Learning to Think for Understanding: Introducing Systems Thinking into Professional Military Education

A Monograph

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Future conflicts that involve combat operations against multiple peer competitors within five domains of operations will inherently involve understanding complex problems. With the continuously changing character of war in mind, it is crucial to examine the current US Army PME curriculum to determine how the US Army can best teach its leaders to think and learn for understanding. Understanding is the bedrock of the commander's role in the operation process and the US Army incorporates into all the principles of mission command. The US Army needs to teach additional thinking skills early in PME and continuously build upon those skills at all echelons of PME to facilitate the understanding of complex problems. Systems thinking is a new way to think and learn about different problems. It is a lens that allows one to see the whole, understand, and overcome complexity. Leaders with the cognitive skills to think and learn for understanding complex problems will better understand the operational environment, make decisions faster than the adversary, and maintain the competitive advantage.

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Abstract

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Future conflicts that involve combat operations against multiple peer competitors within five domains of operations will inherently involve understanding complex problems. With the continuously changing character of war in mind, it is crucial to examine the current US Army PME curriculum to determine how the US Army can best teach its leaders to think and learn for understanding. Understanding is the bedrock of the commander's role in the operation process and the US Army incorporates into all the principles of mission command. The US Army needs to teach additional thinking skills early in PME and continuously build upon those skills at all echelons of PME to facilitate the understanding of complex problems. Systems thinking is a new way to think and learn about different problems. It is a lens that allows one to see the whole, understand, and overcome complexity. Leaders with the cognitive skills to think and learn for understanding complex problems will better understand the operational environment, make decisions faster than the adversary, and maintain the competitive advantage.

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Abbreviations

ADDIE	Analysis, Design, Development, Implementation, and Evaluation
ADM	Army Design Methodology
ADP	Army Doctrine Publication
ALA	Army Learning Area
AOC	Army Operating Concepts
AR	Army Regulation
ATP	Army Techniques Publication
BOLC	Basic Officer Leadership Course
COE	Center of Excellence
FM	Field Manuals
GLO	General Learning Outcome
IPB	Intelligence Preparation of the Battlefield
MDMP	Military Decision-Making Process
MDO	Multi-Domain Operations
PME	Professional Military Education
RMA	Revolution in Military Affairs
TRADOC	Training and Doctrine Command
ULO	Unified Land Operations

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Introduction

> There are two main causes for this military shortsightedness: the first is the worship of traditions, and the second is our incapacity to see world forces in their true relationship.
>
> —JFC Fuller, *Foundations of Science and War*

Since the late eighteenth century, the world has seen a consistent evolution in the character of war with every new century offering sets of continuously adapting problems for military leaders to understand. Warfare has evolved from air-land battle to full spectrum operations to unified land operation and now to multi-domain operations.[1] Currently, some of the most complex problems in our history confront the US Army, such as planning for large scale combat operations against multiple peer competitors within five domains of operations. Complex or ill-structured problems present a challenge in that they are comprised of a system of problems and variables that are inter-connected and inter-dependent.[2] Therefore, the more complex the problem, the more important it is to understand the system of problems, its variables and the relationships that exist within it. As national security problems increase in complexity it will become more important that Army leaders have multiple ways to think and learn for that understanding. A leader predicates his ability to generate options and provide solutions to commanders for these complex problems on truly understanding the problem.

The new Army Doctrine Publication (ADP) 6-0, Mission Command, highlights decision-making as an element needed for proper command of an organization.[3] Commanders seek to build and maintain situational understanding to make effective decisions and to assess operations accurately. Indecisiveness and ill-informed decisions from a lack of understanding can cripple the

[1] US Department of the Army, Army Doctrine Publication (ADP) 1, *The Army* (Washington, DC: Government Printing Office, 2019), 2-2.

[2] US Department of the Army, Army Techniques Publication (ATP) 5-0.1, *Army Design Methodology* (Washington, DC: Government Printing Office, 2015), 4-1 – 4-2.

[3] US Department of the Army, Army Doctrine Publication (ADP) 6-0, *Mission Command: Command and Control of Army Forces* (Washington, DC: Government Printing Office, 2019), 1-17.

Army's operations process and collapse the Army's philosophy of mission command. The Army defines understanding as the product of applying analysis and judgement to the relevant information to determine the relationships among variables.[4] Within the Army's leader development program, the education pillar or the professional military education (PME) program, is responsible for building a soldier's cognitive skills and their ability to analyze and assess problems to achieve understanding.

The Army's educational institutions currently teach cognitive skills such as critical and creative thinking at all ranks to better learn for understanding and to better execute doctrinal processes.[5] The Army uses processes such as the operations process, intelligence preparation of the battlefield (IPB), the Army design methodology (ADM), the military decision-making process (MDMP), and troop leading procedures (TLPs) to assist leaders in understanding military problems and generating adaptable solutions to those problems. With the continuously changing character of war in mind, it is crucial to examine the current PME curriculum to determine how else the US Army can best teach its leaders to think and learn for understanding.

The US Army should implement new cognitive skills at varying levels during all officer PME courses to facilitate the understanding of complex problems. Systems thinking is another cognitive skill that can assist leaders in understanding and managing complexity. It calls for learners to ask the right questions to determine the root cause of the problem. It also challenges learners to analyze relationships between variables in an environment from many different perspectives.[6] Teaching systems thinking would fill a curriculum gap that currently causes Army leaders to remain process oriented, linear thinkers who do not have the skills needed to fully

[4] US Army, ADP 6-0, 2-3.

[5] US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Pamphlet (TP) 525-8-2, *The US Army Learning Concept for Training and Education: 2020-2040* (Washington, DC: Government Printing Office, 2017), 21.

[6] Donella H. Meadows, *Thinking in Systems: A Primer* (White River Junction, VT: Chelsea Green Publishing, 2008), 2.

understand problems before trying to solve them and make decisions. Future conflicts that involve multi-domain operations and large-scale combat operations will inherently involve understanding complex problems. Understanding is the bedrock of the commander's role in the operation process and the assimilates it into all the principles of mission command. The implementation of systems thinking into Army PME would disprove JFC Fuller's theory of military short sightedness and ultimately facilitate the foundation of the Army's operation process.

If PME institutions can introduce systems thinking skills early in education and can continuously build on those skills in future levels of PME, it would provide a common language that commanders and staffs can use to properly frame a problem Leaders with the cognitive skills to think and learn for understanding complex problems will better understand the operational environment, make decisions faster than the adversary, and maintain the competitive advantage.

This study will follow a traditional gap analysis approach that examines the current ability to understand military problems with the desired, expected ability to understand future military problems. After defining and analyzing this gap, this study will recommend a plan of action to move our educations system forward and fill in the education gap. I will focus on translating the big ideas of the systems thinking theoretical framework into a cognitive skill that the military can teach and that will enhance the ability for leaders to understand complex problems. The study consists of five main sections. Following the introduction, the literature review will briefly examine the primary research material used to conduct the gap analysis, develop the provided recommendation, and to provide an example of successful implementation. The first section will be an analysis of current and past warfare and a description of the current cognitive skills taught within Army PME and to show why the Army implemented those skills into the curriculums. The second section will be an analysis of future warfare and complex adaptive systems to highlight the types of problems leaders in the Army will face in the future. The third section will be the gap analysis, which will emphasize why the Army's leaders need to

better understand complex problems and how it can best learn for understanding within the PME construct. The fourth section will provide an overview of the principles of systems thinking, describe different sub-skills of the model to show how one can integrate the skill into different levels of education, and show how the military can apply it to understanding complex problems. The fifth section will provide a recommendation on how to implement systems thinking into the PME system how to integrate it into current curriculums. Lastly, I will conclude with a summary of my findings for each section. At completion, this monograph will highlight the need for the Army to teach additional cognitive skills within the PME construct and will provide recommendations for how to introduce and build upon those skills throughout a soldier's career.

