Army Research Laboratory

Cognitive Representations of Battlespace Complexity: Six Fundamental Variables of Combat

Thomas M. Cook Dennis K. Leedom Jock O. Grynovicki Michael G. Golden

ARL-TN-155

FEBRUARY 2000

20000314 063

DTIC QUALITY INSPECTED 3

Approved for public release; distribution is unlimited.

SPSS[®] is a registered trademark of SPSS, Inc.

Windows[™] is a trademark of Microsoft Corporation.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Army Research Laboratory

Aberdeen Proving Ground, MD 21005-5425

ARL-TN-155

February 2000

Cognitive Representations of Battlespace Complexity: Six Fundamental Variables of Combat

Thomas M. Cook Dennis K. Leedom Jock O. Grynovicki Michael G. Golden Human Research & Engineering Directorate

Approved for public release; distribution is unlimited.

Abstract

War is a complex phenomenon. The dynamics and complexities associated with modern military engagements, from peace keeping to major regional conflict, demand that the information associated with such environments be carefully selected, framed, and presented to facilitate effective decision making at all levels. We hypothesized that the six fundamental variables of combat represented by the military acronym METT-TC (Mission, Enemy, Troops, Terrain and weather, Time available, and Civilian considerations) would provide a framework from which to efficiently organize and represent the salient dimensions of the battlefield during the military decision-making process (MDMP). The U.S. Army's Crusader Concept Experimentation Program 3 (CEP 3) was selected as an ideal arena in which to conduct a preliminary investigation of METT-TC dimensions and their associations with representative battle command decisions. Subjects were five field grade officers permanently assigned to a U.S. Army combat unit. During a 2-week experiment period, 24 decisions were isolated and documented across three phases of combat operations (delay, defend, attack). Importantly, decision makers reported high levels of both "significance" and "understanding" for most of the dimensions represented by METT-TC, except for "civilian considerations," which were not represented in the experimental scenarios. Significant differences in levels of "understanding" according to decision types (major versus minor) were observed. In summary, experienced military decision makers recognize the importance of METT-TC dimensions, and we suggest that these dimensions offer a means to present aggregate information to increase situational understanding. Further research is recommended to isolate patterns of interactions among these important dimensions across the full spectrum of military operations.

CONTENTS

INTRODUCTION	3
BACKGROUND	4
OBJECTIVE	9
APPROACH	9
Environment Experimental Scenario Participants Data Collection Instruments Statistical Analysis Software Procedures	10 11 11 11 12 12
RESULTS	12
CONCLUSIONS AND FUTURE DIRECTIONS	15
REFERENCES	17
DISTRIBUTION LIST	19
REPORT DOCUMENTATION PAGE	25
TABLES	
 Salient Dimensions of Battlespace Complexity: METT-TC Descriptive Statistics for METT-TC Dimensions Intercorrelations Among METT-TC Dimensions 	6 13 14

COGNITIVE REPRESENTATIONS OF BATTLESPACE COMPLEXITY: SIX FUNDAMENTAL VARIABLES OF COMBAT

INTRODUCTION

"War is by nature confused, and the process of command complex" (Van Creveld, 1985).

The basic nature of combat and the demands of command in battle have not changed appreciably in the last 1000 years, and such factors as friction, chance, and uncertainty remain the basic contributors to "the fog of war" (Czerwinski, 1998). However, numerous factors and dimensions have changed the landscape of modern warfare and have increased the complexity of the environment. Such factors as globalization, rapid change, information technology (IT), increased weapons lethality, and the mass media have resulted in increased demands on combat leaders at all levels. These factors have become strong potential sources for increased stress in the absence of new resources to cope with the inevitable demands of the battlefield (Davis, 1977).

We live in an "open" age, characterized in part by rapid change, increased awareness, information and technological explosion, economic and social globalization, and a broad spectrum of national and international political influences and conflicts. Each of these factors can interact in complex ways to profoundly influence our perceptions of and actions in the world. It is becoming increasingly clear that all military situations and environments are sensitive to initial conditions and include uncertainties, nonlinearities, and discontinuities which have substantial implications for decision makers, planners, analysts, and modelers (Davis, 1997).

Throughout history, many exquisite military plans resulted in disaster because of a failure by commanders to effectively cope with the salient factors and their unforeseen and unexpected interactions (Cohen & Gooch, 1991). Modern military systems are made increasingly complex by the many human and technological elements involved. The sources of complexity include dimensional complexity (process and interactions on many levels), uncertainty and computational complexity (Cooper, 1994). Military organizations, if they are to effectively adapt to complex environments, must learn to cope with probabilistic rather than deterministic attributes and must recognize that elements at all levels and on all sides of a conflict will interact, learn, and modify their behavior over time.

The United States military is investigating the applications of such "new science" ideas as complexity, chaos, complex adaptive systems, and nonlinear and ecological paradigms in an effort to understand, comprehend, and cope with the demands associated with the variety of missions

anticipated in the 21st century (Czerwinski, 1998). In fact, such language is appearing in doctrinal publications and across the range of National Security and command, control, communications, computer, intelligence, surveillance and reconnaissance (C4ISR) communities (Alberts & Czerwinski, 1997; Alberts, 1999).

Indeed, the extreme environmental conditions (e.g., weather, terrain) and cognitive demands typically associated with combat require that digitized information systems be carefully designed to augment and support the military decision maker's ongoing cognitive efforts (Bourne, 1969). Such systems must be able to adapt in order to correct and maintain current representations of the important dimensions of the decision space, consistent with the decision maker's attempt to place stimuli into some kind of sensible framework (Weick, 1995). To fully appreciate and understand the magnitude of such implications, the forces impinging upon them, and their relationships to each other, we should attempt to put them within a heuristic framework (Basan, 1998; Hunt & Blair, 1985). Because of the multi-variate and dynamic nature of combat environments, we have begun to investigate applications of the emerging sciences of "complexity" and "complex adaptive systems." Specifically, we are exploring these approaches as a means to provide a unifying framework for designing, building, and operating knowledge systems for military decision makers, especially in combat environments where the demands on individuals, teams, and organizations are considerable.

This research was sponsored by the U.S. Army Research Laboratory's Science and Technology Objective (STO) Program entitled "Cognitive Engineering of the Digital Battlefield." The primary focus of the STO is battle command decision making in digital environments. For this investigation, we hypothesized that the dimensions represented by the military acronym METT-TC (Mission, Enemy, Troops, Terrain and weather, Time available, and Civilian considerations) can provide a useful and valid framework from which to organize and represent the fundamental dimensions of complexity associated with combat environments and the military decision-making process (MDMP) (U.S. Army, 1992) and a useful framework to develop and maintain dominant battlespace knowledge (DBK) (Libicki & Johnson, 1996).

