

Visualization: Teaching the Art

A Monograph

by

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Effectively applying operational art and battle command is a challenging task. Several factors associated with the operational level of war create an environment that is uncertain and complex. The expanding size, scope and depth of joint areas of operations place great demands on command and control systems. Future threats will use a wide variety of tactics and technologies to negate American military superiority. Political considerations directly influence operational level planning and execution. Joint operations involve a wide range of land, air, sea, informational, and space capabilities. Integrating these capabilities into a synchronized concept of operation is a complex undertaking. A large number of actors influence operational actions. These actors include nongovernmental organizations, coalition partners, international organizations, and the media. Planning and conducting operations in this environment requires commanders and staffs that are skilled in operational art. According to Joint Publication 1-02, operational art is the employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art, as all forms of art, is an act of creation. The operational commander's vision is the source of creation that leads to the campaign plan. According to Field Manual 3-0, this process of creating a vision for a future operation is called battlefield visualization. Exceptional commanders can visualize the necessary steps to achieve the mission, anticipate opportunities, and estimate how their major operations will develop before they ever make contact with the enemy. Effective visualization places high demands on conceptual competencies. A central issue for the Army is how to provide an educational system that develops the necessary cognitive and conceptual skills in future operational commanders. The purpose of this monograph is to answer the research question: does the Army's officer education system develop the cognitive and conceptual abilities of officers to prepare them for operational level decision-making? The underlying proposition of this research is that commanders with greater conceptual and cognitive abilities will have a better ability to visualize their battle space and mission. In turn, these abilities will aid them in making qualitatively better decisions faster than their adversaries. The ultimate goal is to stimulate improvements in the Army's institutional officer training system. The research makes several recommendations for improving educational and training methods that promote the development of visualization skills. The monograph explores how the Army can develop training models and educational techniques that develop the cognitive and conceptual skills that are most demanded during visualization. The author organizes the monograph into four chapters. The first identifies the type of decision-making model used during operational level decision-making. The second chapter examines the doctrinal foundations of battlefield visualization and identifies the skills required for effective visualization. The third chapter evaluates the effectiveness of the Army's officer education system in developing the necessary skills for visualization. The author concludes that several improvements in educational curriculums could promote more effective development of visualization skills. The final chapter contains several recommendations for improving officer educational models.

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ABSTRACT

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Effectively applying operational art and battle command is a challenging task. Several factors associated with the operational level of war create an environment that is uncertain and complex. The expanding size, scope and depth of joint areas of operations place great demands on command and control systems. Future threats will use a wide variety of tactics and technologies to negate American military superiority. Political considerations directly influence operational level planning and execution. Joint operations involve a wide range of land, air, sea, informational, and space capabilities. Integrating these capabilities into a synchronized concept of operation is a complex undertaking. A large number of actors influence operational actions. These actors include nongovernmental organizations, coalition partners, international organizations, and the media. Planning and conducting operations in this environment requires commanders and staffs that are skilled in operational art

According to Joint Publication 1-02, operational art is the employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art, as all forms of art, is an act of creation. The operational commander's vision is the source of creation that leads to the campaign plan. According to Field Manual 3-0, this process of creating a vision for a future operation is called battlefield visualization. Exceptional commanders can visualize the necessary steps to achieve the mission, anticipate opportunities, and estimate how their major operations will develop before they ever make contact with the enemy. Effective visualization places high demands on conceptual competencies. A central issue for the Army is how to provide an educational system that develops the necessary cognitive and conceptual skills in future operational commanders.

The purpose of this monograph is to answer the research question: does the Army's officer education system develop the cognitive and conceptual abilities of officers to prepare them for operational level decision-making? The underlying proposition of this research is that commanders with greater conceptual and cognitive abilities will have a better ability to visualize their battle space and mission. In turn, these abilities will aid them in making qualitatively better decisions faster than their adversaries. The ultimate goal is to stimulate improvements in the Army's institutional officer training system. The research makes several recommendations for improving educational and training methods that promote the development of visualization skills.

The monograph explores how the Army can develop training models and educational techniques that develop the cognitive and conceptual skills that are most demanded during visualization. The author organizes the monograph into four chapters. The first identifies the type of decision-making model used during operational level decision-making. The second chapter examines the doctrinal foundations of battlefield visualization and identifies the skills required for effective visualization. The third chapter evaluates the effectiveness of the Army's officer education system in developing the necessary skills for visualization. The author concludes that several improvements in educational curriculums could promote more effective development of visualization skills. The final chapter contains several recommendations for improving officer educational models.

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Introduction

Future conflicts will place great demands on operational commanders and their staffs. Many characteristics of future war and conflicts are uncertain. New technologies and strategies will drive the scope, complexity, intensity, and tempo of future conflicts to new, more lethal heights. Future operations will not provide military forces the luxury to prepare, deploy, and then fight. Joint forces will deploy and fight simultaneously under severe time pressures. The size of joint areas of operations will continue to expand as the range, precision and lethality of weapons continue to increase. This expansion will place greater demands on leaders at all levels. These characteristics require commanders and staffs that are well skilled in operational art. Operational art is practiced not only by joint task force commanders, but also their senior staff officers and subordinate commanders.

Joint Publication (JP) 3-0 defines operational art as the employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art translates the joint force commander's strategy into operational design, and, ultimately, tactical action, by integrating key activities at all levels of war.¹ Operational art, as all forms of art, is an act of creation. The operational commander's vision is the source of creation that drives campaign and operational planning. Joint and Army doctrine recognizes the process that commanders use to develop a vision for an operation as battlefield visualization.² Visualization is the process whereby the commander develops a clear understanding of his current state with relation to the enemy and environment, envisions a desired end state, and then visualizes the sequence of activities that will move his force from its current state to the end state.³ The commander articulates his vision in his planning guidance and intent. His guidance and intent represents how

he intends to impose his will on the enemy in order to accomplish an assigned mission.

Visualization is a vital skill required for understanding and exercising operational art.

Future joint operations will place greater demands on the cognitive and conceptual abilities of operational commanders. Joint Vision 2010 anticipates that joint capabilities will enable military forces to change the conduct of operations. Instead of relying on massed forces and sequential operations, joint forces “will achieve massed effects in other ways.”⁴ Future joint warfare will employ a “multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint air, land, sea, and space forces to accomplish assigned operational tasks.”⁵ Achieving this vision will require commanders who can understand their environment and visualize major joint operations. Commander will need to develop creative concepts and schemes that maximize friendly strengths and capabilities.

Exceptional commanders can visualize--understand their current state, determine a desired end state, and visualize the steps to achieve end state--in their mind's eye. They see the necessary steps to achieve the mission, anticipate opportunities, and estimate how their major operations will develop before they make contact with the enemy. Their vision provides confidence and focus to their subordinates and staffs. History provides many examples of great commanders whom possessed these exceptional cognitive and conceptual abilities. There is ample evidence to suggest that these abilities are the result of years of study, experience, and maturation. The challenge for the United States (US) Army is to develop competent officers capable of making high quality operational level decisions in complex and uncertain environments.

Field Manual (FM) 22-100, *Leadership*, identifies four categories of leadership skills: tactical, technical, interpersonal, and conceptual.⁶ Current Army training models and strategies appear to focus on the first three competencies. Effective visualization places high demands on conceptual competencies. Visualization is a complex and demanding task at the operational level. Commanders receive information from a variety of sources that they must synthesize and

blend with their knowledge, experience, and intuition to create a vision for the operation. A central issue for the Army is how to provide an educational system that develops these critical cognitive and conceptual skills in future operational commanders.

Purpose

The purpose of this monograph is to answer the research question: does the Army's officer education system develop the cognitive and conceptual abilities of officers to prepare them for operational level decision-making? The underlying proposition of this research is that commanders with greater conceptual and cognitive abilities will have a better ability to visualize their battlespace and mission. In turn, these abilities will aid them in making qualitatively better decisions faster than their adversaries. The ultimate goal is to stimulate improvements in the Army's institutional officer training system. The research makes several recommendations for improving educational and training methods that promote the development of visualization skills in future operational commanders.

Chapter 1

Theoretical Foundations

Operational art requires commanders who can visualize, anticipate, and create opportunities that exploit enemy vulnerabilities to quickly achieve objectives. To analyze current educational models it is necessary to identify the skills and attributes required for battlefield visualization. These skills and attributes are based on the type of decision-making model predominantly used at the operational level of command. The following sections define visualization and describe the operational decision-making environment to identify the dominant operational decision-making model.

Doctrine of Visualization

Visualization is one of the vital abilities required by operational commanders and their subordinates. Successful operations depend on the ability of commanders to effectively exercise battle command. Battle command is the exercise of command in operations against a hostile, thinking opponent.⁷ The art of battle command lies in the conscious and skillful exercise of visualization, decision-making, and leadership. Visualization lies at the heart of battle command. It is the mental process that is both intertwined with and essential for effective decision-making. To make effective decisions during battle, the commander must formulate and communicate a vision of how he wants the operation to unfold. By clearly articulating his vision for the operation, the commander ensures the optimum development and execution of his concept of operations.

Visualization is both an art and science that consists of three aspects.⁸ The first aspect of visualization is an understanding of the current state. The current state is the commander's mental representation or model of the situation that faces his organization. Visualization defines the nature of the operational problem. The commander's understanding of his current state extends to all relevant factors of the situation that affect military operations. FM 3-0 describes

the concept of battlespace to aid commanders and staffs in assessing the situation. Battlespace is a conceptual view of the environment, factors, and conditions commanders must understand to successfully apply combat power, protect the force, or complete the mission.⁹ From an analysis of the unit's battlespace, the commander and staff determine the essential and relevant factors that influence their current state. This understanding extends beyond physical aspects of terrain, enemy forces, and friendly forces. It includes intangible factors such as political implications, morale, and other moral factors. Depending of the situation and on the individual commander, the mental model of the current state usually is based on the factors of METT-TC.¹⁰ A clear and complete mental image and understanding of the unit's current state is critical to the visualization process because it serves as the foundation for all subsequent aspects of visualization.

The value of the science component of visualization is fairly straightforward. Digital information systems, staff estimates, and terrain visualization tools directly support the commander's ability to visualize the operation. Modern command and control systems are capable of providing a near-real time representation of the battlefield while processing vast amounts of data. However, these systems alone do not provide a complete understanding of the current situation. The commander and staff must apply their judgment, expertise, and experience to gain an understanding of the command's mission, morale, and capabilities. Martin Van Creveld concluded that current commanders are no better in dealing with the information they need for the command process than their predecessors a century or even a millennium ago.¹¹ Digital information systems and other command and control technologies appear to have the most value in providing the commander and staff with information about the current state of the situation.