Literature Review

Through the lenses of doctrine, theory, and historic sources, I will identify a gap in the Army's education system, present an argument as to why and how the Army needs to fill that gap, and provide historic examples to strengthen my argument. A variety of military and contemporary sources will provide a holistic view of how thinking in systems can improve overall understanding of the world we live in. Many recent studies have identified the complexity of future conflict; however, they fail to address the cognitive skills needed to understand these problems. The goal of this literature review is to provide an overview of sources I have explored while researching systems thinking. It also will demonstrate how my research fits within the Army's continuing efforts in developing an officer's ability to understand complex problems throughout their career.

Recent work in the study of revolutions in military affairs (RMA) has focused on the stark contrast between past/current and future warfare. Many books and doctrinal publications such as *The Dynamics of Military Revolutions: 1300-2050* by MacGregor Knox and Williamson Murray and *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* by Antoine Bousquet have described the past character of warfare as complicated and manageable,

but the character of future warfare as complex and something for which militaries will be ill-prepared.[7] In this study, such books along with the Army's Operating Concepts describe the type of warfare the Army developed its current PME curriculum for. They also describe the future type of warfare the Army needs to revise its PME curriculum for. These assessments of past and future warfare provide the context for the Army's current and future state with regards to its PME program.

Army regulations (AR) and Training and Readiness Command (TRADOC) regulations govern the Army's PME program. They provide both the purpose and proponent for each level of schooling as well as the process used to determine the curriculum at those specific levels. Using these regulations, each proponent produces strategies that further clarifies the outcomes of each level of schooling and aligns resources for the design of the curriculum. Given the outcomes and resources, curriculum directors shape and design tasks into a course and implement it at each level. This study uses these regulations and strategies to describe the current state of cognitive skills taught in the Army's PME program and how the Army implements those skills into operations.

The US Army uses ADPs and field manuals (FM) to direct the conduct of operations by Army forces in the field (and to a limited extent the guidelines for training for operations). It is the language of the profession and the body of professional knowledge that guides how Soldiers perform tasks related to the Army's role: the employment of land-power in a distinctly American context.[8] Within doctrine, the Army describes processes that provide an inherent logic on how to employ and synchronize forces in the conduct of operations. This study uses the key terms and taxonomies in Army doctrine to describe the essential cognitive and physical skills needed for

[7] MacGregor Knox and Williamson Murray, eds., *The Dynamics of Military Revolution, 1300-2050* (New York: Cambridge University Press, 2001), 11.

[8] US Department of the Army, Army Doctrine Publication (ADP) 1-01, *Doctrine Primer* (Washington, DC: Government Printing Office, 2019), 1-1.

officers to use doctrinal processes and to provide reasoning behind why the Army needs to train officers in these skills. By understanding the future state of warfare and current state of PME, this study was able to determine that a gap exists between the cognitive skills taught and the cognitive skills officers need to conduct the processes in current Army doctrine.

In this study, theory helps one understand the dynamics of complexity and systems thinking. Contemporary complexity theory books define complexity, complex-adaptive systems, and complex problems such as *Harnessing Complexity* by Robert Axelrod and Michael Cohen and *Complexity: A Very Short Introduction* by John Holland. Systems thinking theory books such as Jamshid Gharajedaghi's *Systems Thinking: Managing Chaos and Complexity* and Donella Meadow's *Thinking in Systems: A Primer* define the foundations of the skill, describe a model for its use, and identify different sub-skills that one needs to execute this type of thinking. Lastly, military theory books such as Shimon Naveh's *In Pursuit of Military Excellence* show how the military contextualizes complexity and systems thinking within its planning and conduct of operations. This study uses these books to give a general understanding of the importance of systems thinking with regards to complexity, which is the basis for recommending a method of implementation into Army PME.

History and context allow us to learn from other's experiences and enables us to view different perspectives. This study uses a variety of articles to provide examples of how political and social organizations use systems thinking to understand complex problems. Using historic examples allows this study to evolve a theory of action into a recommendation represented within context. John Gaddis states that one can represent history by drawing upon the experiences of others who have encountered similar situations to increase the chances of acting wisely.[9]

[9] John Lewis Gaddis, *The Landscape of History: How Historians Map the Past* (New York: Oxford University Press, 2002), 9.

Lastly, Carl von Clausewitz teaches us that theory cannot equip the mind with the formulas for solving problems, but it can give the mind insight into phenomena and their relationships that let us rise into the higher realms of actions.[10] Recent journals and articles provide an overview of best practices that allow one to scope and scale those practices to an organization or situation. To provide a feasible recommendation, I used both civilian education books and models such as *Taxonomy of Educational Objectives: The Classification of Educational Goals* by Benjamin Bloom and military education guidance such as Training and Doctrine Command's (TRADOC) regulations and pamphlets to gain a basic understanding of how adults learn to understand in civilian and military education settings. This study also used recent articles on implementing systems thinking into education programs to gain some insight as to how other organizations are improving their ability to understand complex systems and problems. With different perspectives and a general framework, this study was able to provide context and create a legitimate theory of action for implementation in the future.

In synthesizing the themes used for this literature review, the main ideas provide the backbone for this study. Although the world's militaries have undergone numerous RMAs, the information age is proving to be one of the more complex. The Army has built its current PME construct using outdated regulations and strategies and has not yet adapted its curriculums to meet the future character of warfare. Army doctrine suggests that the underlying skill needed for officers to properly to organize and employ military forces is "understanding". A gap in skills for officers to understand currently exists in Army PME and to fill that gap, the Army needs to learn how to think for understanding. Systems thinking is a cognitive skill that can breed a learning organization and assist officers in understanding complex problems. The Army should implement this way of thinking early in officer education, integrate into all facets of PME curriculum

[10] Carl von Clausewitz, *On War*, translated and ed by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), 578.

through contextualization, and then scale and scope it as the officer increases in rank and education level to create common language used across Army organizations.

The Current State: How we Got Here

> The central idea of an army is known as its doctrine, which to be sound must be based on the principles of war, and which to be effective must be elastic enough to admit of mutation in accordance with change in circumstances. In its ultimate relationship to the human understanding this central idea or doctrine is nothing else than common sense—that is, action adapted to circumstances.
>
> —JFC Fuller, Foundations of Science and War

Carl von Clausewitz says that war is more than a true chameleon that slightly adapts its characteristics to the given case.[11] To meet the demands of the changing character of war, the US Army continuously updates its doctrine, regulations, and strategies to keep the force trained and ready for the current and next fight. The US Army uses both leader development doctrine and strategies to standardize the progression of leader development, including its PME, for leaders across the Army. The Army's education system provides soldiers the attributes and competencies required to operate successfully in any environment and aims to grow leaders' intellectual capacity to understand the complex contemporary security environment.[12] Thinking skills are those skills that help one formulate or solve a problem, decide, or fulfill a desire to understand. They allow one to search for answers and reach for meaning.[13] Thinking that is deliberate, productive, and purposeful is the core of learning for understanding. The Army implemented critical and creative thinking skills in its PME to adapt and react to the changing character of war, however, these skills were not enough to enable understanding of the non-linear problems the US Army faced in the information age.