BACKGROUND

U.S. Army doctrine states that "...information products and their interpretation result in decisions and directives. Battle command involves acquiring and displaying this information. All units continually acquire information about the mission, enemy terrain and weather, troops available, and time (METT-T) through a variety of means" (U.S. Army, 1992). While some hold

to the idea that METT-T only applies as a framework during deliberate planning (estimate of the situation), we believe that such estimates are, in fact, continuous and constitute the vast majority of salient issues for decision makers at all levels of leadership during the execution of operations. In recent years, the dimensions represented by METT-T have been expanded to include the importance of civilian considerations (e.g., politics, culture, globalization, media, etc.), and recent service doctrine and joint publications are now using the term METT-TC.

Variables normally associated with each of the METT-TC dimensions are described in Table 1. We believe that these dimensions are of such fundamental importance that they can, for example, provide the foundation and framework of a dynamic, multi-agent visualization tool to provide DBK, support situational awareness and understanding, and improve the effectiveness of decision making during stress.

Military decision making is not merely a mathematical computation or a "cookbook" process. Effective decision making requires both the situational awareness to recognize the essence of a given problem and the creative ability to devise a practical solution (U.S. Marine Corps, 1997). The dynamics and complexities associated with modern military operations and decision making demand that the information associated with such dynamic environments be carefully selected, framed, and presented at the appropriate time to facilitate effective decision making. McMaster (1996) believes that information only becomes knowledge when it is integrated with an entire system in such a way that it is available for action at appropriate times and places.

Kahan, Worley, and Stasz (1989) conducted a review of "commander's information" and concluded that previous work in this area was characterized by serious shortcomings in the areas of conceptual and methodological limitations. Their descriptions are instructive and bear directly on the internal, external, and operational validity of the present research.

In the conceptual arena, four limitations were described:

- 1. Lack of a conceptual framework (i.e., decision-making and planning processes)
- 2. The situational framework was not considered
- 3. Information needs not assessed from the commander's point of view
- 4. Assumptions that information needs can be generalized across commanders In the methodological arena, two limitations were described:
- 1. Results were not corroborated

Table 1

Dimensions	Description	Essential elements
Mission	Primary task assigned to a unit.	Who, what, when, where, why
Enemy	Opposition or threat as defined. Should consider technology factors	Capabilities, likely courses of action (COAs) impact on own forces, positions, morale, reserves, tactics, etc.
Troops	Troop strength and combat status; in terms of the seven battlefield operating systems (BOSs) and human dimension factors (e.g., readiness, morale, etc.) The seven BOSs are Command and control Maneuver Fire support Intelligence Air defense Mobility, counter-mobility, survivabi Combat service support	Maneuver, fire support and engineer assets are usually the key elements considered, depending on the mission Technology and equipment in terms of Types Availability Functionality Reliability, maintainability, support
	Assessment of technology and equipm	ent
Terrain & weather	Military aspects of terrain and weather; when terrain affects friendly and enemy capabilities to shoot, move, and communicate. When weather affects equipment, trafficability, and soldiers	Essential factors represented by OCOKA: When 'O' = Observation and fields of fire 'C' = Cover and concealment 'O' = Obstacles and movement 'K' = Key terrain 'A' = Avenues of approach Weather conditions and predictions Effects on man-generated obscurants Drainage
Time	A critical factor in all operations	Effects on ingress and egress Coordination and planning Preparation and reconnaissance Movement considerations (all phases) Rate of closure of a moving enemy Timing and duration of preparatory fires Completion of specific actions Must account for effects of weather
Civilian considera- tions	Factors (own and others) not covered above, which could have an effect on the success of the mission	Politics, economics, and area stability Media Culture, subcultures, and power groups Ethics and morals Allies, coalition partners, neutrals Non-governmental organizations (NGOs) Refugees Humanitarian assistance Rules of engagement re: civilians

Salient Dimensions of Battlespace Complexity: METT-TC

2. *There was no consensus among studies* (i.e., results varied widely regarding the "essential" elements of information identified; range from 20 to 62,900 essential elements).

Regarding "situational framework," Kahan, Worley, and Stasz (1989) concluded that the dimensions represented by METT-TC do, in fact, define the context of a command decision. They also argue that other elements that define the situational framework (and thus drive the commander's information needs) are the organizational structure of the command post, the commander's image or mental representation of the situation, and the interaction between the commander and his or her immediate subordinates.

Oliver & Roos (1996) suggest that scientific investigations of complex problems and environments should focus on dynamics and on the patterns and regularities that can be observed in a body of information. Further, they believe that complex systems fall into two categories: (a) complex deterministic systems (CDS), which are typically physical and with constant parameters, and (b) complex adaptive systems (CAS), which are probabilistic and include agents or sub-systems that interact, learn, and modify their behavior over time. CAS also exhibit characteristics wherein input and output are not proportional and wherein phenonema are unpredictable but are self organizing within bounds (Czerwinski, 1998). Such characteristics as nonlinearity can magnify seemingly insignificant differences in initial conditions (input states) to produce significant consequences. Long-term outcomes are essentially unpredictable but do emerge as a result of the actions (e.g., decisions) taken to influence conditions (Oliver & Roos, 1996). Van Creveld (1985), when addressing the impact of automation and technology on modern warfare, states that "...taken as a whole, present-day military forces, or all the imposing array of electronic gadgetry at their disposal, give no evidence whatsoever of being one whit more capable of dealing with the information needed for the command process than were their predecessors a century or even a millennium ago." While Van Crevald reminds us that few things change in the nature of warfare, we must also recognize that our "understandings," "images," and "mental models" of the world are undergoing rapid evolution in the Information Age as new paradigms, images, representations, and frameworks emerge.

Waldrop (1992) argues that complex systems are, in fact, characterized by many independent agents acting with each other in many ways. As a complex phenomenon, the environment of war can be expected to rapidly fluctuate between order and disorder, and the effective military command and control system should behave as a CAS rather than as a CDS. Senge (1990) further clarifies the multi-dimensionality of complex problem spaces by recognizing two classes of complexity: *detail complexity* and *dynamic complexity*. Detail complexity represents the most common understanding of

the term and includes large multivariate spaces. Dynamic complexity represents situations when cause and effect are subtle and when the effects of interventions over time are not obvious. Examples of dynamic complexity include (a) when the same action has dramatically different effects in the short run and the long run, and (b) when obvious interventions produce unintended consequences. Further, Senge suggests that the real leverage in most situations lies in understanding dynamic complexity, not detail complexity, and that we want to avoid "fighting complexity with complexity" (i.e., complex solutions to complex problems). We must begin to see relationships rather than linear cause-effect chains and to see processes rather than snapshots.