The second aspect of visualization is the ability to clearly discern a desired end state. The desired end state is the commander's mental representation of the military conditions that he believes will result in the achievement of the strategic objective. The end state is usually expressed in terms of the disposition and strength of friendly forces in relation to the enemy, time

and terrain. At the tactical level this determination of is relatively simple. The higher headquarters' order normally provides the unit's tasks, purpose, objectives, and area of operations. At the operational level of war this discernment is more complex. Normally operational objectives and missions are influenced by a variety of sources. These sources include mandates, ever evolving political guidance and policy, economic input, coalition concerns, military guidance from combatant commanders, and an analysis of the political-military situation. Once determined, the end state helps drive the organization of the theater, force composition, concept of operations, and operational objectives. The determination of an achievable end state is critical for mission success.

The final aspect of visualization is the ability to envision the relationship and interaction between friendly and enemy forces that leads to the development of the sequence of activities from the current state to the end state.¹² This aspect implies the need for the commander to engage in some degree of course of action development and analysis during visualization.¹³ This aspect of visualization is necessary for the commander to identify key tasks in his intent, develop guidance to focus the staff during course of action development, and eliminate unacceptable concepts early in the planning process. By providing his key tasks, anticipated sequence of activities, and planning guidance, the commander focuses the staff on concepts that are ultimately developed into courses of action.

Commanders must be capable of visualizing complex joint operations over time. This concept is important because a single operation rarely achieves strategic goals. Operational commanders must have the ability to envision a series of major operations linked in time, space, and purpose that ultimately achieve the strategic objective. Other key requirements that support this ability include an understanding of relevant time and distance factors, joint force capabilities, effects of weather and terrain, operational risks, and abilities of subordinate commanders. As the commander envisions the operation he must have the ability to see and understand the requirements for key operational functions such as intelligence, maneuver, fires, and logistics.

The staff aids the commander in this aspect by providing relevant information and estimates to him during the planning process. Even so this aspect of visualization places the most demands on the commander's knowledge, experience, judgment, and conceptual abilities.

The commander articulates his vision through his planning guidance and intent. His guidance and intent must provide sufficient detail to guide the development of the operational plan and its subsequent execution. This is the most critical point during the planning process where the commander has the greatest opportunity to directly influence the plan. An accurate and well-articulated vision ensures a common understanding during planning, focuses the staff on critical objectives, and speeds the development of plans.

Conceptual Tools for Visualization

Armed Forces and Army doctrine provide several conceptual tools that aid the commander in visualizing and designing operational plans. These tools consist of the commander's estimate of situation, operational questions, elements of operational design, and forms of maneuver. The ability of operational commanders and their staffs to understand and apply these concepts to complex operational problems is vital for success. Understanding these tools provides the experience base in the form of procedural knowledge that supports visualization skills.

Commander's Estimate of the Situation

The term estimate implies a one-sided evaluation of a two or more sided issue where many of the pertinent facts are unknown or distorted.¹⁴ An estimate aids in clarifying problems and developing solutions to complex problems. Commanders use an estimate of the situation to maintain an accurate and timely assessment of the current condition and state of friendly forces, enemy forces, and neutral actors in their battlespace. The estimate also helps commanders anticipate future requirements, information needs, and decisions. Commanders do not normally maintain a formal written estimate but rather maintain a mental representation of the battle and relevant factors affecting their anticipated decisions. Joint Publication 3-0 discusses strategic

estimates that combatant commanders, functional commanders, and joint staffs maintain to assist in future planning.¹⁵ Other joint publications imply the need for the commander to maintain an estimate of the situation during planning and execution of joint operations. Field Manual 3-0, *Operations*, is clearer on the need for commanders at all level to maintain an estimate of the situation.¹⁶ The estimate generally considers the factors of METT-TC, which are fundamental to assessing and visualizing.¹⁷ The estimate of the situation, based on the factors of METT-TC, is a valuable tool that aids commanders by providing a systemically framework for considering all critical factors that affect operations.

Operational Questions

At the most basic level operational art addresses ends, ways and means necessary to achieve strategic objectives. To aid in this analysis joint and Army doctrine describe three fundamental questions that operational commanders must consider in developing their vision for an operation. The first question is: what military (or related political and social) conditions must be produced in the operational area to achieve the strategic goal? This question addresses the “ends” portion of the vision. The second question is: what sequence of actions is most likely to produce that condition? This question addresses the “ways” of the vision. The third question is: how should resources be applied to accomplish that sequence of actions? This question addresses the “means” of the vision. FM 3-0 adds a fourth question that causes the operational commander to consider the risks associated with his vision. While these questions are straightforward, they are often difficult to answer in the uncertainty and complexity of operational level warfare. As a result, the cognitive skills, conceptual abilities, and knowledge required to answer these questions comes from years of deliberate study, education and experience.

Elements of Operational Design

Joint and Army doctrine contain several interrelated concepts that aid operational commanders and staffs with the development of plans and operational schemes. The elements of operational design provide a conceptual linkage of ends, ways, and means (see Figure 1-1). They

help clarify and refine the vision of operational-level commanders by providing a framework for them to describe operations in terms of task and purpose.¹⁸ They are required due to the complex nature and broad scope of operational level warfare. Once the elements are clarified they are operationalized into concepts of operations, objectives, tasks, and other control measures. Ultimately they bridge the gap from concept to plan by providing focus, priority, resources, and direction to planning.

End state and military conditions	Center of gravity
Decisive points and objectives	Lines of operations
Culminating point	Operational reach, approach, and pauses
Simultaneous and sequential operations	Linear and nonlinear operations
Tempo	

Figure 1-1. Elements of Operational Design.

Because of the centrality of the elements of operational design to visualization, they must be addressed in the education of future operational level leaders. Operational commanders and staffs must go beyond simply understanding these conceptual tools. They must be able to apply them in complex, lethal situations to achieve strategic objectives against a thinking, adaptive enemy. The most creative part of operational art is in the application these elements. As a result educational systems must address both the theory and application of the elements. The quality and accuracy of operational visualization depends on the understanding of these elements. As such they must play a central role in the education of operational visualization.

Forms of Maneuver

Field Manual 3-0, *Operations*, describes five forms of maneuver – frontal attack, penetration, envelopment, turning movement, and infiltration.¹⁹ FM 3-0 also describes three types of defensive operations, mobile defense, area defense, and retrograde operations, to guide planning for defensive operations. The forms of maneuver provide a conceptual framework for

describing, designing, and conducting operations. Commanders use the forms of maneuver as a basis for developing courses of action. Forms of maneuver are especially useful in offensive and defensive operations.

Operational Environment

The operational environment directly influences the type decision-making model most used at this level of war. The two most significant conditions of the operational decision-making environment are uncertainty and complexity. Several factors combine to create these conditions. It is expected that the growth in tempo, battlespace, and information will continue to increase the uncertainty and complexity of future operations.

The political dimension of the operational level of war often creates complexity and uncertainty. Operational commanders must understand national policy and political objectives. Unfortunately, political policy often evolves as a crisis develops, greatly challenging operational planning. Diplomatic mandates, agreements, and guidance are often ambiguous and vague. This is usually necessary to build international and domestic consensus for military action. As a result operational commanders must often translate changing and ambiguous political objectives into a military end state and a concise concept of operations. In addition the commander must consider the short and long term political implications of his military actions. Accurately predicting short and long-term political implications of military decisions is extremely challenging.

The nature of future threats increases the uncertainty and complexity of future operations. Potential threats vary from heavy conventional units to adaptive, asymmetric forces.²⁰ Future adversaries will likely have greater access to advanced technology along with modern weaponry, including weapons of mass destruction, and the requisite skills to maintain and employ it.²¹ Threat tactics will attempt to negate American military strengths in a variety of ways such as using terrorist attacks against civilian and vulnerable military targets, fighting in urban terrain, employing information warfare, and attempting to deny entry operations at ports and airfields. In

sum, joint forces must prepare to face a wider range of threats employing varying combinations of technology and tactics at varying levels of intensity.

The nature of joint operations will likely continue to expand in depth and scope, increasing the complexity of operations. The decrease in the density of forces to space and an increase in accuracy and lethality of weapons have caused a dynamic expansion of the operational battlefield.²² This expansion of the commander's battlespace has greatly increased the number of factors that affect military operations. The combination of long-range precision weapons and highly mobile air and ground forces has increased the depth of operations. Future joint operations will include the employment of forces and fires at greater depths than ever before. The potential for simultaneous operations in depth on a vast non-linear battlefield increases the demands on joint command and control systems to control and synchronize operations. Visualizing joint operations of this scope and depth will tax the mental skills of operational commanders and staffs.

The large number of potential actors in the operational commander's battlespace also adds to the uncertainty and complexity of operations. Multinational operations place unique demands on operational command and control systems. There is an increased requirement for interaction and coordination with international, United Nations, and other governmental organizations, especially during stability or support operations. The proliferation of nongovernmental organizations in joint areas of operation requires special attention at all levels of command. Adding to these demands is the present of real-time media coverage. Operational commander must interact and shape a worldwide information environment. Considering all these potential actors and their potential impact on operations place great demands on the visualization skills of operational commanders.

These numerous factors combine to create a decision-making environment dominated by uncertainty and complexity. These two conditions affect the decision-making model used at the operational level. In fact, Martin Van Creveld proposed that the entire quest of command and control processes has been to reduce or even attempt to eliminate uncertainty.²³ These conditions

also provide insights into the stakes involved in operational level decisions. Visualization under these conditions is a difficult task. The complexity and uncertainty of operational decisions weighs heavily on the mind of operational commanders, directly influencing his decision-making processes.

Decision Making Models

Joint Publication 5-0 details the joint planning process. The planning doctrine describes the procedures used by operational commanders and staffs to develop plans and estimates. Armed Forces and Army doctrine does not describe the mental decision-making model used by commanders to make decisions that result in intent, guidance and orders. The following sections describe the current theories for how individuals, like operational commanders, make decisions. The decision-making model most used by operational commanders provides the source for identifying the qualities needed for effective battlefield visualization.