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[11] Clausewitz, *On War*, 89.

[12] US Department of the Army, Army Regulation (AR) 350-1, *Army Training and Leader Development* (Washington, DC: Government Printing Office, 2017), 46.

[13] Vincent R. Ruggiero, *The Art of Thinking*, 11th Edition (Upper Saddle River, NJ: Pearson Education, 2015), 4.

The Evolution of Warfare and Its Doctrine

Military historians and analysts alike classify the changing character of war as either a military revolution or a revolution in military affairs. A military revolution is uncontrollable and unpredictable; it fundamentally changes the character of war and brings systemic changes in politics and society.[14] A revolution in military affairs usually aligns itself with a great military revolution and is a less extensive change. RMA's are susceptible to human direction as military organizations simply find new ways to defeat their opponents as they assemble a complex mix of tactical, organizational, doctrinal, and technological changes.[15] They take place almost entirely at the operational level of war. In the last 50 years, the US Army experienced the end of the nuclear military revolution and entered a period of limited warfare where only minor modifications to its doctrine occurred.

After the nuclear revolution and the Cold War, the US Army utilized the technological advances that emerged from its associated RMA and the beginning of great power competition to evolve its doctrine, tactics, and procedures. It wrote the operational level of war back into its doctrine and developed the operating concept of Air-Land Battle in the 1986 version of FM 100-5. The result was complete American victory in the First Gulf War which accentuated the disparity between old and new.[16] Following this victory, the US Army rode the wave of technological successes into the information age and continued to procure sophisticated, high cost weapons with few updates to its doctrine until the September 11th, 2001 terrorist attacks.

In 2001 and 2003, the United States began the Afghanistan and Iraq Wars respectively. These wars presented the US Army with a situation that was different and far less clear than that of the Cold War. As a result, by 2010 Army doctrine focused heavily on counterinsurgency

[14] Knox and Murray, *The Dynamics of Military Revolution: 1300-2050*, 6.

[15] Ibid, 12.

[16] Ibid, 188.

operations. It described the operating environment as complex and uncertain, marked by rapid change and a wide range of threats where threats to the Nation that will originate among diverse populations. It named violent extremist organizations as the most likely threat to US interests as they would facilitate "wars of exhaustion" against the United States.[17] By 2014, Army doctrine began to broaden the aperture of warfare and described the character of war as evolving based on the operational environment, emerging technologies, and changing enemy capabilities.[18] The doctrine described the operating environment as even more complex with more contingencies to plan for. It describes the enemy as emanating from nation states or nonstate actors that would employ traditional, unconventional and hybrid strategies to threaten US security.[19] With increasing levels of complexity and uncertainty in warfare, the technological tools of AirLand Battle were no longer the primary tools of the current conflict.

To provide context to doctrine and guide future force developments and strategies, the Army produces an Army Operating Concept (AOC) roughly every four years that describe how it will conduct warfare during a given timeframe. After several years of unsuccessful strategies in Afghanistan and Iraq, the US Army developed a concept called Full Spectrum Operations (FSO) in 2010 where they combined the old and successful doctrinal concepts of maneuver warfare to gain physical advantages over the enemy with a new concept of wide area security to preserve freedom of movement. These operations allowed the US Army to seize, retain, exploit the initiative, and succeed in wide a range of contingencies.[20] In 2014, the US Army transitioned its concept to Unified Land Operations (ULO), which are efforts across the range of military

[17] US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Pamphlet (TP) 525-3-1, *The United States Army Operating Concept: 2016-2028* (Washington, DC: Government Printing Office, 2010), 10.

[18] US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Pamphlet (TP) 525-3-1, *The United States Army Operating Concept: Win in a Complex World 2020-2040* (Washington, DC: Government Printing Office, 2014), 7.

[19] Ibid, 8.

[20] US Army, TP 525-3-1, *The United States Army Operating Concept: 2016-2028*, 11.

operations to gain and maintain a position of relative advantage to prevent or deter conflict, win in war, and create the conditions for favorable conflict resolution.[21] Both FSO and ULO concepts are predicated on decentralized operations, or mission command, where subordinate leaders are trusted to understand complicated situations and make impactful decisions. The need for competent junior leaders drove the requirement for the US Army to transform its leader development strategy and education system.

Professional Military Education

Army Regulation (AR) 350-1, Army Training and Leader Development, names the US Army's TRADOC as its proponent for its education system and training requirements. AR 350-1 directs that Army leader development efforts fall in three different domains: institutional, operational, and self-development. The institutional domain includes Army centers/schools that provide initial training and subsequent functional and professional military education and training for soldiers and military leaders. Army schools develop individuals throughout their careers for more complex duties and progressively higher positions of responsibility in future assignments.[22] It is the responsibility of Army schools to train and educate soldiers in the core competencies needed for any operating environment.

Within the institutional domain and TRADOC, subordinate schools and centers such as Army University, the Center for Initial Military Training, and war fighting function centers of excellence (COEs) are transforming the Army's education system by growing intellectual capacities to understand complex environments. Schools and centers create and modernize learning strategies to meet the education demands set forth by the new operating concepts and training doctrine and to create a culture of career-long learning. Specifically, the Army University

[21] US Army, TP 525-3-1, *The United States Army Operating Concept: Win in a Complex World 2020-2040*, 46.

[22] US Army, AR 350-1, 3.

creates learning environments required to produce agile, adaptive and innovative leaders across the Total Force in support of the Army Operating Concept.[23]

Army University's strategy strives to enhance learning across the Army by creating a learning enterprise that develops leaders who can accomplish all missions in every environment imaginable.[24] These strategies show the approach that the COEs use to align learning requirements with mission essential and critical tasks and sets the framework for curriculums to meet General Learning Outcomes (GLOs) within the Army Learning Areas (ALAs) framework.[25] GLOs are statements of essential knowledge, skills, abilities, and attributes resulting from training, education and experience at each level along a leader's career.[26] US Army educators use verbiage from Bloom's Taxonomy, a hierarchical ordering of cognitive skills, to assess educational outcomes, objectives, and standards. University is responsible for managing common core learning requirements within PME and ensuring curriculums achieve the GLOs that are developed from critical common Soldier tasks/learning objectives, common skill level, and organizational level shared tasks/learning objectives.[27] By using an outcome-based approach, Army University can predict the Army's common educational needs and adapt to changing operating environments to retain a learning advantage over the its adversaries. It can alter its ability to cultivate the cognitive abilities of all US Army leaders as the environment changes.[28]

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[23] US Army, AR 350-1, 46.

[24] US Department of the Army, The Army University, *The Army Learning Strategy 2017*, 8.

[25] US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Regulation (TR) 350-70, *Army Learning Policy and Systems* (Washington, DC: Government Printing Office, 2017), 24.

[26] US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Pamphlet (TP) 350-70-14, *Training and Education Development in Support of the Institutional Domain* (Washington, DC: Government Printing Office, 2015), 19.