Kaufmann (1995) and Oliver & Roos (1996) offer the "fitness landscape" metaphor as a means of presenting and visualizing the many main effects and interactions that characterize a complex environment. The basic idea is that adaptive organizations will attempt to alter and improve their situation (e.g., improve knowledge of the situation) by taking "adaptive walks" to move to higher "fitness points." Failure to do so will allow competitors to outpace the organization and achieve dominance. Some key concepts associated with fitness landscapes include (Oliver & Roos, 1996):

1. Obstacles on the Fitness Landscape. If an organization is unable to evolve gradually, that is, the pace of change exceeds the capacity of the organization to adapt and mutate by reassembling its fundamental structures, it will face extinction. On the battlefield, this means defeat.

2. *Co-evolution on the Fitness Landscape*. Each player in a co-evolutionary struggle will attempt to improve his or her position on the landscape and will adapt to improvements by others. As each group develops a new innovation, it alters the fitness landscape of the other.

3. *Epistatic Coupling*. The fitness of any particular location on the fitness landscape is not an objective and identical value for every player. Certain higher fitness points will have more value to some players than others.

We believe that the applications of the "fitness landscape" metaphor to combat environments and to associated visualization concepts show considerable promise. This research is a first attempt to reduce the potentially large number of dimensions that influence "fitness" on the fitness landscape in combat environments and to provide a set of basic building blocks to represent salient information at any given moment in time.

OBJECTIVE

The ongoing objective of this research thrust is to better understand fundamental dimensions of battlespace complexity during the MDMP. The general thesis of the primary research effort is that the dimensions represented by METT-TC represent the essential elements of information needed by combat decision makers and that the dimensions interact in complex ways that depend on the dynamics of the battlespace environment. During this preliminary investigation, we are describing main effects of the variables only and intend to address interactions during the next phase. We were also interested to see if these dimensions would vary, based on the relative importance of the decision to be made (e.g., "major" [significant change in the currently implemented COA] versus "minor" [minor adjustment in the currently implemented COA]).

We hypothesized that the six dimensions of METT-TC can provide useful, dynamic representations of key aspects of the battlespace environment for combat decision makers and include the fundamentals necessary for DBK (Libicki & Johnson, 1996). Knowledge gained from this research program will be applied to better understand battlespace information requirements and suggest ways to better frame represent and visualize salient information at the appropriate time and place. Results are expected to substantially assist technologists and systems engineers in developing knowledge systems to assist decision makers in maintaining a current and coherent image of the battlespace.

Based on our understanding of the issues, we hypothesized that the dimensions captured by METT-TC would provide a framework from which to organize and represent the salient dimensions of the battlespace and would be of particular significance to combat decision makers during the MDMP.

APPROACH

The specific focus of this investigation was to gather preliminary data regarding the assertion that METT-TC dimensions represent important elements in the commander's decision-making process during the execution phase of ground combat. We had hypothesized that effective combat decision making would be influenced, in part, by the *perceived significance* and level of *understanding* of selected dimensions of battle-tested frameworks associated with combat environments. Further, the dimensions traditionally represented by the military acronym METT-TC would represent salient dimensions of environmental complexity and would represent important "chunks" of information framework during the MDMP. We also believed that the decision maker's reported understanding of these dimensions and their relative

significance to the decision would vary according to the types of decisions (e.g., major change versus minor adjustments).

The U.S. Army's *Crusader Concept Experimentation Program 3* (CEP 3) was presented as an ideal arena in which to conduct a preliminary investigation of selected dimensions of environmental complexity (e.g., METT-TC) and their relationship to representative battle command decisions. We were invited to collect data and information associated with the battle command staff decision-making process while observing the 3rd Brigade Combat Team (BCT), 1st Cavalry Division, during their support of the CEP3.

The objective of CEP3 was to conduct a series of soldier-in-the-loop experiments to evaluate operational concepts for the Crusader Program using a synthetic theater of war (STOW) environment developed by the Depth and Simultaneous Attack Battle Lab (D&SABL). Specific focus was on critical operational issues (COIs) related to command and control, sustainment, and system survivability. Performance data and insights are being used to prepare a document about "How to Fight the Crusader." CEP3 also supported 3rd BCT 1st Cavalry Division battle staff training of mission-essential tasks by producing realistic conditions to practice tasks on multiple occasions with a mix of staff configurations. Other battle staffs participating in CEP3 were 2-82 and 1-21 field artillery battalions. Battle staffs from the three headquarters (3BCT, 2-82, and 1-21) implemented the military planning and decision-making process, prepared and rehearsed operations, and conducted tactical engagements. During these operations, battle staffs implemented tactical orders, applied approved doctrine, and evaluated new and emerging concepts such as display and use of a nearly perfect enemy intelligence picture (from modular semi-automated force [ModSAF]). The III Corps Battle Simulation Center provided facilities, equipment, and technical support needed to establish and operate the synthetic environment. CEP3 was conducted in and surrounding Building 19032 at Fort Hood, Texas.

Environment

The 3rd BCT was situated in a field tactical operations center (TOC) configuration with organic shelters and command vehicles co-located with the III Corps Battle Simulation Center. The 3rd BCT TOC was fully populated by the command group and appropriate staff sections and personnel. The TOC command configuration changed throughout the exercise with various combinations of the commanding officer, executive officer, S-2 (intelligence), and S-3 (operations) present at any one time. The fire support officer (FSO) remained throughout the exercise. The weather was mostly clear and in the 70° to 80° Fahrenheit range with moderate humidity.

Ambient lighting and noise levels and the personnel density were normal for a field TOC. The operational tempo (OPTEMPO) was moderate with about 4 hours a day devoted to actual exercise participation.

Experimental Scenario

A tactical scenario consisting of three major events was implemented to create OPTEMPO in which issues related to the commander's courses of action (COAs) could be evaluated. Tactical engagements involved dynamic interactions between forces fighting on simulated National Training Center (NTC) terrain. Three battle runs were planned with each run consisting of three phases: (1) delay, (2) defend, and (3) attack.

Participants

Participants were five experienced field grade officers permanently assigned to the 3rd BCT. The 3rd BCT commander and his staff were representative of similar regular Army units in terms of grade distribution (e.g., E-2 to E-9 and 0-1 to 0-6) and experience. This occasion was one of about four yearly opportunities when the 3rd BCT staff trains in the field during exercise conditions. All participants were cooperative and supportive of the data collection effort.