The most popular decision-making models fall into two categories: analytical and recognitional.²⁴ Analytical models typically involve several linear steps. These steps normally include defining the problem, generating courses of action, evaluating courses of action, and carrying out the selected course of action. The evaluation of the courses of action involves analyzing and comparing them against a number of value-based criteria. Visualization in an analytical model would be similar to a math equation. Once the commander identified and qualified required inputs for the current and end state, he would mentally develop potential options, compare them, and issue his guidance. Unfortunately, the analytical model fails to define how goals are defined and how courses of action are identified.²⁵

The uncertainty and complexity of the operational environment reduce the applicability of the analytical model. The unique nature of the operational environment does not lend itself to known parameters or to an accurate predict of evaluation criteria for likely outcomes of developed courses of action. It is even more unlikely that an individual could quantify the number of variables in the operational environment to predictable outcomes. The analytical

model for the commander's decision-making model is inappropriate. Empirical studies indicate that decision makers seldom use the model.²⁶ Analytical models overlook the dynamic evolution of problem understanding over time. Usually decision makers continually refine their understanding of the problem and potential solutions over time by using cognitive strategies to evaluate new information and test assumptions. Additionally, studies indicate that the act of battlefield visualization is not an analytical process, but a creative process that involves recognitional and cognitive mechanisms.²⁷

The recognitional model of decision-making is based on research and empirical studies of the relationship between experts and novices in problem solving. Research in this field indicates that experts are able to recognize and identify a large number of familiar patterns and then quickly apply a solution based on their knowledge and past experiences. Gary Klein and his associates developed a recognitional model of decision making called rapid recognition-primed decision-making.²⁸ In its simplest form the decision maker recognizes a situation as familiar and implements a typical action. This research is based on a large number of studies that analyzed the decision-making processes of experts in a number of widely diverse fields.

There is evidence that simple recognitional models of decision-making are inadequate at the operational level.²⁹ The model does not explain how decisions are made during uncertain, novel, or unexpected situations. These are the typical situations faced by operational commanders. Mental models of a situation or problem are often constructed over time rather than instantly retrieved whole, as suggested in the recognitional approach. Situation assessment and action selection are often intertwined rather than separate steps.³⁰ For example, commanders and planners naturally identify the mission and conceptualize a rough course of action simultaneously. As Gary Klein and his associates noted:

Effective planners hypothesize courses of action as a way of helping clarify the mission. Planners gain a better understanding of the problem by posing potential solutions and then folding back on the situation to check for compatibility. As a result, there is a very tight and continuous mutual feedback loop between mission identification and course of action selection.³¹

The continuous conceptualization of the problem and potential solutions involves a more conscious use of cognitive processes than proposed by a purely recognitional model. While pattern recognition appears to be critical for proficient performance in familiar situations, other processes may also be crucial for success in uncertain and novel situations. For example Gary Klein discusses how potential solutions may be tested by mentally simulating their outcomes.³²

To cope with uncertain, novel, and complex situations decision makers must go beyond simple recognitional approaches. Instead of dropping pattern recognition in novel situations, experienced decision makers learn to pause and think critically about the results of their recognition. Experienced decision makers develop strategies for testing the validity of recognition responses and for controlling recognition processes and modifying their results.³³ Research indicates that experienced commanders are capable of perceiving when their recognition is weak or incomplete, critique their assessments, and improve their solutions. Experienced decision makers look for problems in consistencies or gaps in their current understanding of the problem, use various strategies to confirm assumptions, and actively look for new information to support their decision processes. These processes are called metacognitive because they probe for flaws in recognized assessments and plans, try to patch up any weaknesses discovered, and evaluate results.³⁴

Numerous studies and research by the United States Army Research Institute indicates that decision makers use a decision-making model that combines recognitional processes with other cognitive processes that validate, test, and refine initial responses to arrive at decisions. This model of decision-making is called recognitional / metacognitive. Decision makers use recognitional approaches to identify familiar patterns while metacognitive processes are used to monitor and regulate recognition. The name of the model implies that the two paths along which expert decision-making develops are intertwined. The model explains how experienced decision

makers are able to exploit their experience by using pattern recognition and at the same time handle uncertainty and novelty.³⁵

The recognitional / metacognitive theory emphasizes the active construction of mental models and plans over time by a process of activating and combining existing knowledge; and metacognitive skills for monitoring and regulating that process.³⁶ Figure 2-1 provides a graphic representation of the decision making model.

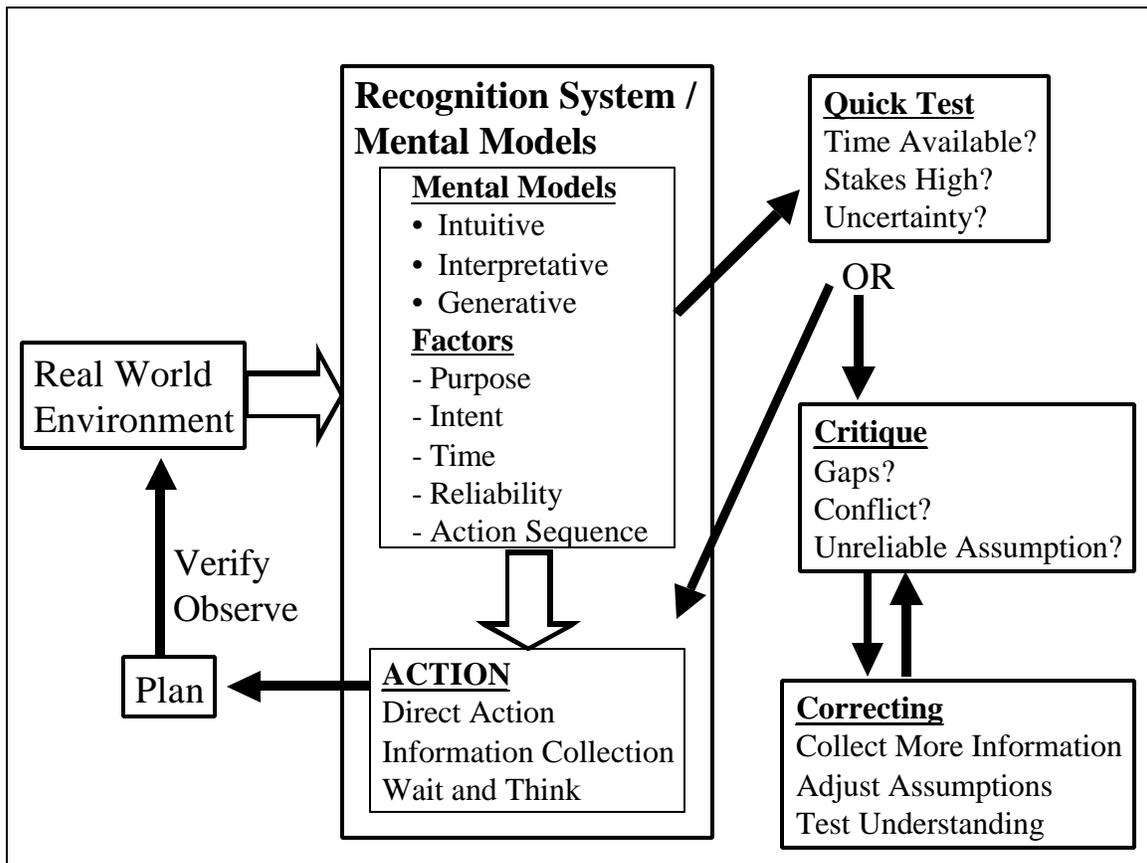


Figure 1-2. Recognitional / Metacognitive Decision Making Model.

The model consists of a recognitional system and three metacognitive processes. The model begins with a recognitional approach that involves an assessment of the situation and problem then the generation of an appropriate mental model, similar to pattern matching processes. Mental models refer to situation-specific structures, mental representations about the nature of the problem and potential solutions. Recent studies of military decision making reveal

that decision makers typically consider their purpose, friendly and enemy intent, time, model reliability, and a potential action sequence as part of their mental models. Research by Marvin S. Cohen and his associates propose three types of mental models by which experts might respond to a problem as a function of its degree of novelty in relation to their existing knowledge.³⁷

- **Intuitive mental model (pattern-matching).** This is a pattern-recognition model used when the decision maker recognizes the situation as familiar or typical.
- **Interpretative mental model** This type of model is used in situations that are not fully captured by a single pre-existing schema, but partially matches several. The decision maker constructs a cognitive model of the environment by combining several pre-existing representations within the constructed model.
- **Generative mental model** In this type of model the decision maker cannot construct a cognitive model as in the previous cases because there are gaps in experience or relevant event sequences. The decision maker generates expected sequences of events by drawing on deeper qualitative and quantitative knowledge of the relevant factors and their casual relationships. Mental simulations of actions, causes, effects, and consequences are normally used in this model.³⁸

Next the decision maker attempts to verify his mental model by using metacognitive processes. The model distinguishes three metacognitive functions that monitor and regulate the recognition processes. The first metacognitive process is the quick test. The quick test is a rapid assessment of the value of taking more time for critical thinking versus acting immediately on the current recognitional response. The quick test determines whether to engage in critiquing and correcting processes or whether the current level of understanding can (or must) suffice.³⁹ The quick test considers the time available, the cost of an error, and the degree of uncertainty in the situation. In some cases the quick test could be a relatively explicit and conscious process. For experienced decision makers working with familiar circumstances the process could be rapid and virtually automatic, taking the form of pattern-recognition processing. The quick test reveals

problems in understanding or potential areas of concern in mental models. Once an area of concern is detected the next step seeks to uncover the nature of the problem or understanding.

The second metacognitive process is critiquing. Critiquing seeks to identify problems in the mental model. The process identifies three categories of uncertainty: incompleteness, conflict, and unreliable assumptions. A model or plan is incomplete if it is missing critical information required for completion of the plan or to verify the potential for a successful outcome of the plan. Conflict exists when there are arguments that support contradictory assessments. A model is unreliable when it depends on implausible assumptions. When a problem is detected with the model or plan during critiquing, the decision maker attempts to resolve the problem through the next metacognitive process.

The last metacognitive process is correcting. Correcting is the metacognitive process used to construct an improved model or plan. The correcting process may involve the collection of more information to support the decision maker. The decision maker may adjust, refine, or develop new assumptions to improve his interpretation of the situation. The decision maker continues to critique his model with each new revision made during the correcting process, creating a feedback loop between critiquing and correcting. Finally this process continues until a satisfactory model is developed or the quick test concludes that time has ran out. The decision maker takes action and observes the consequences of his decision, potentially starting the entire process over again based on new developments in the situation.

Conclusions

Visualization is a vital component of command, especially at the operational level. Several doctrinal tools aid commanders in their visualization process. The Army's officer education system must provide officers with an in-depth understanding of these concepts. Understanding these concepts enables officers to systematically address uncertain and novel situations at the operational level. Recent research and empirical studies indicate the recognitional / metacognitive model has the most utility in uncertain and complex situations.⁴⁰

The model integrates pattern recognition processes with other metacognitive processes necessary for coping with uncertainty, a central feature of operational level decision-making. Based on the operational decision making environment and the recognitional / metacognitive decision-making model the next chapter will examine the skills that operational commanders require to effectively visualize operations.

