AWE conducted at the NTC. During the interview with the author, LTC Rivera was able to recount several instances of "information overload" and the analysis of irrelevant information instigated by information-age technologies. LTC Rivera's observations are in no way meant to find fault with the 4th ID or the system developers but merely point out that the integration of battle command and digital technology still has a long way to go. Having spent a great deal of time with the 4th ID as they prepared for their Division AWE, LTC Rivera developed a great deal of empathy with the staff. Besides the normal difficulties associated with battle command exercises, the 4th ID also dealt with the enormous tasks of integrating new technologies and equipment, training its personnel to use that equipment, and enduring the scrutiny of the Army's senior leadership.

111 Ibid.

112 Ibid. The BCTP observer/controllers were amazed at how a live feed from a UAV could distract the entire command post. The IMRB actually posed little threat to the unit's plan but the staff nevertheless were drawn to video monitors showing advancing enemy tanks. This created an impression of alarm that caused the staff to develop contingency plans and shift resources to deal with this new threat.

[113] Ibid. This phenomenon was also noted in the Advanced Warfighter Experiment, Operation Desert Hammer VI Final Report, (Fort Knox, Kentucky: US Army Armor Center Mounted Warfighting Battlespace Lab, 28 July 1994), Issues- Leaders, 4. The reason for this is that users did not feel comfortable using the digital systems due to inadequate training, familiarity, and experience with the new systems. Some of the leaders also expressed distrust in the new technology and preferred to work with tried and tested tools.

[114] FM 101-5-1: Operational Terms and Graphics, (Washington DC: Headquarters, Department of the Army, 1997), 1-33.

[115] See quote referenced in endnote #40.

[116] Julian S. Corbett, Some Principles of Maritime Strategy, (London: Longmans, Green, and Co., 1911), 2.

[117] Sun Tzu, The Art of War, translated by Samuel B. Griffith, (London: Oxford University Press, 1963), 92.

[118] Charles Pickar, Blitzkrieg: Operational Art or Tactical Craft?, (Fort Leavenworth, KS: U.S. Army School of Advanced Military Studies), 8.

[119] TRADOC Pam. 525-5, Force XXI Operations, 1-5 (see quote referenced by endnote #40). Knowledge based order relies on a shared vision of success developed by the commander and understood throughout the organization. This knowledge of what the commander sees a success imparts control over and guides the organization.

[120] Manuel De Landa, War in the Age of Intelligent Machines, (New York: Zone Books, 1991), 78. De Landa describes how distributing decision making can distribute uncertainty throughout the organization thereby reducing the friction that occurs when too many decisions are forced to the top.

[121] Ibid., 79.

[122] LTC Jeffrey W.S. Leser, "Battle Command: Vision for Success", *Military Review*, March-April 1997, 57. LTC Leser is one of the Army's biggest proponents of the concept of the commander's vision. He has written several articles for professional journals expounding the merits of the commander's vision/intent. One of his basic tenets is that the commander's vision should not be tied to any particular course of action. This would inhibit a subordinate's initiative because they are limited to a narrow description of success. Subordinates end up improvising instead of displaying initiative. If the situation invalidates the intended course of action, the subordinate must guess what the commander really thought of as success or risk taking action that is contrary to the commander's desires. Tying the vision to a course of action also inhibits the exploitation of unforeseen opportunities since the organization is narrowly focused on a particular plan and may not recognize that a better path to success is available.

[123] FM 101-5-1: Operational Terms and Graphics, (Washington DC: Headquarters Department of the Army, 30 September 1997), 1-34.

[124] David G. Chandler, The Campaigns of Napoleon, (New York: Macmillian Publishing Co., Inc., 1966), 396.

[125] Ibid., 411.

[126] Robert M. Epstein, Napoleon's Last Victory: 1809 and the Emergence of Modern War, (Fort Leavenworth, KS: School of Advanced Military Studies US Army Command and General Staff College, 1992), 81.

[127] LTC Peter J. Palmer, "Decision Point Tactics and the Meeting Battle: Fighting the Enemy, Not the Plan", *Infantry*, Jan-Feb 97, 29.

[128] Ibid., 31.

[129] Klein, "Strategies of Decision Making", *Military Review*, May 1989, 58. Klein's research on military decision making demonstrates that limited rational expectation decision theory, or what he calls recognition-primed decision making, is more appropriate for most military decision making situations than the pure rational expectation theory found the MDMP.

[130] LTC John M. Carmichael, The Future of Planning in a Changing World, (Fort Leavenworth, KS: School of Advanced Military Studies United States Army Command and General Staff College, AY 96-97), 48. LTC Carmichael highlights the fact that planning at the operational level is often "collaborative and networked" and the hierarchy of headquarters is less important in developing plans. Subordinate commands often initiate the planning effort based on their intimate knowledge of the conflict environment. In many cases, the higher headquarters makes minor adjustments to the subordinate plan and then integrates it into their base plan. Planners at each level collaborate and essentially build the operational plan from the bottom up. This type of planning may have less utility in the more time-constrained and dynamic environment of tactics but nevertheless points out the fact that many plans are based on direct collaboration with subordinate elements.

[131] FM 101-5-1: Operational Terms and Graphics, September 1997, 1-34.

[132] Ibid.

[133] Ibid., 1-72. The FFIR is designed to provide the commander and staff with routine information about forces available for the operation. It can include things like personnel, maintenance, and ammunition status. The doctrine does not provide any details about how the FFIR contributes to mission success or why it is part of the FFIR. Furthermore, it does not advocate using the FFIR as an information management tool for designating required pipelined information.

[134] See FM 101-5 :Staff Organizations and Operations, (Washington DC, Headquarters Department of the Army, May 97); FM 100-15: Corps Operations (Washington DC, Department of the Army, Oct 96); FM 71-100: Division Operations (Washington DC, Headquarters Department of the Army, Aug 96). FM 101-5 gives only a couple of sentences of attention to FFIR while FM 71-100 and 100-15 do not even mention the term.

[135] George and Meredith Friedman, The Future of War: Power, Technology & American World Dominance in the 21st Century, (New York: Crown Publishers, Inc., 1996), 26. The Friedman's are truly equal-opportunity critics and describe senile weapon systems in all branches of the service. They cite the tank as being the Army's senile weapon system as it takes increasingly greater amounts of armor to keep it survivable against sophisticated anti-tank missiles (p. 122-140). The Navy's senile system is the aircraft carrier that requires the multi-billion dollar Aegis cruiser to protect it from anti-ship missiles and enemy aircraft. Finally, the Friedman's describe how all of the Air Force's manned aircraft are becoming increasingly senile given the rising costs of stealth technology and human limitations to handle the high G-forces necessary to evade supersonic anti-aircraft missiles.

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