[27] US Army, TP 350-70-14, 73.

[28] The Army University, *The Army Learning Strategy 2017*, 6.

The Implementation of New Thinking Skills

TRADOC and its subordinate schools and COEs are responsible for compiling lessons-learned from the operational training domain to account for the changing character of war. It updates doctrine and tactics, techniques, and procedures and then disseminates this information back to the field; or modifies institutional instruction to address gaps in learning.[29] In the 2010 AOC, the US Army began to describe a more complex operating environment and identified critical and creative thinking as cognitive skills required to solve problems and to process and transform data and information into usable knowledge, across a wide range of subjects.[30] Critical and creative thinking are detailed thinking skills that allow one to reason through a problem and generate solutions. They are associated with the judgement and production phases of the brain that complement each other during problem solving and decision making.[31]

The US Army added these skills into common core curriculums across its PME in 2009 with the implementation of its Leader Development Strategy for a 21st Century Army to account for the cognitive demands that decentralized operations were placing on both junior leaders with little experience. Retired General Martin Dempsey, the TRADOC Commander at the time, argued that possessing an education foundation that enabled operational adaptivity, which includes critical and creative thinking, allowed leaders to deal with the unexpected and make sound choices.[32] ADP 6-0 prescribes that both commanders and staffs apply critical thinking by examining a problem from multiple view points and that they apply creative thinking by developing new and innovative ideas to both old and new, but familiar, problems during decision

[29] US Army, AR 350-1, 3.

[30] US Army, TP 525-3-1, *The United States Army Operating Concept: 2016-2028*, 48.

[31] Ruggiero, *The Art of Thinking*, 7.

[32] Martin E. Dempsey, "Joint Education White Paper", Chairman of the Joint Chiefs of Staff, July 16, 2012, Accessed 20 January 2020, https://www.jcs.mil/Portals/36/Documents/Doctrine/concepts/cjcs_wp_education.pdf?ver=2017-12-28-162044-527.

making.[33] These skills help one transition from intuition to reason and reflect upon on the conclusions made. They help counter experience-based biases and errors in logic. Commanders and staffs apply these skills throughout the operations process and during planning processes such as TLPs and MDMP to help understand the situation and make decisions. At a time when the environment was rapidly changing, military operations required Army leaders to critically think about problems, learn faster than their adversaries, and develop creative solutions to those ill-structured problems. With the environment changing and growing in complexity once again, military operations will require new thinking and learning skills to maintain an advantage over the adversary.

Our Future State: Where We are Going

> There is no avoiding the realities of the information age. Its effects manifest differently in different sectors, but the drivers of speed and interdependence will impact us all. Organizations that continue to use 20th-century tools in today's complex environment do so at their own peril.
>
> —Stanley A. McChrystal

The information revolution and its associated RMA has been ongoing for the last 20 years during which the US Army used advancing technology to fight limited wars and prepare for great power competition. However, the information revolution is enduring and may parallel in magnitude the advent of the modern state. The characteristics of this revolution determine the follow-on RMAs, The Information RMA characteristics include the mobilization of whole peoples through secular ideology, the mechanization of killing through science and tech, and the ultimate terror of thermonuclear annihilation.[34] As the information RMA continues to evolve, so does US Army doctrine. In 2017, the US Army produced its first description of multi-domain operations (MDO) where it elaborated on the increasing complexity of operations and stressed the

[33] US Army, ADP 6-0, 2-4.

[34] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 11.

importance of developing a new understanding of the future operating environment. This new future operating environment will be comprised of complex adaptive systems trying to survive in competition and conflict and will present the US Army with complex and unfamiliar problems that cannot be merely understood by using one's experiences; they must be analyzed and reflected on. As the early Greek imagination envisaged, the past and the present is in front of us–we can see them. The future, invisible, is behind us. Only a few very wise men can see what is behind them.[35]

The Future Character of War

Changes in information technology that allow for the rapid dissemination of information through the internet and the 24/7 media are leading the way in the information revolution. However, by themselves changes in technology do not create and preserve a revolution; changes in society and politics accompany them and are the catalyst for the change in the character of war. Williamson Murray, a military historian, describes the information RMA as a time where militaries are digitizing the battlefield and using information systems to correlate data rapidly from many sources to gain superiority and allow for a quick victory with low casualties.[36] The information revolution and its associated RMA is breaking down barriers between processes that we once isolated in time or space. Robert Axelrod and Michael Cohen argue that the Information Revolution will beget a complexity revolution and it will change the way people understand social, political, and economic systems.[37]

This complexity revolution also changes the way we understand military systems and operations. Military options now go beyond the traditional three domains of land, air, and sea as

[35] Bernard Knox, *Backing into the Future* (New York: W.W. Norton & Company, 1994), 11.

[36] Williamson Murray, *America and the Future of War* (Stanford, CA: Hoover Institution Press, 2017), 31.

[37] Robert Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier* (New York: Basic Books, 2000), 29.

these information systems operate in the information space which includes cyberspace and space domains. Operations in these domains reflect our present understanding of the world in terms of information and networks where strategists and operational artists explicitly link military art and science by deploying scientific ideas and methodology such as complexity and chaos into their operations.[38] The digitization of the battlefield and operations in new domains certainly present different opportunities to gain a clearer understanding of those interactions and execute scientific warfare, but they also present new vulnerabilities for the enemy to exploit. As Clausewitz says, the art of war is not static and with every advance the US Army makes so does an enemy, "he dictates to me as much as I dictate to him."[39] Scientific warfare coupled with human dynamics only increase the intricacy of the environment where studying their interactions and viewing it as a complex system becomes extremely important to understanding unfamiliar problems.

Complexity, Complex Systems, and Unfamiliar Problems

Scientists, sociologists, and phycologist have studied complexity for many years, however; with the coming of the information age, some now consider it a character of warfare. John Holland, a leading figure in the study of complexity defines it as a noun describing objects or systems with many interconnected parts, but also argues that the definition is not rigorous due to the inability to accurately measure the interconnectedness of properties.[40] Because complexity is difficult to define and recognize, it can often cause problems for planners in organizations including the US Army. Dietrich Dorner states that great complexity places high demands on planners' capacities to gather information, integrate, and determine effective solutions.[41]

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[38] Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity*, 2-3.

[39] Clausewitz, *On War*, 77.

[40] John Holland, *Complexity: A Very Short Introduction* (Oxford, UK: Oxford University Press, 2014), 1-3.

[41] Dietrich Dorner, *The Logic of Failure: Why Things Go Wrong and What We Can Do to Make Them Right* (New York: Metropolitan Books, 1996), 38.

Therefore, US Army planners must consider a situation's complexity and a problem's complexity prior to responding. Although, it is nearly impossible to quantify complexity, we often discuss complexity in the context of a complex systems so that we can better understand the interrelations between variables and better understand the situation we face.