Data Collection Instruments

Battle command decision-making data were captured using the newly developed "commander-centered decision environment inventory" (C2DEI) (Cook, 1998) and the "decisionmaker self-report profile" (DMSRP) (Golden, 1998). C2DEI data are the focus of this report as they relate to salient dimensions of battlespace complexity and as associated with the combat decision-making process. Information related to decision types and decision-maker background data (e.g., rank, experience, demographics) was extracted from the DMSRP. All scenario events were in the "execution" phase of hostilities. All data were collected after completion of the scheduled events

The C2DEI was developed as a self-report instrument specifically to assess the significance of METT-TC dimensions during the MDMP. METT-TC dimensions were measured using 5-point Likert scales ranging from "1 = very low" to "5 = very high" for both "significance" and "level of understanding" of each dimension. Significance was defined as the degree to which the

dimension was important for the particular decision. Understanding was defined as the degree to which the salient aspects of the dimension were recognized and known to the decision maker.

Statistical Analysis Software

Data were analyzed using the statistical software package SPSS[®] for Windows[™] Version 6.5 (SPSS[®], 1993).

Procedures

It was expected that the brigade commander in the TOC would make a series of critical decisions over the course of each exercise scenario and that the instruments designed by our team would capture the salient factors associated with each of these decisions. Because of a very heavily committed BCT staff, we were only able to focus on one critical decision per day in the BCT and at each of the available battalions. Our team observed the evolution of each of the events and made observations as best possible without getting in the way in the typically crowded space. At the conclusion of each of the events, an after-action review (AAR) was held to assess the day's activities. At the conclusion of the AAR, we were joined by the TOC commander (CO or XO) and, when available, the S-3. A member of our team assisted each decision maker in the completion of the DMSRP and the C2DEI instruments. Completion typically took about 15 to 20 minutes per decision.

RESULTS

The primary trust of this investigation was to assess the relative "significance" and "level of understanding" of each dimension of METT-TC during a series of command decisions. During the 2-week data collection period, 24 command decisions were identified (Golden, Cook, Grynovicki, Kysor, & Leedom, 2000), and METT-TC data were collected using the C2DEI. Background, decision type, and phase of combat variables were extracted from the DMSRP. Of the 24 command decisions, 6 were considered to be "major" (i.e., a significant change in the implemented COA) and 18 were considered to be "minor" adjustments of the currently implemented COA. Of the 24 decisions made, nine were during "delay" operations, ten were during "defend" operations, and five were during "attack" operations.

For each of the dimensions represented by METT-TC, decision makers reported high levels of both "significance" and "understanding," except for "civilian considerations" which was

not represented in the experiment scenarios (see Table 2). Significant differences between the information that was needed (significance) and the information that decision makers had available were found for both Enemy and Troops dimensions.

Variable	Mean	SDa	N
Mission significance	4.30	.63	23
Mission understanding	4.39	.58	23
Enemy significance	4.39	.66	23
Enemy understanding	3.70	.93	23
Troops significance	3.75	1.07	20
Troops understanding	3.45	.94	20
Terrain significance	4.00	.79	20
Terrain understanding	3.90	.85	20
Time significance	3.96	.98	23
Time understanding	3.70	.93	23
Civilian significance	NA	NA	NA
Civilian understanding	NA	NA	NA

Table 2

Descriptive Statistics for METT-TC Dimensions

 $^{a}SD = standard deviation$

"Understanding" of the <u>M</u>ission was particularly high (M = 4.39) across decisions as was "significance" of the enemy (M = 4.39) and significance of the mission (M = 4.30). Intercorrelations among METT-TC dimensions are presented in Table 3. Of the 45 intercorrelations, six (13%) were significant (p < .05), suggesting a degree of dependence among several of the dimensions.

"Time available" and "troops (friendly)" considerations were more "significant" to decision makers during delay phases than during either the defense or attack phases (see Tables 4 and 5). "Terrain and weather" considerations were viewed as more significant for major change decisions than for minor adjustment decisions (F [1,19] = 5.04, p < .02).

Tabl	6	2
Tabl	e	Э

METT-TC dimensions	1	2	3	4	5	6	7	8	9	10	11	12
1 Mission cignificance		65*	47*	42	- 41*	- 15	.00	.19	16	07	na	na
 Mission significance Mission understanding 	_	-	.34	.17	46*	33	.25	- .13	.03	.06	na	na
3. Enemy significance	-	-	-	.39	.12	.14	.11	.00	04	.11	na	na
4. Enemy understanding	-	-		-	.08	.33	12	.38	.03	.40	na	na
5. Troops significance	-	-	-		-	.69*	06	03	.19	.33	na	na
6. Troops understanding	_	-	-	-	-		14	.06	11	.49*	na	na
7. Terrain significance	-	-						.62*	26	.14	na	na
8. Terrain understanding	-	-		-	-		-		18	.42*	na	na
9. Time significance	-	-		-	-		-	-		02	na	na
10. Time understanding	-	-	-	-	-	-	-	-	 1	-	na	na
11. Civilian significance	-	-	-	_	-	-	-	-	-		-	
12. Civilian understanding	g —	-		-	-	 '		-			-	

Intercorrelations Among METT-TC Dimensions

Notes. (1) Only complete cases were included in the analysis; (2) na = not applicable for this scenario; (3) * p < .05

Table 4

"Significance"	of Time According to Phase of Combat	
----------------	--------------------------------------	--

Phase	Mean	SD	Cases
Delay	4.56	.53	9
Defend	3.78	.97	9
Attack	3.20	1.10	5
Population	4.00	.98	23

Likelihood Ratio Test = 12.9, p < .05

• •

Phase	Mean	SD	Cases
Delay	4.44	.52	9
Defend	3.29	1.11	7
Attack	3.00	1.15	4
Population	3.75	1.07	20

Table 5

"Significance" of Troops According to Phase of Combat

Likelihood Ratio Test = 13.5, p < .04

CONCLUSIONS AND FUTURE DIRECTIONS

Results of this preliminary investigation support our basic hypothesis that the six dimensions of METT-TC are of considerable importance to decision makers. Further, METT-TC variables reflect the major sources of battlespace "complexity," which can be useful for organizing relationships that are changing and emerging and for knowledge necessary for decision making in near real time. It also appears that the significant dimensions of combat can be reduced to a relatively small set of variables that promise to reduce the "confusion" of combat. However, we still know little about how the many variables associated with the categories of METT-TC interact and recombine over time and how these interactions may influence the MDMP. We suggest that constructs from complexity science, complex adaptive systems theory, the ecological sciences, and systems theory offer considerable promise as an integrated framework to represent initial conditions, emergent properties, uncertainties, nonlinearities, and discontinuities commonly associated with the modern battlespace(s). Importantly, appropriate representations and presentations of the six fundamental dimensions of METT-TC should significantly support decision makers during the development and maintenance of DBK. Our findings also suggest that decision makers' "understanding" of METT-TC dimensions and associated "significance" for the decision vary according to the type of decision (i.e., major versus minor).