CHAPTER 2

IDENTIFYING AND DEVELOPING COGNITIVE QUALITIES

Based on the operational decision making environment and the recognitional / metacognitive decision-making model, several conceptual skills are essential for effective battlefield visualization. The following sections examine these skills in detail and describe effective educational strategies based on a review of empirical research and studies. The visualization model (see Figure 2-1) provides a graphic representation of the three key mental processes, their associated strategies, and supporting skills that are essential for effective visualization. The model represents the cognitive processes involved in “Recognition System / Mental Model” portion of the recognitional / metacognitive decision making model described in Chapter 1.⁴¹

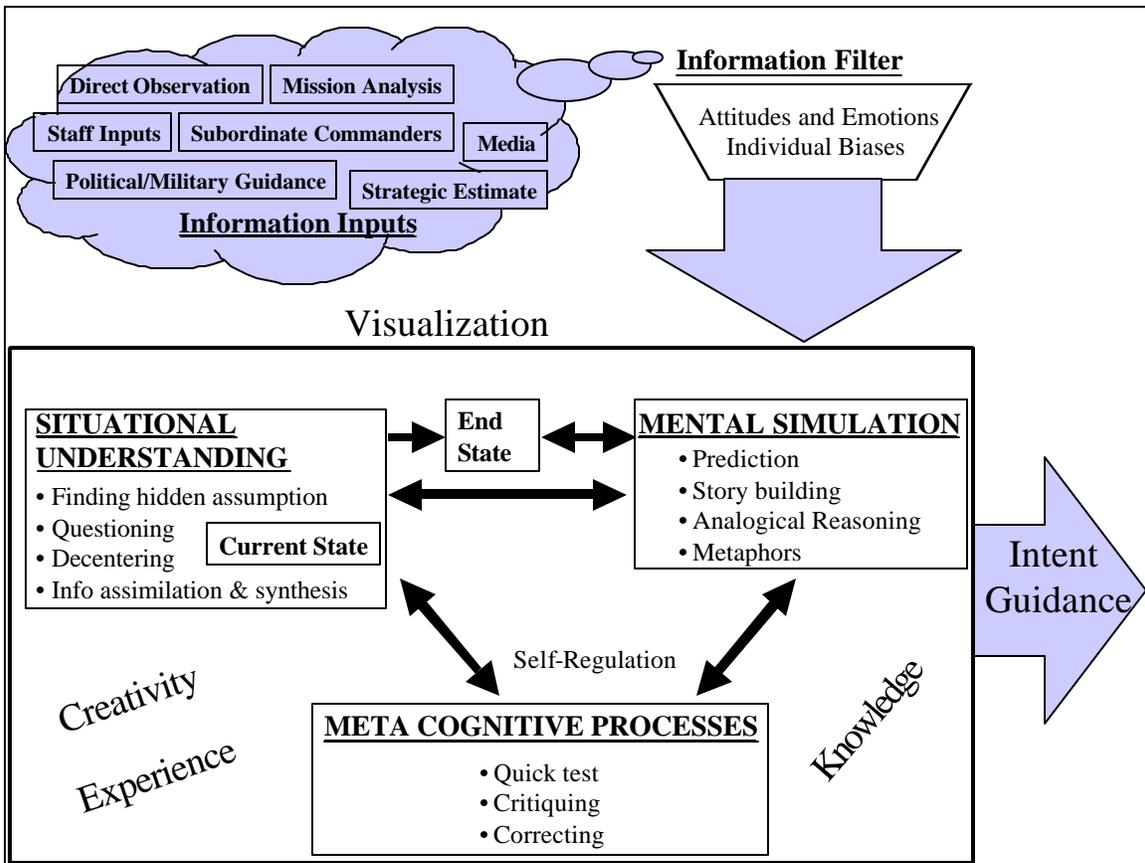


Figure 2-1. Visualization Model.

The Visualization Model consists of three central processes: situational understanding, mental simulation, and metacognitive processes that regulate the commander's thinking and judgment. The model begins with information that the commander receives from a variety of sources to form his situational understanding. The commander filters and processes this information to form a mental model of the situation. In the process of assimilating information the commander's attitudes, emotions, and biases influence his perceptions about the value and priority of each bit of information. Situational understanding provides the necessary foundation for the assessment of the current state and development of the desired end state. Mental simulation is used to determine the sequence of activities and key tasks necessary to achieve the end state as well as help refine the understanding of the situation. Situational understanding and mental simulation (building mental models) are important components that help experts make decisions in naturalistic environments.⁴² Metacognitive processes (quick test, critiquing, and correcting) are used to verify, refine, and adjust the commander's mental simulation and situational understanding. This process of verifying, refining, and adjusting is referred to as self-regulation. The essential components of the visualization process are discussed below in the following sections.

Situational Understanding

Situational understanding is the foundation for developing an accurate mental representation of the current state and directly enables the prediction of the military conditions necessary to attain the strategic objective. FM 3-0 defines situational understanding as the product of applying analysis and judgment to the common operational picture to determine the relationships among the factors of METT-TC.⁴³ An accurate assessment of the situation and operational problem is vital to mission success. For example, selecting the wrong center of gravity will likely have huge operational implications. It could lead to an inadequate force composition, an ineffective concept of operations, or a poor disposition of forces at the start of hostilities. Correcting these type errors once movement and preparations has begun is extremely

difficult and time consuming. This ability to form an accurate, coherent understanding of the current situation enables the commander to define the nature of the operational problem, understand constraints and capabilities, and develop a realistic end state.

The doctrinal tools that aid situational understanding include the elements of operational design, commander's estimate of the situation (critical factors of METT-TC), and other mission analysis products. The elements of operational design provide a framework for analyzing the situation, simulating questioning and consideration about what factors are truly critical to the problem. The overriding goal of the staff's presentation of mission analysis products and briefings is to identify the essential elements of METT-TC so the commander can formulate his intent and guidance, the products of visualization.

The most critical aspect of situational understanding involves the ability to identify the critical factors of METT-TC in order to define the nature of the operational problem. Critical information discernment is a weakness of commanders and staffs as noted by combat training centers, studies by the RAND Corporation, and research by the Army Research Institute.⁴⁴ This research indicates that situational understanding, and especially critical information discernment, is an ability that relies on individual intuition and experience. Currently research has failed to define how decision makers discern critical information about a situation. Since what information is critical and what information is not is highly situation dependent, easy answers will likely be slow in coming. Most researchers agree that situational understanding is an intuition-based ability, relying on procedural knowledge gain through multiple experiences over time. In addition to the vital role of experience, current research has revealed some key aspects of the skills and strategies involved with visualization.

Three key strategies directly aid in developing situational understanding: finding hidden assumptions, questioning, and decentering.⁴⁵ These strategies come from research in the area of critical thinking. Finding hidden assumptions involves the close analysis of information to determine if information presented as facts are really assumptions or assertions. This type of

exploration often reveals potential weaknesses in conclusions presented by the staff or the decision maker's own mental models. Questioning is another technique used to probe, test, and verify information and conclusions. The key is to probe critical issues deeply enough to determine the value of the information, its overall effect on the problem, and its full range of implications. Decentering involves the ability to shift out of a typical way of viewing and understanding a situation and to take on a perspective that may be uncommon. It allows the understanding of how others, like the enemy, are likely to view the situation. Experiments in developing critical thinking skills have shown success in improving the abilities of officers to gain accurate situational understanding by using these techniques.⁴⁶ Army officer education systems can improve the visualization ability of future operational leaders by teaching and exercising these skills.

Mental Simulation

Mental simulation refers to the ability to envision how proposed goals and actions will play out and what their results will be.⁴⁷ Essentially it is mental war gaming. During visualization, mental simulation is used to define key tasks and the sequence of activities that leads to an end state. It is also used as a mechanism to verify, test, and refine situational understanding.⁴⁸ Mental simulation may be rapid or deliberate depending on several factors such as the complexity and uncertainty of the situation, time available (based on quick test), quality of information, and experience of the decision maker. Simulation is a synthesis-based process that relies on declarative knowledge, which is factual knowledge about the situation. It allows the evaluation of ideas when an immediate solution cannot be reached through an intuitive process, such as pattern recognition.

Decision makers use several strategies during mental simulation, including story-building, analogical and metaphoric reasoning, and prediction skills. Story building provides a framework for organizing and understanding events, causality, context, intentions, and actions.⁴⁹ By mentally constructing stories decision makers are able to evaluate ideas. Stories serve as a

natural experiment or simulation. Analogical and metaphoric reasoning is another technique used for mental simulation. An analogue is an event or example drawn from the same or a related domain as the task at hand; a metaphor comes from a markedly different domain.⁵⁰ This type of reasoning functions much like experiments by providing a structure for making predictions when there are many unknown facts. Prediction involves the mental ability to reasonably simulate the likely outcome of an action while understanding the interaction of the action with a wide range of METT-TC factors.

The quality and accuracy of these mental simulation skills is a product of the decision maker's knowledge, judgment, and imagination. The mechanism to develop these skills comes from practice and professional study linked to a quality feedback system. Over time through multiple exercises the decision maker is able to develop an experience and knowledge base that supports effective judgments of concepts and potential outcomes. The challenge for the Army's officer education system is in providing multiple exercises with an effective feedback system to guide the officer's development of these skills.

Metacognitive Processes

Three key metacognitive processes play a vital role in visualization. The quick test, critiquing process, and correcting process (previously discussed) help regulate the visualization process in the same manner as decision-making.⁵¹ Metacognition serves to regulate and enhance situational understanding and mental simulation by making up shortcomings of the two processes. This regulating process is referred to as self-regulation. Self-regulation is critical in uncertain and complex situations, such as during operational planning. Situational understanding is based on procedural knowledge and as such may be of little value in novel situations. Simulation skills are not overly effective when the decision maker lacks the necessary declarative knowledge to effectively visualize outcomes of actions and the relation of other critical factors in the situation. Thus self-regulation may help fill the gaps that appear in the visualization process.

Role of Experience

Experience of the decision maker is a common requirement in the development of effective visualization abilities; situational understanding and simulation skills are very dependant on knowledge, judgment, and intuition that results from experience. Experience plays a vital role in intuition-based processes such as situational understanding.⁵² Officers gain the bulk of their experience base from command and staff assignments. However, the Army's officer educational system can provide opportunities for the development of operational experience. This is especially critical considering the majority of officers' experience comes from tactical troop assignments, not operational level assignments. The Army's educational system can play a vital role in the development of the conceptual skills necessary for visualization at the operational level.

Experience is a necessary, but not sufficient, requirement for effective visualization. Proficiency comes from performing a task repeatedly. One encounter is usually not sufficient to develop an experience base. Repeated encounters enable officers to act quickly with little deliberation. This type of training has the most utility when officers face situations that are familiar. Thus, such a training process is not overly useful to officers working in uncertain and novel situations. There is a clear need for officers to be exposed to many unique decision making situations during their education in order to develop a board base of experience in visualizing complex problems.