A system is an interconnected set of elements that coherently organizes itself in a way that has a purpose or achieves something.[42] According to many systems researchers, a system can demonstrate many behaviors or properties such as self-organization, adaptive, dynamic, but most commonly they display emergent properties and purposeful behavior. Jamshid Gharajedaghi describes an emergent property as the property of the whole and not its parts, a product of interactions that simple tools cannot easily manipulate, and the property is reproduced continuously in real time.[43] Additionally, Holland describes complex systems as systems with elements that have feedback loops or elements that adapt in response to interactions with other elements creating new opportunities for other elements to adapt.[44]

Systems are also comprised of two different types of relationships: linear which one can describe as cause and effect and non-linear where the cause does not produce a relative effect. Feedback loops, both positive and negative, are how a system manages itself and adapts. Donella Meadows states that feedback loops create persistent behavior over time and can be either balancing or reinforcing.[45] These feedback loops increase the complexity of the system and challenges analysts to identify the large number of interactions occurring and their purpose. Dorner claims that the need to see problems as complex systems rarely arose in the past and our current habits of thought do not allow us to understand the types of problems we will face making

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[42] Donella H. Meadows, *Thinking in Systems: A Primer*, 11.

[43] Jamshid Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture* (3rd ed. Amsterdam: Morgan Kaufmann, 2011), 46.

[44] Holland, *Complexity: A Very Short Introduction*, 8.

[45] Meadows, *Thinking in Systems: A Primer*, 25-28.

everything seem complex.[46] However, if we learn to understand and can recognize the problems we face, we can exploit the complexity to better understand the demands needed to generate solutions.

Problems can vary in complexity and familiarity and range from well-structured to ill-structured or complex. Leaders often identify well-structured problems using intuitive thinking and when the elements of the problem show little interactivity. However, ill-structured problems are complex and dynamic and are the most challenging to understand and solve.[47] Additionally, there will not be just one problem in a complex environment; it will consist of a system of problems with no clear solution. When a complex problem exists, leaders must give purpose to the problem and establish goals to help generate solutions and continue planning. Gary Klein states, that to understand and solve ill-structured problem leaders must clarify the situation and their goals at the same time they are trying to achieve them, because actions will change the understanding of the problem.[48] Leaders that constantly re-evaluate their understanding of the situation, their goals, and the ongoing interactions facilitate the development of multiple solutions. With complex and adaptive adversary systems now contesting operations in all domains and unfamiliar or ill-structured problems presenting themselves to leaders, the US Army once again had to revise its operating concept.

Multi-Domain Operations

In December 2018, the US Army produced *The US Army in Multi-Domain Operations 2028*, which proposes detailed solutions to the specific problems posed by the militaries of post-industrial, information-based, peer states, refines its warfighting concept and provides the

[46] Dietrich Dorner, *The Logic of Failure: Why Things Go Wrong and What We Can Do to Make Them Right*, 6-7.

[47] US Army, ATP 5-01, 4-2.

[48] Gary Klein, *Sources of Power: How People Make Decisions* (Cambridge, MA: Massachusetts Institute of Technology Press, 1998), 141.

azimuth for future operations. The *MDO* concept highlights four interrelated trends that are shaping the new operating environment. Adversaries are contesting all domains and one cannot assume U.S. dominance; smaller armies now fight on an expanded battlefield that is increasingly lethal; nation-states have more difficulty in imposing their will within a politically, culturally, technologically, and strategically complex environment; and near-peer states more readily compete below armed conflict making deterrence more challenging.[49] These four trends are inherently complex in themselves, but when considered as interrelated, they present an environment that resembles a complex adaptive system that the US Army has not fought in before as seen in Figure 1. Adversaries have expanded the battlefield in time, domains, geography, and actors by operating in the information space; which creates distinct physical, cognitive, and operational characteristics.[50] Therefore, it must build a new understanding of the future operational environment and understand the interrelationships within friendly and enemy systems before it can execute MDO and compete with and defeat peer threats.

[49] US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Pamphlet (TP) 525-3-1, *The United States Army in Multi-Domain Operations: 2028* (Washington, DC: Government Printing Office, 2018), vi.

[50] US Army TRADOC, TP 525-3-1, *The United States Army in Multi-Domain Operations: 2028*, 8.

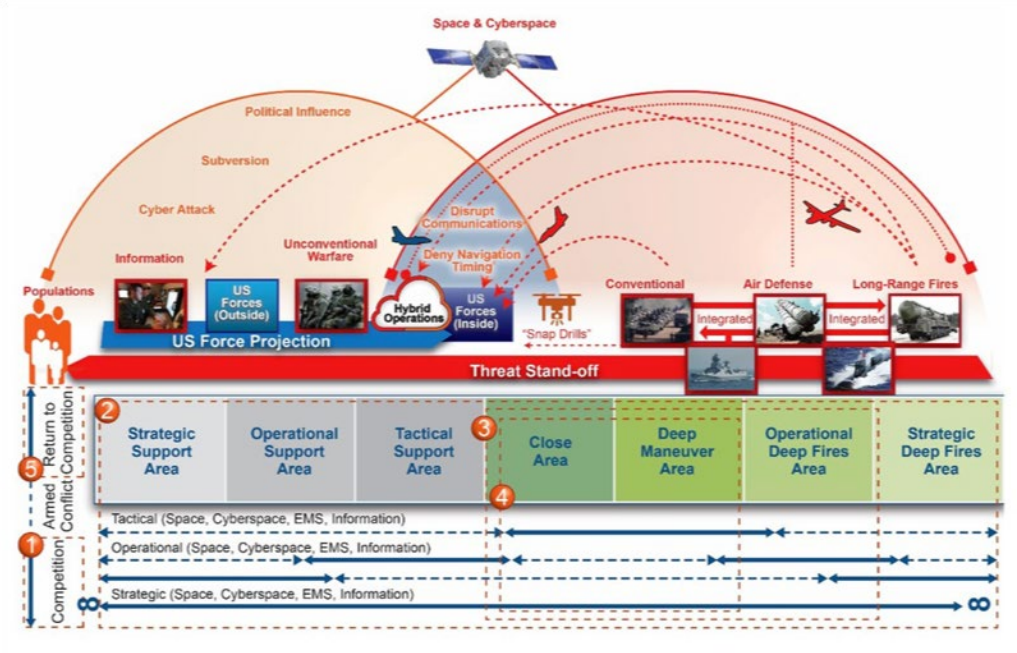

Figure 1. Problems Superimposed on the MDO Framework. US Department of the Army, Training and Doctrine Command (TRADOC), TRADOC Pamphlet (TP) 525-3-1, *The United States Army in Multi-Domain Operations: 2028* (Washington, DC: Government Printing Office, 2018), 16

The *MDO* operating concept highlights three core tenets: calibrated force posture; multi-domain formation; and the convergence of time; space, and capabilities. Convergence is the central and most complex tenet that allows the US Army to solve the problem of multi-layered standoff. It achieves the rapid and continuous integration of all domains across time, space and capabilities to overmatch the enemy and is enabled by mission command and disciplined initiative.[51] Physical, virtual, and cognitive capabilities across the domains and functions possess different time and space characteristics that govern how they can be employed.[52] Therefore, converging capabilities requires a temporal and spatial understanding of the complex environment to identify the decisive spaces where operations can be the most effective. Robert Leonhard states there is no understanding of warfare apart from time; space cannot exist without

[51] US Army TRADOC, TP 525-3-1, *The United States Army in Multi-Domain Operations: 2028*, vii.