Specifically, our data provide initial support and validation for the basic hypothesis that the six dimensions of METT-TC represent fundamentally significant dimensions of the battlespace complexity and the command decision space. The data also validate the use of METT-TC as information and display dimensions and requirements for future command center information technology designs. Finally, the data suggest that decision makers' "understanding" of METT-TC

dimensions and associated "significance" for the decision vary according to type of decision (e.g., major versus minor).

Once the results of this investigation have been replicated in several representative military exercises, cognitive engineering and hardware-software implications for visualization and command center design will be presented. Further research is recommended to assess the internal validity and reliability of the measures and to assess the interactions and dynamics of the METT-TC dimensions across a range of combat scenarios.

REFERENCES

- Alberts, D.S. (1999). <u>Operations research & joint experimentation</u>. Invited presentation at the Military Operations Research Society (MORS) Mini-Symposium/Workshop on Joint Experimentation, Norfolk, VA. Available [on line]: <u>http://www.mors.org</u>
- Alberts, D.S., & Czerwinski, T.J. (1997). <u>Complexity, global politics, and national security</u>. CCRP Publications, Washington, DC. Available [on line]: <u>publications@dodccrp.org</u>
- Basan, T. (1998). A framework for a unified decision making process, <u>Australian Defense Force</u> Journal, 132, 41-59.
- Bourne, P.G. (Ed.) (1969). <u>The psychology and physiology of stress</u>. New York: Academic Press.
- Cohen, E.A., & Gooch, J. (1991). <u>Military misfortunes: The anatomy of failure in war</u>. New York: Vintage Books.
- Cook, T.M. (1998). <u>The command-centered decision environment inventory (C2DEI)</u>. Aberdeen Proving Ground, MD: U.S. Army Research Laboratory.
- Cooper, C. (1994). Complexity in C3I systems. <u>Complexity International 1</u>. Available [on line]: <u>http://www.csu.edu.au/ci/vol1/Clive.Cooper/paper.html</u>
- Czerwinski, T.J. (1998). <u>Coping with the bounds: Speculations on nonlinearity in military</u> <u>affairs</u>. Washington, DC: National Defense University.
- Davis, P.K. (1997). <u>Implications of complex-adaptive system (CAS) research for defense</u> <u>analysis</u>. Paper presented at the Military Operations Research Society (MORS) Mini-Symposium and Workshop, Warfare Analysis and Complexity. The Johns Hopkins University Applied Physics Laboratory, Silver Spring, MD. Available [on line]: <u>http://www.mors.org</u>
- Golden, M.G. (1998). <u>The decision maker self-report profile (DMSRP)</u>. Aberdeen Proving Ground, MD: U.S. Army Research Laboratory.
- Golden, M.G., Cook, T.M., Grynovicki, J.O., Kysor, K.P., & Leedom, D.K. (2000). <u>ARL</u> <u>insights from the battle command re-engineering III concept experimentation program</u> (ARL-TR-2082). Aberdeen Proving Ground, MD: U.S. Army Research Laboratory.
- Hunt, J.G., & Blair, J.D. (1985). <u>Leadership on the future battlefield</u>. Washington, DC: Pergamon-Brassey's.
- Kahan, J.P., Worley, D.R., & Stasz, C. (1989). <u>Understanding commanders' information needs</u> (ISBN: 0-8330-0973-7). Santa Monica, CA: The RAND Corporation.

- Kaufmann, S. (1995). <u>At home in the universe: The search for laws of self-organization and complexity</u>. New York: Oxford University Press.
- Libicki, M.C., & Johnson, S.E. (Eds.) (1996). <u>Dominant battlespace knowledge</u>. CCRP Publications, Washington, DC. Available [on line]: <u>publications@dodccrp.org</u>
- McMaster, M.D. (1996). <u>The intelligence advantage: Organizing for complexity</u>. Boston: Butterworth-Heinemann.
- Oliver, D., & Roos, J. (1996). <u>The poised organization: Navigating effectively on knowledge</u> <u>landscapes</u>. Paper presented at the INFORMS College on Organization Science, Atlanta, GA.
- Senge, P.M. (1990). <u>The fifth discipline: The art & practice of the learning organization</u>. New York: Currency Doubleday.

SPSS, Inc. (1993). SPSS® base system syntax reference guide: Release 6. Chicago: Author.

- U.S. Army (1992). <u>The infantry battalion</u> (Field Manual [FM] 7-20). Washington, DC: Author. Available [on line]: <u>http://155.217.58.58/cgi-bin/atdl.dll/fm/7-20/toc.htm</u>
- U.S. Marine Corps (1997). MCDP 1: Warfighting. Washington, DC: Author.

Van Creveld, M. (1985). Command in war. Cambridge, MA: Harvard University Press.

Waldrop, M.M. (1992). <u>Complexity: The emerging science at the edge of order and chaos</u>. New York: Simon & Schuster.

Weick, K.E. (1995). Sensemaking in organizations. Thousand Oaks, CA: SAGE Publications.

NO. OF

COPIES ORGANIZATION

- 1 ADMINISTRATOR DEFENSE TECHNICAL INFO CENTER ATTN DTIC OCP 8725 JOHN J KINGMAN RD STE 0944 FT BELVOIR VA 22060-6218
- 1 DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL CS AS REC MGMT 2800 POWDER MILL RD ADELPHI MD 20783-1197
- 1 DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL CI LL TECH LIB 2800 POWDER MILL RD ADELPHI MD 207830-1197
- 1 DIR FOR PERSONNEL TECHNOLOGIES DEPUTY CHIEF OF STAFF PERSONNEL 300 ARMY PENTAGON 2C733 WASHINGTON DC 20310-0300
- 1 OUSD(A)/DDDR&E(R&A)/E&LS PENTAGON ROOM 3D129 WASHINGTON DC 20301-3080
- 1 CODE 1142PS OFFICE OF NAVAL RESEARCH 800 N QUINCY STREET ARLINGTON VA 22217-5000
- 1 COMMANDER US ARMY RESEARCH INSTITUTE ATTN PERI ZT (DR E M JOHNSON) 5001 EISENHOWER AVENUE ALEXANDRIA VA 22333-5600
- 1 DEPUTY COMMANDING GENERAL ATTN EXS (Q) MARINE CORPS RD&A COMMAND QUANTICO VA 22134
- 1 HEADQUARTERS USATRADOC ATTN ATCD SP FORT MONROE VA 23651
- I COMMANDER USATRADOC COMMAND SAFETY OFFICE ATTN ATOS (MR PESSAGNO/MR LYNE) FORT MONROE VA 23651-5000