The full potential of experience is reached when followed by feedback that focuses on the cognitive aspects of decision-making. Feedback provides the main source of information for evaluating the quality of visualization, decisions, and judgments.⁵³ Experience needs to include feedback that is accurate, diagnostic, and timely.⁵⁴ Feedback can take the form of after action reviews or one-on-one mentoring. Regardless of the technique used, the feedback should focus on the cognitive aspects behind decisions such as how the decision maker assessed the situation, how were decisions made, why decisions were made, and what was the expected outcome. These

techniques are referred to as cognitive critiques.⁵⁵ Educational systems must include exercises that provide cognitive critiques following decision-making exercises to reach the full potential of experienced-based strategies.

Role of Creativity

Creativity has a central role in visualization. Creativity in operational art implies the visualization of novel combinations of capabilities, concepts of operations, and forms of maneuver that rapidly accomplish strategic objectives. Creativity is a subject studied by many psychologists and educators. Theories for creativity, the creative process, and developing creativity abound.⁵⁶ Based on an analysis of creativity literature, there is not a widely accepted theory for how creativity is developed or enhanced by educational processes. Creativity appears to be a group of related abilities consisting of fluency, the ability to produce many ideas; originality, the ability to produce unusual, novel ideas and concepts; and flexibility, the ability to consider a variety of approaches. Several other conclusions apply to developing creativity in future operational officers. First, the uncertainty and complexity of future operational environments means that creativity will continue to grow in importance. Joint Vision 2010 anticipates future capabilities, operational environments, and adversaries will place greater demands on operational commanders. Creative concepts of operations, combinations of joint capabilities, and lines of operations offer the potential for surprise, shock, and rapid attainment of military objectives.

Educational processes can enhance creativity. Researchers agree that creativity is usually the result of deliberate study and practice in a particular field or profession. This means that an educational system striving to develop creativity should include a study of history and theory. History provides a source of ideas and a basis for judgments. Theory and doctrine provide the framework for understanding essential concepts such as the elements of operational design. Hands-on experimentation appears to be the most effective educational technique for developing creativity. This educational strategy involves students developing and testing hypotheses in a

constructive environment. A great deal of learning occurs from this type of action-outcome environment.

Writing and reading also play an important role in the development of creativity. Writing compels students to organize thoughts and develop conclusions based on an analysis of events. Reading serves as second-hand experience. It broadens the readers experience base by providing an account of the action-outcome of the decisions made by others. Effective educational systems that promote the development of creativity should use reading and writing exercises as a tool.

Educational strategies that enhance visualization skills must integrate military theory, lessons from military history, and doctrine. Military theory is a coherent expression about how war works.⁵⁷ The conceptual dimension of military theory has immense practical importance, because it provides the mental model for understanding the dynamics of operational level conflict. Military history describes how war and operations actually occur in reality. Doctrine provides the basis for common action and thought. In order to enhance visualization skills, educational strategies must integrate all three elements with a focus on decision making. The greatest opportunity for creativity in operational art occurs in the selection and combination of the elements of operational design and forms of maneuver. Theory, doctrine, and history education should focus on these concepts in combination with constructive exercises that reinforce the application of the concepts

Conclusion

There are three cognitive processes that support visualization: situational understanding, mental simulation, and metacognitive processes. Each of these processes is supported by a series of strategies and skills. In addition visualization skills depend on the decision maker's experience and creativity. Enhancing these skills is a challenge for educational systems. Educational strategies that repeatedly expose students to complex, uncertain operational decision-making environments have great potential for enhancing visualization skills. Educational models and exercises must target understanding and applying of doctrinal tools such as elements of

operational design, estimates of the situation, forms of maneuver, and operational questions. This type of strategy relies on experimentation followed by a feedback system that addresses the cognitive aspects of decision-making. A study of military theory, history, and doctrine provides the foundation for placing experiences in the context and for expanding the decision makers experience base. A study of military theory, history, and doctrine linked to multiple decision-making exercises and feedback mechanisms provides the best model for developing visualization skills. These conclusions provide the basis for analyzing the Army's educational system.

CHAPTER 3

THE ARMY'S OFFICER EDUCATION SYSTEM

This chapter evaluates the effectiveness of the Army's officer education system in developing visualization skills. The evaluation focuses on the two main field grade level courses, the Command and General Staff Officer's Course and the War College. Before the grade of major, the Army's educational system focuses on a branch specific curriculum, predominantly at the tactical level. After a short overview of both college curriculums, this chapter evaluates their educational methods based on the conclusions reached in the last chapter. The most effective model for developing visualization skills combines a study of military theory, history, and doctrine with multiple operational decision-making exercises and focused feedback. Since the source of creativity in operational art comes from the application and combination of the elements of operational art, educational models should focus on teaching these concepts through a study of theory, doctrine, and history, followed by reinforcement through practical exercises.

The Command and General Staff Officers' Course

The Command and General Staff Officers Course (CGSOC) is the Army's immediate-level service college. Army officers are selected to attend the ten-month resident course between their tenth and twelfth year of service, otherwise the course is completed by correspondence. The mission of the CGSOC is to educate selected officers in the values and attitudes of the profession of arms and in the conduct of military operations during peace, conflict, and war with emphasis at corps and division level.⁵⁸ The course is divided into four terms. Term I consists of four core courses: Fundamentals of War Fighting (C300), Resource Planning and Force Management (C400), Operational War Fighting (C500), Fundamentals of Excellence: Character and Competence (C700), and The Evolution of Modern Warfare (C600). The Evolution of Modern Warfare course continues through Term II and Term III. Term II and Term III offer elective courses in the areas of history, logistics, tactics, leadership, joint services, operational warfare,

and strategic issues. Students are required to select certain electives based on their branch. The last term consists of a capstone, simulated war fighting exercise called Prairie Warrior. The college's curriculum uses an active teaching model. Students are responsible for the majority of their own learning. Classroom time is mainly used for critical discussions, practical exercises, and student-led instruction and briefings. Lectures are kept to a minimum. The three courses that most directly influence visualization skills are tactics, operational war fighting, and history courses.

The focus of the core tactics course, C300, is corps, division, and brigade operations. The course emphasizes the military decision making process (MDMP) through classroom instruction, reading assignments, and group planning exercises. The course provides an extensive study of tactical level doctrine, tactics, and techniques. The course includes several group planning exercises that reinforce the use of the MDMP in offensive and defensive operations. The course concludes with a simulated division level exercise.

Fundamentals of Operational War fighting is the Command and General Staff College's foundation for joint professional military education and addresses all learning areas prescribed by the Chairman of the Joint Chiefs of Staff for Service Intermediate Level Colleges.⁵⁹ The course is very broad because it covers a wide range of strategic and operational issues in just 130 hours of class time. The course begins with an introduction to the strategic level of war focusing on national security and military strategy, the international security environment, and sister services' capabilities and organizations. The course also includes instruction on campaign and joint task force planning during a major theater war and smaller scale contingencies. These lessons are reinforced with group planning exercises. The elements of operational design are addressed during this course. For the majority of students this is their first formal instruction and study of operational, joint, and multinational issues.

The goal of the core history course, The Evolution of Modern Warfare, is to develop CGSOC graduates who understand the nature of military theory and have the knowledge and

skills needed to apply historical insights to current and future military problems.⁶⁰ The course objectives are to enable the student to evaluate change and continuity in warfare, evaluate change and continuity in the art of command, evaluate doctrine using military history and theory, and understand the nature of combat.⁶¹ The course traces the evolution of modern warfare from the eighteenth century to the present day. The course uses historical and theoretical readings from a number of various sources. Weekly class time is devoted to discussion and analysis of key issues in assigned readings.

The War College

The War College is the Army's senior-level service college. Selected Army officers of the rank of lieutenant colonel or colonel attend the college with other joint officers, international officers, and senior civilian governmental personnel. The War College's mission is to prepare selected military, civilian, and international leaders to assume strategic leadership responsibilities in military and national security organizations and to educate students about the employment of land power as part of a unified, joint, or multinational force in support of the national military strategy.⁶² The War College is responsible for producing graduates who understand how to operate in a strategic security environment, who can deal effectively with complex problems involving national security, and who can render sound advice or make the appropriate decisions when the application of force is being considered as a policy option in conjunction with other measures.⁶³ The ten-month academic year is divided into three terms. Four primary core courses are offered during Term I: Strategic Leadership; War, National Policy, and Strategy; Joint Systems and Processes; and Implementing National Military Strategy. Virtually all class activities during Term I focus on the organization, mobilization, deployment, employment, and sustainment of unified, joint and multinational forces. Term II consists of three elective courses that include regional strategic appraisals and the Strategic Crisis Exercise. Term III consists of four advanced elective courses and is followed by National Security Seminar Week. The War College's curriculum focuses on the strategic and operational levels of war by emphasizing

theory, processes, concepts, systems, and joint decision-making processes. The emphasis on strategic warfare includes an in depth study of national military strategy and its linkages with geopolitical issues and other elements of national power. The operational emphasis includes instruction and exercises involving campaign planning, joint capabilities, and the conduct of theater-level warfare. Numerous lessons and courses are dedicated to the capabilities, doctrine, and employment of the Marine Corps, the Navy, and the Air Force as well as intra-agency coordination.

The college's educational program uses active learning techniques. Active learning techniques place the responsibility for learning on the student and use a variety of techniques to reinforce, expand, and challenge the student's understanding of concepts. Learning occurs by doing and participating rather than by just observing and listening. The curriculum is designed to improve students' skills -- analytical, synthesizing, and evaluative -- through case studies, exercises, and war games as well as by seminar discussions. The curriculum also uses vignettes and historical examples combined with current events.

Evaluation

The formal education of officers is only one part of the formula for developing visualization skills. The process of developing competent operational level staff officers and commanders is a long-term process of individual study, experience, and formal education. Individual study allows officers to expand their understanding of operations and history as well as improve areas of weakness. Troop assignments between these two courses play a major role in preparing officers for operational level assignments. Troop assignments build and expand tactical skills and leadership abilities of officers. Formal education provides the opportunity for focused study, individual improvement, and self-reflection.

The War College and the CGSOC provide the fundamental requirements for developing visualization skills. Both colleges use a combination of doctrine, theory, and history combined with practical exercises as part of their curriculum. The War College and the CGSOC adequately

address operational planning and doctrine. Both college curriculums provide an appropriate level of instruction on the organization, doctrine, and capabilities of other services. Both colleges also integrate guest speakers as part of their curriculum. Speakers normally include operational commanders, senior Army commanders and staff officers, political leaders, and foreign officers. Guest speakers help to inform and expand the educational experience of college students.