[52] US Army TRADOC, TP 525-3-1, *The United States Army in Multi-Domain Operations: 2028*, C-7.

time as time comes before, follows, and orders the sequence and tempo of operations; it simply defines political and military power.[53]

Convergence establishes itself on the US Army's philosophy of mission command and the ability to make decisions. This need for understanding emphasizes the importance of applying analysis and judgment to determine the relationship between operational and mission variables to make those decisions.[54] Units at all echelons must first rely on their cognitive skills and training to recognize the characteristics of friendly and enemy complex systems and second exercise disciplined initiative to converge capabilities and design solutions that take advantage of friendly superiority or that affect the adversary's system.

The Gap: Where PME Falls Short

The noun "understanding" has been in Army doctrine for many years, however in 2019 the Army formally gave that noun a definition and never has it been so important. The information age presents the US Army with complex and unfamiliar problems that leaders at all echelons will need to understand to make timely decisions. As the Army Learning Strategy states, the complexity of current and future operating environments places tremendous cognitive demands on US Army leaders. The Army's education system and the cognitive skills it teaches is a critical component of learning and adapting to the current operating environment. It is responsible for developing leaders that think broadly and contextually about the nature of conflicts and have a working knowledge of the environment.[55] It must go beyond rote memorization and become more about connecting ideas. The Army's education system has adapted its thinking and learning skills once before by adding critical and creative thinking to curriculums and we are now in an era where it is time for PME to adapt again. The cognitive

[53] Robert Leonhard, *Fighting by Minutes: Time and the Art of War* (Santa Barbara, CA: Praeger Publishing, 1994), 4.

[54] US Army, ADP 6-0, 2-3.

[55] The Army University, *The Army Learning Strategy 2017*, 6.

skills currently taught are not enough to enable understanding complexity. The US Army needs to implement new learning skills within its PME system so that it can better understand complex problems within a complex operating environment.

Understanding in the US Army

Understanding is the basis for all action in the US Army as it is the foundation of any decision made. It is also critical for decentralized execution an allows for subordinates to take initiative. The commander or leader at every echelon strives to maintain situational understanding as a problem evolves to not only facilitate decision making but also to share information and support unity of effort throughout the organization.[56] ADP 6-0 stresses that the success of any military operation demands timely and effective decision making and is based on the situation understanding of a particular situation, but also recognizes times of uncertainty that preclude perfect understanding.[57] Commanders and leaders will choose one of two approaches to make decisions: intuitive or analytic or as Daniel Kahneman describes, they will use System 1 or System 2 thinking. In System 1 thinking, a leader has some expertise or experience in the situation and an intuitive solution comes to mind and is likely correct; but in System 2 thinking the leader switches to a more deliberate form of thinking which helps reason through complex situations.[58] Effective leaders will consider their own and their organization's experiences as well as time when choosing a decision-making approach.[59] Whether due to the complexity of the situation, lack of experience, or time available; it is when a leader chooses analytic decision-making that developing understanding of the situation and operating environment becomes important.

[56] US Army, ADP 6-0, 1-8.

[57] Ibid, 2-3.

[58] Daniel Kahneman, *Thinking Fast and Slow*, 12-13.

[59] US Army, ADP 6-0, 2-5.

The US Army uses several processes to assist leaders in understanding the operational environment, making decisions, and leading their formations. Processes such as mission command and the operations process provide the fundamentals needed for commanders to guide their staffs during planning and the major activities the staff does during planning. Processes such ADM, MDMP, TLPs, and IBP are planning processes that help commanders and staffs understand the situation, visualize a future state, and develop ways to reach that future state. Conducting these processes allows leaders to add meaning to data, information, and knowledge (Figure 2) and involves continuous learning to account for changes in the situation.[60] Accounting for changes in the situation allows leaders to maintain situational understanding and make decisions faster. When commanders can synthesize the interrelated issues to see the whole picture, they can better direct their staffs during planning.

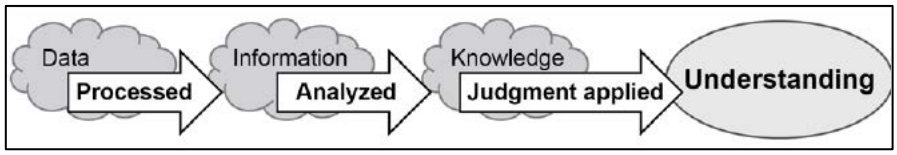

Figure 2. Achieving Understanding. US Department of the Army, Army Doctrine Publication (ADP) 6-0, *Mission Command: Command and Control of Army Forces* (Washington, DC: Government Printing Office, 2019), 2-4

The first fundamental of planning is understand the situation and develop solutions to problems.[61] Doctrine combines these two tasks because understanding the environment directly leads to identifying and framing the correct problem to solve, which further improves one's understanding. An operational problem exists when there is an inconsistency between the way something is and should be and can impede commanders from achieving their objectives or achieving their desired end state.[62] Making sense of the environment and the problem allows for

[60] US Department of the Army, Army Doctrine Publication (ADP) 5-0, *The Operations Process* (Washington, DC: Government Printing Office, 2019), 2-1.

[61] US Army, ADP 5-0, 2-3.

[62] US Army, ATP 5-01, 4-1.

commanders and staffs to move towards visualizing available options and solutions. Although, some problems may not have defined solutions.

When leaders face an ill-structured problem, they must be cautious of developing their understanding of the situation through their experiences and the military processes. Many experiments have shown that experts in different fields can perceive things such as discriminations, patterns, and alternative perspectives allowing for them to make quality intuitive decisions quickly. However, there is peril in expertise within a complex adaptive system. Kahneman describes this trap as "what you see is all there is" where he says one takes the information they have, constructs a story, believes it, and ignores their own ignorance.[63] System 1 thinking can also present an illusion that we understand the situation based off history and past experiences. Kahneman says the sense-making machinery of System 1 makes us see the world simpler and more predictable than it really is.[64] The use of intuition blinds one to the interrelationships in a system and allows one to generate simple causes and effects in a situation.

Dietrich Dorner calls this expertise or intuition ones "reality model" and says it can be right or wrong, complete or incomplete.[65] He also states that in times of uncertainty, an individual's reality model has a high probability it will be both wrong and incomplete and the desire for security prevents them from accepting their ignorance.[66] This trap can especially hold true when leaders settle for the information they have must make decisions under a time constraint. To counter this trap, especially in times of uncertainty, leaders must be willing to admit ignorance and if time permits, continue to strive for understanding. To best prepare leaders

[63] Kahneman, *Thinking Fast and Slow*, 201.

[64] Ibid, 204.

[65] Dorner, *The Logic of Failure: Why Things Go Wrong and What We Can Do to Make Them Right*, 41.

[66] Ibid, 42.

for uncertain times and complex problems, the US Army must use PME to give them new ways of thinking and learning for understanding.

Learning for Understanding

Merriam-Webster's dictionary defines the noun understanding as having a mental grasp or the power of comprehension; simply the ability to understand or be familiar with the character or propensities of something.[67] In Bloom's Taxonomy, comprehension follows knowledge and he defines it as translating facts and ideas into meaning, interpreting those facts and ideas into a new configuration, and finally being able to make some use of those facts and ideas in an estimate or prediction.[68] The 2001 revised version of Bloom's taxonomy replaces the word comprehension with understanding, seen in Figure 3, and defines it as the ability to construct meaning from different types of functions be they written or graphic messages or activities like interpreting, exemplifying, classifying, summarizing, inferring, comparing, or explaining.[69] Finally, the US Army defines understanding in the context of a specific situation as knowledge that has been synthesized by applying judgment to comprehend the situation's inner relationships, to ultimately enable decision making and drive action.[70] It is clear by all three definitions that understanding is the precursor to being able to use information for future action; however it is also clear that understanding is not just intuitive and based off experiences; one must synthesize it from data, information, and other knowledge presented.