NO. OF

- 1 DIRECTOR TDAD DCST ATTN ATTG C BLDG 161 FORT MONROE. VA 23651-5000
- 1 USA BIOMEDICAL R&D LABORATORY ATTN LIBRARY FORT DETRICK BUILDING 568 FREDERICK MD 21702-5010
- 1 HQ USAMRDC ATTN SGRD PLC FORT DETRICK MD 21701
- 1 COMMANDER USA AEROMEDICAL RESEARCH LAB ATTN LIBRARY FORT RUCKER AL 36362-5292
- 1 US ARMY SAFETY CENTER ATTN CSSC SE FORT RUCKER AL 36362
- 1 CHIEF ARMY RESEARCH INSTITUTE AVIATION R&D ACTIVITY ATTN PERI IR FORT RUCKER AL 36362-5354
- 1 US ARMY NATICK RD&E CENTER ATTN STRNC YBA NATICK MA 01760-5020
- 1 US ARMY TROOP SUPPORT CMD NATICK RD&E CENTER ATTN BEHAVIORAL SCI DIV SSD NATICK MA 01760-5020
- 1 US ARMY TROOP SUPPORT CMD NATICK RD&E CENTER ATTN TECH LIBRARY (STRNC MIL) NATICK MA 01760-5040
 - 1 DR RICHARD JOHNSON HEALTH & PERFORMANCE DIVISION US ARIEM NATICK MA 01760-5007
 - 1 NAVAL SUBMARINE MEDICAL RSCH LAB MEDICAL LIBRARY BLDG 148 BOX 900 SUBMARINE BASE NEW LONDON GROTON CT 06340

NO. OF COPIES ORGANIZATION

- 1 USAF ARMSTRONG LAB/CFTO ATTN DR F WESLEY BAUMGARDNER SUSTAINED OPERATIONS BRANCH BROOKS AFB TX 78235-5000
- 1 ARI FIELD UNIT FORT KNOX BUILDING 2423 PERI IK FORT KNOX KY 40121-5620
- 1 COMMANDANT USA ARTILLERY & MISSILE SCHOOL ATTN USAAMS TECH LIBRARY FORT SILL OK 73503
- 1 COMMANDER WHITE SANDS MISSILE RANGE ATTN STEWS TE RE WHITE SANDS MISSILE RANGE NM 88002
- 1 COMMANDER WHITE SANDS MISSILE RANGE ATTN TECHNICAL LIBRARY WHITE SANDS MISSILE RANGE NM 88002
- 1 USA TRADOC ANALYSIS COMMAND ATTN ATRC WSR (D ANGUIANO) WHITE SANDS MISSILE RANGE NM 88002-5502
- 1 STRICOM 12350 RESEARCH PARKWAY ORLANDO FL 32826-3276
- 1 COMMANDER USA TANK-AUTOMOTIVE R&D CENTER ATTN AMSTA RS/D REES WARREN MI 48090
- 1 COMMANDER USA COLD REGIONS TEST CENTER ATTN STECR TS A APO AP 96508-7850
- 1 PURDUE UNIVERSITY SERIALS UNIT CDM KARDEX 1535 STEWART CENTER WEST LAFAYETTE IN 47907-1535
- 1 GOVT PUBLICATIONS LIBRARY 409 WILSON M UNIVERSITY OF MINNESOTA MINNEAPOLIS MN 55455

NO. OF

- 1 DR RICHARD PEW BBN SYSTEMS AND TECH CORP 10 MOULTON STREET CAMBRIDGE MA 02138
- 1 DR HARVEY A TAUB RSCH SECTION PSYCH SECTION VETERANS ADMIN HOSPITAL IRVING AVENUE & UNIVERSITY PLACE SYRACUSE NY 13210
- 1 DR ROBERT C SUGARMAN 132 SEABROOK DRIVE BUFFALO NY 14221
- 1 DR ANTHONY DEBONS IDIS UNIVERSITY OF PITTSBURGH PITTSBURGH PA 15260
- 1 DR ROBERT KENNEDY ESSEX CORPORATION SUITE 227 1040 WOODCOCK ROAD ORLANDO FL 32803
- 1 DR NANCY ANDERSON DEPARTMENT OF PSYCHOLOGY UNIVERSITY OF MARYLAND COLLEGE PARK MD 20742
- 1 DR BEN B MORGAN DEPARTMENT OF PSYCHOLOGY UNIVERSITY OF CENTRAL FLORIDA PO BOX 25000 ORLANDO FL 32816
- 1 LAWRENCE C PERLMUTER PHD UNIV OF HEALTH SCIENCES THE CHICAGO MEDICAL SCHOOL DEPT OF PSYCHOLOGY 3333 GREEN BAY ROAD NORTH CHICAGO IL 60064
- 1 GENERAL MOTORS CORPORATION NORTH AMERICAN OPERATIONS PORTFOLIO ENGINEERING CENTER HUMAN FACTORS ENGINEERING ATTN MR A J ARNOLD STAFF PROJ ENG ENGINEERING BLDG 30200 MOUND RD BOX 9010 WARREN MI 48090-9010
- 1 GENERAL DYNAMICS LAND SYSTEMS DIV LIBRARY PO BOX 1901 WARREN MI 48090

NO. OF

COPIES ORGANIZATION

- 1 DR LLOYD A AVANT DEPARTMENT OF PSYCHOLOGY IOWA STATE UNIVERSITY AMES IA 50010
- 1 DR MM AYOUB DIRECTOR INST FOR ERGONOMICS RESEARCH TEXAS TECH UNIVERSITY LUBBOCK TX 79409
- 1 MR KENNETH C CROMBIE TECHNICAL LIBRARIAN E104 DELCO SYSTEMS OPERATIONS 6767 HOLLISTER AVENUE GOLETA CA 93117
- 1 MR WALT TRUSZKOWSKI NASA/GODDARD SPACE FLIGHT CENTER CODE 588.0 GREENBELT MD 20771
- 1 US ARMY ATTN AVA GEDDES MS YA:219-1 MOFFETT FIELD CA 94035-1000
- 1 COMMANDER US ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE NATICK MA 01760-5007
- 1 HQDA (DAPE ZXO) ATTN DR FISCHL WASHINGTON DC 20310-0300
- 1 HUMAN FACTORS ENG PROGRAM DEPT OF BIOMEDICAL ENGINEERING COLLEGE OF ENGINEERING & COMPUTER SCIENCE WRIGHT STATE UNIVERSITY DAYTON OH 45435
- 1 COMMANDER USA MEDICAL R&D COMMAND ATTN SGRD PLC (LTC K FRIEDL) FORT DETRICK MD 21701-5012
- 1 PEO STANDARD ARMY MGMT INFORMATION SYSTEM ATTN AS PES STOP C-3 FT BELVOIR VA 22060-5456
- 1 PEO ARMORED SYS MODERNIZATION US ARMY TANK-AUTOMOTIVE CMD ATTN SFAE ASM S WARREN MI 48397-5000