Theory is addressed in both colleges. During the CGSOC readings from military theorists, such as Carl Von Clausewitz, are included as part of the core history course. The core operational war fighting course also includes readings from military theorist and political scientists. Several electives include a study of military theory too. The War College integrates the study of military theory during core and elective courses. The War College also includes a study of decision-making theory and critical thinking strategies during the first core course. The CGSOC does not provide a course of instruction about decision-making theory. The focus of C300 and C500 is on teaching the processes and tools for planning. The curriculum does not specifically address how individuals and groups make decisions, the essence of decision-making theory. The failure to provide a study of decision-making theory at the beginning of the academic year is a critical weakness in the CGSOC.

Both colleges effectively integrate history into their curriculums. The War College integrates history throughout the academic year as part of each course. The CGSOC provides one core history course and offers a number of history electives during terms II and III. History electives during the CGSOC use a variety of effective educational methods ranging from campaign studies, battle analyzes, lectures, student-led briefings, and staff rides. History studies at both colleges support the development of visualization skills by exposing students to the experiences, insights, and events from the past.

Both colleges integrate the use of decision-making and planning exercises throughout the academic year. The War College includes several strategic and operational planning exercises as well as two major exercises. The CGSOC includes three tactical and two operational planning

exercises during the first term and many of the electives include planning exercises. The CGSOC concludes with a one-week simulated exercise. These exercises are useful in developing visualization skills. But more exercises would promote a greater development of visualization skills.

The War College and the CGSOC provide the fundamental requirements for developing visualization skills. Both courses use a combination of theory, doctrine, and history combined with practical exercises as part of their curriculum. The War College and the CGSOC address the application of all doctrinal tools that aid in visualization. But both colleges could make improvements. The most important issue is the need for greater integration of theory, doctrine, history, and exercises. This improvement would enhance the development of visualization skills. The following chapter examines several recommendations for improving the course curriculum at the War College and the CGSOC.

CHAPTER 4

RECOMMENDATIONS

Based on the evaluation of the War College and CGSOC the following chapter provides several recommendations for improving their educational models to enhance visualization skills. The most effective educational model for developing visualization skills integrates a study of theory, doctrine, and history with numerous decision-making exercises. The focus of the educational model is the application of the elements of operational design, forms of maneuver, and joint capabilities during uncertain, novel, and complex conditions. This educational approach develops an experience and knowledge base that the decision maker can rely upon for generalization, analogies, pattern-recognition, and interferences when faced with unfamiliar, complex operational situations. The following sections contain several recommendations for improving educational methods and doctrine.

Doctrine

Addressing educational models also requires addressing doctrine, since educational materials are based on doctrine. A critical analysis of doctrine reveals a shortfall in the area of decision-making theory. Armed Forces and Army doctrine describe planning processes while avoiding discussions about how decisions are made. This is a critical shortcoming of Armed Forces and Army doctrine. Without a doctrinal foundation, it is difficult to develop educational methods that specifically target improving the cognitive skills associated with decision-making and visualization. The Combined Arms Center at Fort Leavenworth has recently released FM 6-0, *Command and Control*, for Army-wide staffing. The field manual addresses a wide range of issues involved with commanding and controlling units.⁶⁴ The field manual does not address decision-making theory or cognitive skills and strategies used during decision-making. Likewise, Armed Forces doctrine only covers procedures for planning and provides only minimum discussions about visualization and decision-making.

Army and Armed Forces doctrine should provide guidance and advice about cognitive strategies, such as mental simulations, used during visualization and decision-making (and found in detail in Chapters One and Two of this monograph). Field Manual 6-0 should provide a discussion about the strategies used during situational assessment and mental simulation. The manual should include critical thinking skills and strategies developed by various scientists working for and with the US Army Research Institute.⁶⁵ Armed Forces doctrine should include more discussions about the importance of visualization during planning and decision-making. Joint Publication 5-0 and 3-0 should discuss the role of visualization during decision-making, describe its role in the development of intent, and stress the importance of an accurate vision.

Student Textbook

Doctrine cannot cover all decision-making and cognitive theories. Many of these theories are still being developed and refined. “Recent surveys of social science research in decision making repeatedly call attention to the current state of ignorance about how crucial decisions are made by governments, business corporations, and other public organizations, as well as by individuals.”⁶⁶ The Army’s knowledge of visualization and decision-making is still evolving as researchers learn more about the nature of these mental processes. But field grade officers need to understand the theories of decision-making, critical thinking strategies, and visualization skills. The War College introduces these concepts and tools to students during the first core course of the academic year, while CGSOC does not. A student textbook would solve the problem. The CGSOC provides a number of student textbooks about a variety of subjects such as history, tactics, logistics, and planning. These textbooks provide guidance from doctrine, lessons learned, and recent research. The CGSOC should develop and issue a student textbook that covers decision-making theories and models, critical thinking skills, and visualization strategies. The textbook would provide the students with an understanding of visualization and its role in decision making and planning.

Introductory Course

The CGSOC should provide a course during the first weeks of the academic year that examines visualization, critical thinking strategies, and decision-making. Like the first course during the War College, the CGSOC course should cover the skills and strategies used during visualization and decision-making. The class would assist students with applying visualization skills and strategies during the academic year. The class would also enable students to refine their decision-making and visualization skills before follow-on troop assignments.

The first core course of the War College introduces students to critical thinking skills. The Strategic Leadership class examines the conceptual, technical, and interpersonal competencies required to lead large organizations using historical and current applications. The course also covers the Army War College's critical thinking model, and underscores the roles that adult learning, seminar learning, and group dynamic plays during the academic year. By covering decision making and cognitive theory instruction early, students are better able to apply these cognitive skills and strategies throughout their academic year. The classes also provide the students with cognitive strategies and various techniques that aid in decision making during uncertain and complex situation. These strategies also have a direct application to improving their ability to visualize large, complex operations.

The CGSOC conversely provides no introductory instruction about decision-making theory and visualization skills. The CGSOC does teach and apply the MDMP and joint planning processes during the core curriculum and during many of the elective courses. Unfortunately these classes only focus on the doctrinal, procedural application of these planning processes. The CGSOC needs a short introductory course that covers decision-making theory, critical thinking strategies, and visualization skills. The course would allow students to apply and develop their cognitive and conceptual skills over the academic year.

Increased Number of Decision-Making Exercises

The War College and CGSOC could increase the number of decision-making exercises, especially exercises at the operational level of war. An increase in exercises would also contribute to a greater development of visualization skills. As noted in Chapter Two, effective visualization depends heavily on recognitional processes. Recognitional processes are developed through repeated exposures to problem sets that lead to the accumulation of experiences. These experiences not only serve the decision maker in pattern recognition during familiar situations but also provide a source of knowledge that can be used to formulate solutions in unfamiliar situations. Practice in decision-making, especially in novel situations, helps develop the essential metacognitive skills and strategies that are vital to effective visualization in unfamiliar situations. By providing multiple decision-making exercises the colleges could improve the visualization skills of students.

The CGSOC has the challenge of addressing tactical and operational skills. Visualization and decision-making at the tactical level appear to rely heavily on recognitional skills, such as pattern recognition. Operational decision-making and visualization incorporates additional metacognitive strategies with recognitional approaches. Since visualization at the tactical level and operational level rely on many of the same cognitive processes, experience with visualizing complex or uncertain tactical operations would also aid in improving the ability to visualize operational level activities. Practicing visualization and decision-making allows students to develop the basic strategies needed for visualizing more complex joint operations.

Repetition is the key to developing visualization skills and for building an experience base that enhances recognitional processes. The War College and the CGSOC provide about six to ten decision-making exercises, depending on the number and type of electives selected by a student. The CGSOC core operational course provides only two planning exercises. The number of tactical decision-making exercises during the CGSOC varies depending on electives, but is less than eight planning exercises.

Both the War College and CGSOC should use more decision-making exercises to reinforce theory, doctrine, and the lessons of history. Exercises should focus on the application of the elements of operational design, forms of maneuver, and joint capabilities in a competitive environment that allows the students to see the results of their decisions and plans. Exercises allow students to build their experience and knowledge base. This is especially critical for the education of future operational leaders. Operational experience is difficult to develop since most Army officers spend the majority of their careers at the tactical level. When effectively integrated with history and doctrine, exercises build procedural knowledge of operational concepts that are used for interferences, generalizations, and analogies during visualization. Exercises have the most value when they are synchronized with lessons on theory, history, and doctrine.

Integration of Theory, Doctrine, History, and Exercises

The integration of lessons from theory, doctrine, and history, reinforced by exercises is a powerful educational tool for developing visualization abilities. Military theory proposes hypotheses of how certain concepts apply during war. Theory also provides the means that allow students to organize experiences and knowledge in relation to concepts. History describes how events happened, allowing students to understand the interaction of forces and circumstances in relation to concepts proposed by theory. History also provides an understanding of the human dimensions of combat. Knowledge of doctrine is essential for being able to communicate a vision or plan in a common language and in a common organization. Exercises, especially competitive simulations, provide the mechanism to reinforce lessons and provide the opportunity for experimentation. Experimentation is essential for developing creativity. Feedback helps reinforce the lessons learned during exercises.

Each aspect of this educational model has its own strengths and weaknesses, requiring all four areas to be used together. Simulations cannot fully replicate the human dimensions of operational conflict. For example, simulations cannot produce the devastating psychological effects of surprise, exploitation, or exhaustion. Likewise, most simulated exercises cannot fully

replicate the demands and pressures of operational command. It is also very difficult to replicate the political, social, and cultural context of operations during exercises, including simulations. Simulations often create an environment in virtual isolation of the political aspects of an operation. Simulations have the potential to teach some bad lessons to decision makers. To reduce these shortcomings a study of history is required. History places past operations in the political and social context of their time. History provides insights into the pressures and demands of operational decision-making. History provides examples of the psychological effects of surprise, exploitation, and exhaustion. A study of history in combination with simulations promotes a balanced understanding of operational conflict.

Doctrine and theory provide the mental mechanisms for organizing, conceptualizing, and communicating a vision. Knowledge of doctrine and theory combined with the experience of analogy provide the decision maker with a foundation from which to generalize, infer, and anticipate outcomes during visualization. For example, when considering the potential for culmination due to logistical constraints, the decision maker does not visualize empty fuel tankers or depleting stockpiles of ammunition. The decision maker is able to consider the effects of logistics shortfalls in abstract terms in relation to the operation's tempo, need for operational pauses, and reduction in combat potential of the force. By understanding the concept of culmination the decision maker is able to predict the effect and outcome of logistic shortfalls. The ability to understand potential real-world effects in abstract terms comes from a study of doctrine and theory. History also aids this understanding by providing examples of theoretical and doctrinal concepts.