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[67] Merriam-Webster Dictionary, s.v. "Understanding", accessed January 26, 2020, https://www.merriam-webster.com/dictionary/understanding.

[68] Benjamin S. Bloom et al, ed., *Taxonomy of Educational Objectives: The Classification of Educational Goals* (London, WI: Longmans, Green, and Co LTD, 1956), 89-90.

[69] Lorin W. Anderson and David R. Krathwohl, eds., *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Longman, 2001), 67.

[70] US Army, ADP 6-0, Glossary-4.

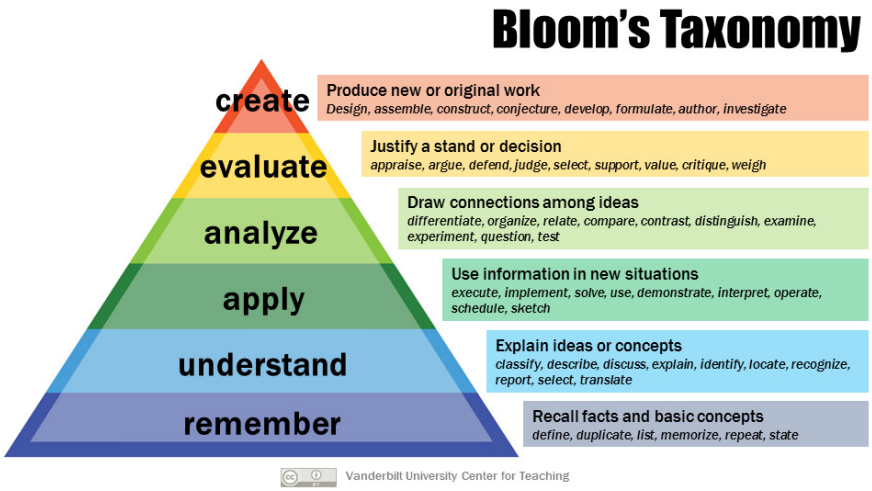

Figure 3. Blooms Taxonomy. Vanderbilt University Center for Teaching. Accessed 20 January 2020. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Learning for understanding involves multiple cognitive skills to synthesize information combined with experience. It is an emergent property that evolves from visualizing the relationships within an environment, critically analyzing the information given, and then making meaning out of that information. Seeing the relationships in an environment allows leaders to view it as a system.[71] When leaders view the environment as a system, they can see the elements are not working in isolation and are working to achieve something greater than its individual parts. Additionally, the behavior of a system is its propensity or its performance over time. The analysis of this behavior over time provides clues to the system's structure and is the key to understanding not only what is happening, but also why it is happening.[72] Critical thinking involves the judgment of information, asking the right questions, and essentially a process for improving the reactions and beliefs that each of us make.[73] This allows leaders to gain a deeper understanding of the information before making meaning of it. Making meaning allows leaders to restore the differences from what is initially perceived to what is actually happening and remain

[71] Donella Meadows, *Thinking in Systems: A Primer*, 11.

[72] Ibid, 89.

[73] M Neil Browne and Stuart M Keely, *Asking the Right Questions: A Guide to Critical Thinking, 8th ed.* (Upper Saddle River: Pearson Education, 2007), ix.

in touch with a situation that is uncertain.[74] Once leaders make meaning of the information and subsequently act on it, they must reflect in (or during) their action as well as reflect on their action to fully learn for understanding.[75] Peter Schwartz says, looking ahead at the uncertainties allows leaders to foresee surprising events and act with confidence.[76] Having the cognitive skills necessary and being able to use experiences to learn for understanding gives leaders the tools needed to face uncertain situations, think faster than the adversary, and maintain the advantage. Therefore, systems thinking is a skill the US Army must teach to aid in the understanding of future conflict and the problems we will face.

Systems Thinking

> But in war more than any other subject we must begin by looking at the nature of the whole; for here more than elsewhere the part and the whole must always be thought of together,
>
> —Carl von Clausewitz, *On War*

Systems thinking is simply a new way to learn and think about things. Donella Meadows, a world renown systems analyst, expresses that as our world continues to change rapidly and become more complex, systems thinking will help us manage, adapt, and will give us the freedom to identify the root causes of problems and see new opportunities.[77] It is a lens that allows us to see the whole, think for understanding, and overcome complexity. The skill itself involves mastering sub-skills individually such as identifying structure, function, and form and mapping relationships. Then one must put those skills together as a whole within external and internal context and with a purpose. It is useful in many fields spanning from social to physical

[74] Klaus Krippendorf, *The Semantic Turn: A New Foundation for Design* (Boca Raton, FL: Taylor & Francis, 2006), 52.

[75] Donald A. Schoen, *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions* (San Francisco: Jossey-Bass, 1987), 26.

[76] Peter Schwartz, Art of the Longview, 3.

[77] Meadows, *Thinking in Systems: A Primer*, 2.

sciences, management, engineering, and warfare. It is a precursor to solving problems, because we often do not know the correct problem or set of problems we are trying to solve. We label a bundle of problems with a single conceptual label and ignore the fact that the bundle of problems is so ensnarled and that only solving one problem will likely cause others.[78] It sets the stage for critically analyzing the set of problems and developing creative solutions. Leaders across several fields have successfully used it in the past and it will be a critical skill needed for the future.

Systems Thinking: A New Language

As the world continues its progression away from the industrial revolution and further into the information revolution, we must also progress the way we think and the way we express those thoughts. Gharajedaghi states that chaos and complexity are not characteristics of a new reality, but that they are only features of our perceptions and understanding. He states that we see the world in the information revolution as complex, because we use inadequate concepts and language to explain it.[79] The world has relied too long on analytics, rational thought, cause, effect, and linear thinking. In the fast-paced, information laden world of today, citizen challenge nation leaders to find a quick fix to new and unfamiliar social and security problems. However, these types of problems are not simple, they are complex and are often a system of problems. The desire to simplify problems and find a quick fix often leads to more problems. As Peter Senge writes, "today's problems come from yesterday's solutions" as quick solutions simply shift problems from one part of the system to another.[80] Meadows states, at a time when the world is messy, more interconnected, and more rapidly changing then the more ways we can see and learn,

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[78] Dorner, *The Logic of Failure: Why Things Go Wrong and What We Can Do to Make Them Right*, 54-55.

[79] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 25.

[80] Peter Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization* (New York: Doubleday, 1990), 58.

the better.[81] We need to slow down our thinking and begin to use a language of systems and interaction that restructures how we think and will help us learn a new way of seeing and acting in the world.

As stated earlier, a system is an interconnected set of elements that works to achieve something. Systems thinking is about seeing wholes instead of parts. Senge states that systems thinking allows us to see interrelationships and patterns of change rather than just snapshots in time; allows us to see the thing that gives living systems their unique character. It is about understanding the properties of the system's individual elements, its interconnections and feedback, and its purpose within an internal and external context. It helps us break through the feeling of helplessness in a world overwhelmed with complexity as it is a discipline for seeing "structure" in a complex environment.[82] Ultimately, this new way of learning and seeing allows us to see patterns that help us understand the propensity of the system, which will help us understand future complex problems. To operationalize the system thinking skill, one must first learn the foundations in parts to better understand the interactions and the purpose of the whole skill.