NO. OF

- 1 PEO COMBAT SUPPORT ATTN AMCPEO CS US ARMY TANK AUTOMOTIVE CMD WARREN MI 48397-5000
- 1 PEO INTELLIGENCE & ELECTRONIC WARFARE ATTN AMCPEO IEW VINT HILL FARMS STATION BLDG 197 WARRENTON VA 22186-5115
- 1 PEO COMMUNICATIONS ATTN SFAE CM RE FT MONMOUTH NJ 07703-5000
- 1 PEO STRATEGIC DEFENSE PO BOX 15280 ATTN DASD ZA US ARMY STRATEGIC DEFENSE CMD ARLINGTON VA 22215-0280
- 1 PROGRAM MANAGER RAH-66 ATTN SFAE AV BLDG 5300 SPARKMAN CENTER REDSTONE ARSENAL AL 35898
- 1 GENERAL ELECTRIC COMPANY ARMAMENT SYSTEMS DEPT RM 1309 ATTN HF/MANPRINT R C MCLANE LAKESIDE AVENUE BURLINGTON VT 05401-4985
- 1 JOHN B SHAFER 250 MAIN STREET OWEGO NY 13827
- 1 OASD (FM&P) WASHINGTON DC 20301-4000
- 1 COMMANDANT US ARMY ARMOR SCHOOL ATTN ATSB CDS (MR LIPSCOMB) FT KNOX KY 40121-5215
- 1 COMMANDER US ARMY AVIATION CENTER ATTN ATZQ CDM S (MR MCCRACKEN) FT RUCKER AL 36362-5163
- 1 COMMANDER US ARMY SIGNAL CTR & FT GORDON ATTN ATZH CDM FT GORDON GA 30905-5090

NO. OF

COPIES ORGANIZATION

- 1 PROJECT MANAGER SIGNALS WARFARE ATTN SFAE IEW SG (ALAN LINDLEY) BLDG P-181 VINT HILL FARMS STATION WARRENTON VA 22186-5116
- 1 COMMANDER MARINE CORPS SYSTEMS COMMAND ATTN CBGT QUANTICO VA 22134-5080
- 1 DIRECTOR AMC-FIELD ASSIST IN SCIENCE & TECHNOLOGY ATTN AMC-FAST FT BELVOIR VA 22060-5606
- 1 COMMANDER US ARMY FORCES COMMAND ATTN FCDJ SA BLDG 600 AMC FAST SCIENCE ADVISER FT MCPHERSON GA 30330-6000
- 1 COMMANDER I CORPS AND FORT LEWIS AMC FAST SCIENCE ADVISER ATTN AFZH CSS FORT LEWIS WA 98433-5000
- 1 HQ III CORPS & FORT HOOD OFFICE OF THE SCIENCE ADVISER ATTN AFZF CS SA FORT HOOD TX 76544-5056
- 1 COMMANDER HQ XVIII ABN CORPS & FORT BRAGG OFFICE OF THE SCI ADV BLDG 1-1621 ATTN AFZA GD FAST FORT BRAGG NC 28307-5000
- 1 SOUTHCOM WASHINGTON FIELD OFC 1919 SOUTH EADS ST SUITE L09 AMC FAST SCIENCE ADVISER ARLINGTON VA 22202
- 1 HQ US SPECIAL OPERATIONS CMD AMC FAST SCIENCE ADVISER ATTN SOSD MACDILL AIR FORCE BASE TAMPA FL 33608-0442
- 1 HQ US ARMY EUROPE AND 7TH ARMY ATTN AEAGX SA OFFICE OF THE SCIENCE ADVISER APO AE 09014

NO. OF COPIES ORGANIZATION

- COMMANDER HQ 21ST THEATER ARMY AREA CMD AMC FAST SCIENCE ADVISER ATTN AERSA APO AE 09263
- 1 COMMANDER HEADQUARTERS USEUCOM AMC FAST SCIENCE ADVISER UNIT 30400 BOX 138 APO AE 09128
- 1 HQ 7TH ARMY TRAINING COMMAND UNIT #28130 AMC FAST SCIENCE ADVISER ATTN AETT SA APO AE 09114
- 1 COMMANDER HHC SOUTHERN EUROPEAN TASK FORCE ATTN AESE SA BUILDING 98 AMC FAST SCIENCE ADVISER APO AE 09630
- 1 COMMANDER US ARMY PACIFIC AMC FAST SCIENCE ADVISER ATTN APSA FT SHAFTER HI 96858-5L00
- 1 COMMANDER US ARMY JAPAN/IX CORPS UNIT 45005 ATTN APAJ SA AMC FAST SCIENCE ADVISERS APO AP 96343-0054
- 1 AMC FAST SCIENCE ADVISERS PCS #303 BOX 45 CS-SO APO AP 96204-0045
- 1 MS DIANE UNGVARSKY HHC 2BDE 1AD UNIT 23704 APO AE 09034
- 1 CDR & DIR USAE WATERWAYS EXP STN ATTN CEWES IM MI R (A S CLARK) CD DEPT #1153 3909 HALLS FERRY ROAD VICKSBURG MS 39180-6199

NO. OF COPIES ORGANIZATION

- 1 DR SEHCHANG HAH DEPT OF BEHAVIORAL SCIENCES & LEADERSHIP BUILDING 601 ROOM 281 US MILITARY ACADEMY WEST POINT NEW YORK 10996-1784
- 1 US ARMY RESEARCH INSTITUTE ATTN PERI IK (DOROTHY L FINLEY) 2423 MORANDE STREET FORT KNOX KY 40121-5620

1 US MILITARY ACADEMY MATHEMATICAL SCIENCES CENTER OF EXCELLENCE DEPT OF MATHEMATICAL SCIENCES ATTN MDN A MAJ M D PHILLIPS THAYER HALL WEST POINT NY 10996-1786

- 1 NAIC/DXLA 4180 WATSON WAY WRIGHT PATTERSON AFB OH 45433-5648
- 1 ARL HRED AVNC FIELD ELEMENT ATTN AMSRL HR MJ (R ARMSTRONG) PO BOX 620716 BLDG 514 FT RUCKER AL 36362-0716
- 1 ARL HRED AMCOM FIELD ELEMENT ATTN AMSRL HR MI (D FRANCIS) BUILDING 5678 ROOM S13 REDSTONE ARSENAL AL 35898-5000
- 1 ARL HRED AMCOM FIELD ELEMENT ATTN ATTN AMSRL HR MO (T COOK) BLDG 5400 RM C242 REDSTONE ARS AL 35898-7290
- 1 ARL HRED USAADASCH FLD ELEMENT ATTN AMSRL HR ME (K REYNOLDS) ATTN ATSA CD 5800 CARTER ROAD FORT BLISS TX 79916-3802
- 1 ARL HRED ARDEC FIELD ELEMENT ATTN AMSRL HR MG (R SPINE) BUILDING 333 PICATINNY ARSENAL NJ 07806-5000
- 1 ARL HRED ARMC FIELD ELEMENT ATTN AMSRL HR MH (C BIRD) BLDG 1002 ROOM 206B FT KNOX KY 40121