Theory and doctrine can provide the foundation for understanding the conceptual tools that aid visualization; elements of operational design, estimate of the situation, forms of maneuver, and operational questions. History provides the source for understanding how these concepts were applied during past conflicts. Military students can learn valuable lessons in applying these tools from case studies, campaign analyzes, and biographical research of past

commanders. But creativity and experience comes from repeatedly applying these tools to operational problems and missions. Simulations provide the mechanism for creating operational problems and missions for students.

Computer simulations offer an ideal means for exercises. There are a variety of commercial and military simulations available, each with their own strengths and weaknesses. Many commercial simulations allow students to fight historical battles as well as experiment with future capabilities and scenarios. Military simulations are normally more resource intensive to use during training, but offer a very realistic replication of military operations. Simulations provide the opportunity for presenting students with a wide range of operational problems. Simulations also have the advantage of being flexible. Controllers can use historical operations or create scenarios that specifically reinforce key concepts or lessons. For example, an exercise may require students to “re-fight” the German invasion of the Soviet Union in 1941. This scenario could provide the means to aid students with understanding and applying the concepts of centers of gravity, lines of operations, culmination, and tempo. Other scenarios could provide the opportunity for students to select various forms of maneuver, providing the means to explore the inherent challenges of executing each form of maneuver. This type of flexibility in scenario design promotes creativity and builds experience. It also allows scenarios to be constructed that reinforce the lessons of theory, doctrine, and history in a logical manner.

The most effective model for developing visualization skills combines a study of military theory, history, and doctrine with multiple operational decision-making exercises and focused feedback. Since the source of creativity in operational art comes from the application and combination of the elements of operational design, educational models should focus on teaching these concepts through a study of theory, doctrine, and history, followed by reinforcement through practical exercises.

CONCLUSIONS

Effectively applying operational art and exercising battle command are challenging tasks. Several factors associated with the operational level of war create an environment that is uncertain and complex. The expanding size, scope and depth of joint areas of operations place great demands on command and control systems. Future threats will use a wide variety of tactics and technologies to negate American military superiority. Political considerations directly influence operational level planning and execution. Joint operations involve a wide range of land, air, sea, informational, and space capabilities. Integrating these capabilities into a synchronized concept of operation is a complex undertaking. A large number of actors influence operational actions. These actors include nongovernmental organizations, coalition partners, international organizations, and the media. Planning and conducting operations in this environment requires commanders and staffs that are skilled in operational art.

Visualization is one of the abilities that assist commanders and their subordinates with applying operational art. Visualization is also a vital component of battle command. Visualization is the process whereby the commander develops a clear understanding of his current state with relation to the enemy and environment, envisions a desired end state, and then visualizes the sequence of activities that will move his force from its current state to the end state. Commanders use battlefield visualization to develop planning guidance and intent. Planning guidance and intent represents how the commander intends to impose his will on the enemy in order to achieve strategic objectives.

Visualization is a vital skill required for understanding and exercising operational art. Several doctrinal tools aid commanders in their visualization process including operational questions, estimate of the situation, elements of operational design, and forms of maneuver. Operational commanders and staff officers must understand and be able to apply these concepts during operational planning. The Army's officer education system must provide officers with an

in-depth understanding of these concepts. Understanding these concepts enables commanders to systematically address uncertainty and complex situations at the operational level.

Recent research and empirical studies indicate the recognitional / metacognitive decision-making model has the most utility in uncertain and complex situations, such as during operational level decision-making.⁶⁷ The decision making model integrates pattern recognition processes with other cognitive processes necessary for coping with uncertainty, a central feature of operational level decision-making. It enables decision makers to make decisions in complex and uncertain situations. The recognitional/metacognitive model influences the cognitive processes used in visualization.

Battlefield visualization involves three cognitive processes: situational understanding, mental simulation, and metacognitive processes. Each of these processes is supported by a series of strategies and skills. In addition visualization skills depend on the decision maker's experience and creativity. Enhancing these skills is a challenge for educational systems. Educational strategies that repeatedly expose students to complex, uncertain operational decision-making environments have the most potential for enhancing visualization skills. Educational models and exercises reinforce understanding and application of doctrinal tools such as elements of operational design, estimates of the situation, forms of maneuver, and operational questions. This type of strategy relies on experimentation followed by a feedback system that addresses cognitive aspects of decision-making. A study of military theory, history, and doctrine provides the foundation for placing experiences in the context and for expanding the decision maker's experience base. A study of military theory, history, and doctrine linked to multiple decision-making exercises and feedback mechanisms provides the best model for developing visualization skills.

The War College and the CGSOC provide the fundamental requirements for developing visualization skills. Both courses use a combination of theory, doctrine, and history combined with practical exercises as part of their curriculum. The War College and the CGSOC address

operational planning at a level of detail appropriate to the rank of their students. But based on an analysis of the most effective educational methods for improving visualization skills, both colleges could make improvements. The most important improvements include increasing the number of decision making exercises and improving the integration of theory, doctrine, history, and exercises. Other improvements include adding courses that examine decision making theory and providing student textbooks that address critical thinking and visualization skills.

ENDNOTES

¹ US Joint Chiefs of Staff, *JP 3-0, Doctrine for Joint Operations* (Washington, D.C.: Government Printing Office, 1995), pg. II-2.

² See the following references for definition of battlefield visualization: Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 5-1. and Department of the Army, *Fm 101-5, Staff Organization and Operations* (Washington, D.C.: Government Printing Office, 1997), pg. 1-3.

³ *Ibid.*, pg. 1-3.

⁴ US Joint Chiefs of Staff, *Joint Vision 2010* (Washington, D.C.: Government Printing Office, 1996), pg. 17.

⁵ *Ibid.*, pg. 20.

⁶ Department of the Army, *FM 22-100, Leadership* (Washington, D.C.: Government Printing Office, 1999), pg. 1-3.

⁷ Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 5-1.

⁸ Department of the Army. *Training and Doctrine Command Pamphlet 525-70, Battlefield Visualization*. (Fort Monroe: Government Printing Office, 1995), pg. 5.

⁹ *Ibid.*, pg. 4-20.

¹⁰ James P Kahan, Robert Worley, and Cathleen Stasz, *Understanding Commander's Information Needs* (Santa Monica: RAND Corporation, 1989), R-3761-A, pg. 12.

¹¹ Martin Van Creveld, *Command in War* (Cambridge: Harvard University Press, 1985), pg. 265.

¹² This aspect of visualization is unique to the Army.

¹³ Army Science Board, *Battlefield Visualization* (Washington, D.C.: Department of the Army, 1998), Final Report, pg. 1-10.

¹⁴ US Joint Chiefs of Staff, *JP 3-0, Doctrine for Joint Operations* (Washington, D.C.: Government Printing Office, 1995), pg. I-8.

¹⁵ *Ibid.*, pg. I-8.

¹⁶ Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 5-3.

¹⁷ METT-TC is the acronym for Mission, Enemy, Terrain and weather, Troops and support available, Time available, and Civil considerations.

¹⁸ Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 5-6.

¹⁹ See Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 7-10. Joint doctrine does not use forms of maneuver. Future joint publications should include discussion about the forms of maneuver as described in FM 3-0.

²⁰ Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 1-9.

²¹ US Joint Chiefs of Staff, *Joint Vision 2010* (Washington, D.C.: Government Printing Office, 1996), pg. 10.

²² The expansion of the battlefield is described by James J. Schneider's article, "The Theory of Operation Art," in *Theoretical Paper*, (Fort Leavenworth: School of Advanced Military Studies, 1998).

²³ Martin Van Creveld, *Command in War* (Cambridge: Harvard University Press, 1985).

²⁴ Marvin S. Cohen and others, *Training Critical Thinking for the Battlefield, Volume Ii: Training System and Evaluation* (Arlington: United States Army Research Institute, 2000), Technical, 00-2.

²⁵ Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 127.

²⁶ Marvin S. Cohen and others, *Training Critical Thinking Skills for Battlefield Situation Assessment: An Experimental Test* (Arlington: United States Army Research Institute, 1996), Final, 1050, pg. 2.

²⁷ Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 8.

²⁸ Gary A. Klein advances the rapid recognition primed decision-making model in his book *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999).

²⁹ Marvin S. Cohen and others, *Rapid Capturing of Battlefield Mental Models* (Fort Leavenworth: United States Army Research Institute, 1995), Technical Report 95-3, pg. 6.

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- ³⁰ Ibid., pg. 7.
- ³¹ Klein, Gary, Sterling Wiggins, and John Schmitt. *Cognitive Aspects of Replanning at Army Division-Level Command Posts*. Arlington: Defense Advanced Research Project Agency, 1999. Final Technical Report, pg. 11.
- ³² Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999).
- ³³ Cohen and others, *Training Critical Thinking Skills for Battlefield Situation Assessment: An Experimental Test*. (Arlington: United States Army Research Institute, 1996). Final Report 1050, pg. 2.
- ³⁴ Marvin S. Cohen, Jared T. Freeman, and Bryan Thompson, *Critical Thinking Skills in Tactical Decision Making: A Model and a Training Strategy* (Arlington: Cognitive Technologies, Inc., 1996), pg. 7.
- ³⁵ Marvin S. Cohen and Jared T. Freeman, *Thinking Naturally About Uncertainty* (Arlington: Cognitive Technologies, Inc., 1997), Final Report, pg. 5.
- ³⁶ Marvin S. Cohen and others, *Rapid Capturing of Battlefield Mental Models* (Fort Leavenworth: United States Army Research Institute, 1995), Technical Report 95-3, pg. 7.
- ³⁷ Ibid., pg. 5.
- ³⁸ Gary A. Klein also discusses how decision makers use mental simulations in his book *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999).
- ³⁹ Marvin S. Cohen and others, *Rapid Capturing of Battlefield Mental Models* (Fort Leavenworth: United States Army Research Institute, 1995), Technical Report 95-3, pg. 9.
- ⁴⁰ Cohen and others, *Training Critical Thinking for the Battlefield, Volume II: Training System and Evaluation* (Arlington: United States Army Research Institute, 2000). Technical Report 00-2.
- ⁴¹ The Visualization Model is based on conclusion developed from the following sources: Shawn A. Noble and Jon J. Fallesen, *Identifying Conceptual Skills of Future Battle Commanders* (Alexandria: United States Army Research Institute, 2000), Final Technical Report 1099. and Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999).
- ⁴² Noble, Shawn A., and Jon J. Fallesen. *Identifying Conceptual Skills of Future Battle Commanders*. (Alexandria: United States Army Research Institute, 2000). Final Technical Report 1099, pg. 21. Also refer to: Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 45.
- ⁴³ Department of the Army, *FM 3-0 (Drag Edition), Operations* (Washington D.C.: Government Printing Office, 2000), pg. 11-14.
- ⁴⁴ See the following references: Kahan, James P, Robert Worley, and Cathleen Stasz. *Understanding Commander's Information Needs*. (Santa Monica: RAND Corporation, 1989), R-3761-A. and Jared T. Freeman and Marvin S. Cohen, *Methods for Training Cognitive Skills in Battlefield Situation Assessment* (Fort Leavenworth: U.S. Army Research Institute for the Behavioral and Social Sciences, 1997), Final Report 97-07.
- ⁴⁵ Freeman, Jared T., and Marvin S. Cohen. *Methods for Training Cognitive Skills in Battlefield Situation Assessment*. (Fort Leavenworth: U.S. Army Research Institute for the Behavioral and Social Sciences, 1997). Final Report, 97-07.
- ⁴⁶ Cohen and others, *Training Critical Thinking Skills for Battlefield Situation Assessment: An Experimental Test*. (Arlington: United States Army Research Institute, 1996). Final Report 1050.
- ⁴⁷ Noble, Shawn A., and Jon J. Fallesen. *Identifying Conceptual Skills of Future Battle Commanders*. (Alexandria: United States Army Research Institute, 2000). Final Technical Report 1099, pg. 60. Also refer to: Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 45.
- ⁴⁸ Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 89.
- ⁴⁹ Ibid., pg. 178.
- ⁵⁰ Ibid., pg. 213.
- ⁵¹ The same metacognitive processes apply to visualization and decision-making. Visualization and decision-making are intertwined processes that rely on many of the same mental skills.
- ⁵² Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 22.
- ⁵³ Thomas S. Wallsten, *Cognitive Processes in Choice and Decision Behavior* (New York: Houghton Mifflin Company, 1982), pg. 3.
- ⁵⁴ John Shanteau, "Competence in Experts: The Role of Task Characteristics," *Organizational Behavior and Human Decision Processes* 53 (1992).
- ⁵⁵ Gary A. Klein, *Sources of Power: How People Make Decisions* (Cambridge: MIT Press, 1999), pg. 105.

⁵⁶ The following book provides an overview of leading theories about creativity: George F. Kneller, *The Art and Science of Creativity* (New York: Holt, Rinehart, and Winston, Inc., 1987).

⁵⁷ James J. Schneider, "How War Works: The Origins, Nature, and Purpose of Military Theory," in *Military Theory Readings* (Fort Leavenworth: School of Advanced Military Studies, 1995), pg. 7.

⁵⁸ United States Army Command and General Staff College, *CGSC Pamphlet 350-1* (Fort Leavenworth: Government Printing Office, 2000).

⁵⁹ United States Army Command and General Staff College, *Fundamentals of Operational War Fighting* [Internet] (Department of Joint and Multinational Operations, 2001, accessed 07/12/2001); available from www.cgsc.army.mil/djmo.htm.

⁶⁰ United States Army Command and General Staff College, *The Evolution of Modern Warfare* [Internet] (Combat Studies Institute, 2000, accessed 7/12/2000); available from www.cgsc.army.mil/csi/courses/c600/LSN%20011sn01.htm.

⁶¹ *Ibid.*

⁶² United States Army War College, *Student Pamphlet, 2001* (Carlisle Barracks: Government Printing Office, 2000), pg. 4.

⁶³ *Ibid.*, pg. 7.

⁶⁴ Department of the Army, *FM 6.0, Command and Control (Final Draft)* (Washington D.C.: Government Printing office, 2000).

⁶⁵ See: Cohen, Freeman, and Thompson, *Critical Thinking Skills in Tactical Decision Making: A Model and a Training Strategy*. (Arlington: Cognitive Technologies, Inc., 1996).

⁶⁶ Frank Heller, *Decision Making and Leadership* (New York: Cambridge University Press, 1992), pg. 11.

⁶⁷ Cohen and others, *Training Critical Thinking for the Battlefield, Volume II: Training System and Evaluation* (Arlington: United States Army Research Institute, 2000). Technical Report 00-2, pg. 7.

ABBREVIATIONS

CGSOC.....Command and General Staff Officers Course

FM.....Field Manual

JP.....Joint Publication

MDMP.....Military Decision Making Process

US.....United States

REFERENCE BIBLIOGRAPHY

- Department of the Army. *FM 101-5, Staff Organization and Operations*. Washington, D.C.: Government Printing Office, 1997.
- _____. *FM 22-100, Leadership*. Washington, D.C.: Government Printing Office, 1999.
- _____. *FM 3-0 (Drag Edition), Operations*. Washington D.C.: Government Printing Office, 2000.
- _____. *FM 6.0, Command and Control (Final Draft)*. Washington D.C.: Government Printing Office, 2000.
- _____. *Training and Doctrine Command Pamphlet 525-70, Battlefield Visualization*. Fort Monroe: Government Printing Office, 1995.
- Biondi, Angelo M. *The Creative Process*. Buffalo: D.O.K. Publishers, Inc., 1972.
- Brookfield, Stephen D. *Developing Critical Thinkers*. San Francisco: Jossey-Bass Publishers, 1987.
- US Army Science Board. *Battlefield Visualization*. Washington, D.C.: Department of the Army, 1998. Final Report.
- Cohen, Marvin S, and Jared T. Freeman. *Thinking Naturally About Uncertainty*. Arlington: Cognitive Technologies, Inc., 1997. Final Report.
- Cohen, Marvin S., Jared T. Freeman, Jon J. Fallesen, and Terry A. Bresnick. *Training Critical Thinking Skills for Battlefield Situation Assessment: An Experimental Test*. Arlington: United States Army Research Institute, 1996. Final Report 1050.
- Cohen, Marvin S., Jared T. Freeman, and Bryan Thompson. *Critical Thinking Skills in Tactical Decision Making: A Model and a Training Strategy*. Arlington: Cognitive Technologies, Inc., 1996.
- Cohen, Marvin S., Bryan B. Thompson, Leonard Adelman, Terry A. Bresnick, Martin A. Tolcott, and Jared T. Freeman. *Rapid Capturing of Battlefield Mental Models*. Fort Leavenworth: United States Army Research Institute, 1995. Technical Report 95-3.
- Cohen, Marvin S., Bryan B. Thompson, Leonard Adelman, Terry A. Bresnick, Lokendra Shastri, and Sharon Riedel. *Training Critical Thinking for the Battlefield, Volume II: Training System and Evaluation*. Arlington: United States Army Research Institute, 2000. Technical Report 00-2.
- Cohen, Marvin S., Bryan B. Thompson, Leonard Adelman, Terry A. Bresnick, Lokendra Shastri, and Sharon Riedel. *Training Critical Thinking for the Battlefield, Volume Iii: Modeling and Simulation of Battlefield Critical Thinking*. Arlington: United States Army Research Institute, 2000. Technical Report 00-2.
- United States Army Command and General Staff College. *CGSC Pamphlet 350-1*. Fort Leavenworth: Government Printing Office, 2000.

-
- _____. *The Evolution of Modern Warfare*. Combat Studies Institute, 2000. Available from www.cgsc.army.mil/csi/courses/c600/LSN%2001sn01.htm, Internet. Accessed 7/12/2000.
- _____. *Fundamentals of Operational War Fighting*. Department of Joint and Multinational Operations, 2001. Available from www.cgsc.army.mil/djmo.htm, Internet. Accessed 07/12/2001
- United States Army War College. *Student Pamphlet, 2001*. Carlisle Barracks: Government Printing Office, 2000.
- Crevelde, Martin Van. *Command in War*. Cambridge: Harvard University Press, 1985.
- _____. *The Training of Officers, from Military Professionalism to Irrelevance*. New York: The Free Press, 1990.
- Freeman, Jared T., and Marvin S. Cohen. *Methods for Training Cognitive Skills in Battlefield Situation Assessment*. Fort Leavenworth: U.S. Army Research Institute for the Behavioral and Social Sciences, 1997. Final Report 97-07.
- Heller, Frank. *Decision Making and Leadership*. New York: Cambridge University Press, 1992.
- Irwin, Ash. *The Levels of War, Operational Art, and Campaign Planning*. Camberley: Strategic and Combat Studies Institute, 1993.
- Kahan, James P, Robert Worley, and Cathleen Stasz. *Understanding Commander's Information Needs*. Santa Monica: RAND Corporation, 1989, R-3761-A.
- Klein, Gary A. *Sources of Power: How People Make Decisions*. Cambridge: MIT Press, 1999.
- Klein, Gary, Sterling Wiggins, and John Schmitt. *Cognitive Aspects of Replanning at Army Division-Level Command Posts*. Arlington: Defense Advanced Research Project Agency, 1999. Final Technical Report.
- Klein, Gary A., and Robert Calderwood. *Investigations of Naturalistic Decision Making and the Recognition-Primed Decision Model*. Yellow Springs, OH: Klein Associates, 1990.
- Klein, Gray A., and Jon Weitzenfeld. "Improvement of Skills for Solving Ill-Defined Problems." *Educational Psychologist* 13 (1978): 31-41.
- Kneller, George F. *The Art and Science of Creativity*. New York: Holt, Rinehart, and Winston, Inc., 1987.
- Moore, W. Edgar. *Creative and Critical Thinking*. New York: Houghton Mifflin Company, 1980.
- Noble, Shawn A., and Jon J. Fallesen. *Identifying Conceptual Skills of Future Battle Commanders*. Alexandria: United States Army Research Institute, 2000. Final Technical Report 1099.
- Osborne, Alex E. *Applied Imagination, Principles and Procedures of Creative Problem-Solving*. 3rd Revised Ed. New York: Charles Scribner's Sons, 1963.

Pask, George. *Knowledge and Innovation of Decision Makers*. London (England): Systems Research Development Ltd., 1982.

Pawlak, Andrzej M. "Fostering Creativity in the New Millennium." *Research Technology Management* 43, no. 6 (2000): 32-38.

Schmitt, John F., and Gary A. Klein. "Fighting the Fog: Dealing with Battlefield Uncertainty." *Marine Corps Gazette* August 1996 (1996): 62-69.

Schneider, James J. "How War Works: The Origins, Nature, and Purpose of Military Theory." In *Military Theory Readings*, 11. Fort Leavenworth: School of Advanced Military Studies, 1995.

_____. "The Theory of Operation Art" In *Theoretical Paper*, Fort Leavenworth: School of Advanced Military Studies, 1998.

Shanteau, John. "Competence in Experts: The Role of Task Characteristics." *Organizational Behavior and Human Decision Processes* 53 (1992): 252-266.

U.S., Joint Chiefs of Staff. *JP 3-0, Doctrine for Joint Operations*. Washington, D.C.: Government Printing Office, 1995.

_____. *Joint Vision 2010*. Washington, D.C.: Government Printing Office, 1996.

Wallsten, Thomas S. *Cognitive Processes in Choice and Decision Behavior*. New York: Houghton Mifflin Company, 1982.