NO. OF

- 1 ARL HRED CECOM FIELD ELEMENT ATTN AMSRL HR ML (J MARTIN) MYER CENTER RM 2D311 FT MONMOUTH NJ 07703-5630
- 1 ARL HRED FT BELVOIR FIELD ELEMENT ATTN AMSRL HR MK (P SCHOOL) 10115 GRIDLEY ROAD SUITE 114 FORT BELVOIR VA 22060-5846
- 1 ARL HRED FT HOOD FIELD ELEMENT ATTN AMSRL HR MV HQ TEXCOM (E SMOOTZ) 91012 STATION AVE ROOM 111 FT HOOD TX 76544-5073
- 1 ARL HRED FT HUACHUCA FLD ELEMENT ATTN AMSRL HR MY (B KNAPP) GREELY HALL (BLDG 61801 RM 2631) FORT HUACHUCA AZ 85613-5000
- 1 ARL HRED FLW FIELD ELEMENT ATTN AMSRL HR MZ (A DAVISON)* 3200 ENGINEER LOOP STE 166 FT LEONARD WOOD MO 65473-8929
- 2 ARL HRED NATICK FIELD ELEMENT ATTN AMSRL HR MQ (M FLETCHER) ATTN SSCNC A (D SEARS) USASSCOM NRDEC BLDG 3 RM 140 NATICK MA 01760-5015
- 1 ARL HRED OPTEC FIELD ELEMENT ATTN AMSRL HR MR (M HOWELL) OPTEC CSTE OM PARK CENTER IV RM 1040 4501 FORD AVENUE ALEXANDRIA VA 22302-1458
- 1 ARL HRED SC&FG FIELD ELEMENT ATTN AMSRL HR MS (L BUCKALEW) SIGNAL TOWERS RM 303A FORT GORDON GA 30905-5233
- 1 ARL HRED STRICOM FIELD ELEMENT ATTN AMSRL HR MT (A GALBAVY) 12350 RESEARCH PARKWAY ORLANDO FL 32826-3276
- 1 ARL HRED TACOM FIELD ELEMENT ATTN AMSRL HR MU (M SINGAPORE) BLDG 200A 2ND FLOOR WARREN MI 48397-5000

NO. OF COPIES ORGANIZATION

- 1 ARL HRED USAFAS FIELD ELEMENT ATTN AMSRL HR MF (L PIERCE) BLDG 3040 RM 220 FORT SILL OK 73503-5600
- 1 ARL HRED USAIC FIELD ELEMENT ATTN AMSRL HR MW (E REDDEN) BLDG 4 ROOM 332 FT BENNING GA 31905-5400
- 1 ARL HRED USASOC FIELD ELEMENT ATTN AMSRL HR MN (F MALKIN) HQ USASOC BLDG E2929 FORT BRAGG NC 28310-5000
- 1 US ARMY RSCH DEV STDZN GP-UK ATTN DR MICHAEL H STRUB PSC 802 BOX 15 FPO AE 09499-1500

ABERDEEN PROVING GROUND

- 2 DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL CI LP (TECH LIB) BLDG 305 APG AA
- 1 LIBRARY ARL BLDG 459 APG-AA
- 1 USATECOM RYAN BUILDING APG-AA
- 1 CDN ARMY LO TO TECOM ATTN AMSTE CL TECOM HQ RYAN BLDG
- ARL HRED ECBC FIELD ELEMENT ATTN AMSRL HR MM (R MCMAHON) BLDG 459 APG-AA

ABSTRACT ONLY

1 DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL CS EA TP TECH PUB BR 2800 POWDER MILL RD ADELPHI MD 20783-1197

REPORT	DOCUMENTATION I	PAGE	Form Approved OMB No. 0704-0188				
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.							
1. AGENCY USE ONLY (Leave blank)	AND DATES COVERED						
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS				
Cognitive Representations of B 6. AUTHOR(S)	AMS Code 622716.H700011 PR: 1L162716AH70 PE: 6.27.16						
Cook, T.M.; Leedom, D.K.; G	rynovicki, J.O.; Golden, M.G. (all of	ARL)					
7. PERFORMING ORGANIZATION NA	ME(S) AND ADDRESS(ES)		8. PERFORMING ORGANIZATION REPORT NUMBER				
Human Research & Engineer	ing Directorate						
Aberdeen Proving Ground, M	D 21005-5425						
9. SPONSORING/MONITORING AGEN U.S. Army Research Laborato	CY NAME(S) AND ADDRESS(ES) ry		10. SPONSORING/MONITORING AGENCY REPORT NUMBER				
Aberdeen Proving Ground, M	ng Directorate D 21005-5425		ARL-IN-155				
11. SUPPLEMENTARY NOTES							
12a. DISTRIBUTION/AVAILABILITY ST	ATEMENT		12b. DISTRIBUTION CODE				
Approved for public release;	distribution is unlimited.						
13. ABSTRACT (Maximum 200 words)	······································						
13. ABSTRACT (Maximum 200 words) War is a complex phenomenon. The dynamics and complexities associated with modern military engagements, from peace keeping to major regional conflict, demand that the information associated with such environments be carefully selected, framed, and presented to facilitate effective decision making at all levels. We hypothesized that the six fundamental variables of combat represented by the military acronym METT-TC (Mission, Enemy, Troops, Terrain and weather, Time available, and Civilian considerations) would provide a framework from which to efficiently organize and represent the salient dimensions of the battlefield during the military decision-making process (MDMP). The U.S. Army's Crusader Concept Experimentation Program 3 (CEP 3) was selected as an ideal arena in which to conduct a preliminary investigation of METT-TC dimensions and their associations with representative battle command decisions. Subjects were five field grade officers permanently assigned to a U.S. Army combat unit. During a 2-week experiment period, 24 decisions were isolated and documented across three phases of combat operations (delay, defend, attack). Importantly, decision makers reported high levels of both "significance" and "understanding" for most of the dimensions represented by METT-TC, except for "civilian considerations," which were not represented in the experimental scenarios. Significant differences in levels of "understanding" according to decision types (major versus minor) were observed. In summary, experienced military decision makers recognize the importance of METT-TC dimensions across the full spectrum of military operations.							
14. SUBJECT TERMS			15. NUMBER OF PAGES				
battle command cognitive engineering	complexity		16. PRICE CODE				
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATIO OF ABSTRACT	N 20. LIMITATION OF ABSTRACT				
Unclassified	Unclassified	Unclassificu	Standard Form 208 (Pour 2-89)				

7

,

*