Systems Thinking in Parts

One can break down systems thinking into three foundational sub-skills: iterative holistic thinking, mapping relationships and feedback loops, and finally determining external purpose of the system and harnessing complexity to design a future for that system within context. These subskills help to tell the story of the system so that we can use that story to generate solutions. First, to holistically think, we can use Gharajedaghi's method of analyzing the variables of the system by understanding the structure or the components of the system; the function or the outcomes produced by the components; the process or the sequence of activities over time all

[81] Meadows, *Thinking in Systems: A Primer*, 6.

[82] Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*, 69.

within context.[83] Analyzing all three of these perspectives simultaneously within context of the environment combats our natural tendency to apply our pre-conceived notions to a system and is essential to seeing the whole as seen in Figure 4.

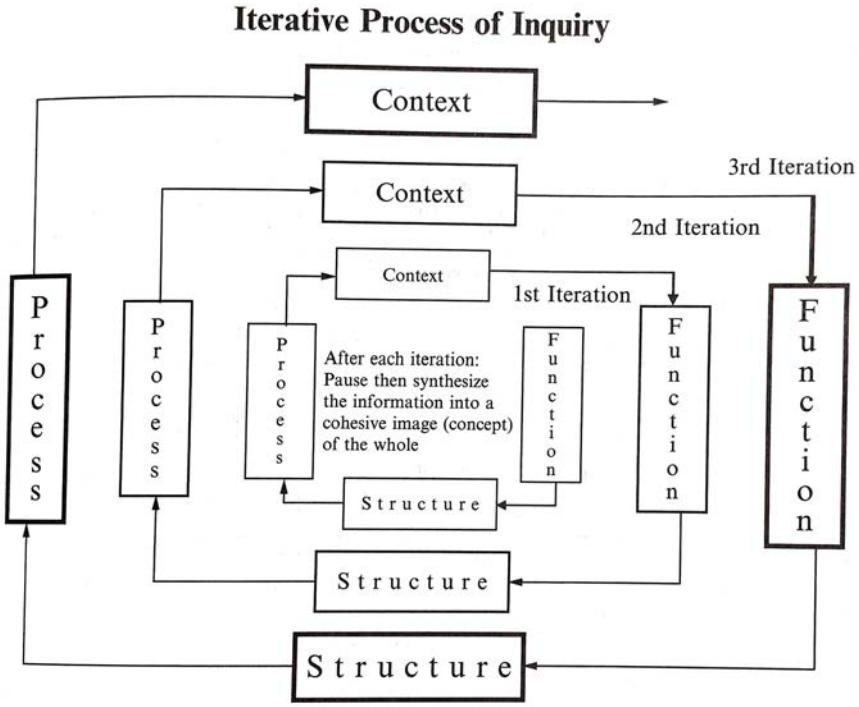

Figure 4. Iterative Process of Inquiry for Understanding Complexity. Jamshid Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, (3rd ed. Amsterdam: Morgan Kaufmann, 2011), 93

It also helps one understand why the components are acting in time and space. Because these four variables form a non-linear relationship, it is essential to iteratively conduct this analysis. Gharajedaghi argues that iteration is the key to understanding complexity as it allows for one to examine the assumptions and properties of each individual component and then in relation to other elements.[84] Identifying the components along with each one's purpose and the sequence

[83] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 90.

[84] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 92.

of their actions allows one to determine the basic connections to other components, which then leads to being able to map the relationships and understand the feedback loops of a larger system.

Mapping relationships and identifying the purpose of those relationships is the next foundational skill of systems thinking. Mapping relationships is about capturing interactions, interconnections, the sequence and flow of activities, and the rules of the system.[85] It is capturing how the system operates, how it organizes itself, how it improves itself, and how it strives for equilibrium all to achieve a purpose. Although a system's organization can include linear relationships, complex systems often have several non-linear relationships that one must identify and attempt to understand. Non-linear relationships are specifically important to identify because they baffle our expectations about action and response relationships and change the relative strength of feedback loops.[86] Senge describes the varying strength of feedback by saying, the harder you push a system, the harder it will push back and try to improve or correct itself.[87] A system organizes itself so that the behavior of the components and the relationships between them capitalize on both reinforcing and stabilizing feedback loops. Reinforcing feedback loops are the engines of growth and stabilizing feedback loops help the system achieve its goal.[88] To truly understand how the system behaves, one must realize that the system operates in beats or periodic repeats of operations that create a hidden order exists to generate wholes out of its parts.[89] Understanding the unique organization of the components helps one understand its emergent properties, which helps highlight its overall purpose for existing in an external environment.

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[85] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 109.

[86] Meadows, *Thinking in Systems: A Primer*, 92.

[87] Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*, 58.

[88] Ibid, 79.

[89] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 118.

The last foundational skill of systems thinking is the being able to understand the system's components and relationships well enough to determine its external purpose and create feasible wholes out of its parts within context. Understanding external context is key to this sub-skill because one cannot create solutions free from affecting other systems in the external environment. Because systems are surprising and their structure behaves in ways that cause problems, it is important to be able to identify why a system exists within an external environment. It allows one to create new alternatives or solutions for that system and avoid known patterns of behavior that initially created the problems.[90] Bryan Lawson states that design involves a sophisticated mental process capable of manipulating information and blending them all into a coherent set of ideas.[91] It simply allows one to harness complexity and redesign a system structure by modifying, adding, or subtracting feedback loops that changes the overall purpose of the system and helps solves a problem. Harnessing complexity is a way to change the structure of a system to increase performance and exploit the understanding of the system itself.[92] Recognizing complexity helps one ask the right questions to better understand the system and identify areas to exploit. To design a new future for a system is choosing how the system will perform instead of predicting how it will perform.[93] Crafting how a system performs enables us to be less surprised by complex system by learning to expect, appreciate, and use the environment's complexity to our advantage. Being able to successfully influence a system predicates itself on the previous two sub-skills by first understanding the components and then the relationships between them. These sub-skills work together to produce the ability to think in

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[90] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 134-135.

[91] Bryan Lawson, *How Designers Think: The Design Process Demystified*, 4th ed. (Amsterdam: Architectural Press, 2006), 14.

[92] Axelrod and Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, 9.

[93] Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture* 137.

systems which is important to solving problems and achieving desired goals in both socio-culture and military operations.

Systems Thinking in Practice

The world is full of complexity and the information age is exponentially increasing the rate of change and level of uncertainty. Prior to the information age, a linear view of nature allowed reductionist to reduce complex problems to manageable problems. However, with the advent of computers, a non-linear view of nature became pervasive where unpredictable interactions frustrated conventional planning.[94] Leaders can no longer afford to apply linear approaches to non-linear problems. As Tom Czerwinski states, "linearity was expected to win both the Vietnam War and the war on poverty simultaneously in the 1960s and it failed at both".[95] We should expect that future events are going to be more difficult to discern due to the amount of entities interacting. Understanding these interactions gives us a different lens to manage the complexity and "cope" with the environment.[96] The information revolution is transforming the way people think about political, social, and military systems, which gives us more examples to follow when applying systems thinking to a problem.

Social and political systems are the backbone of a functioning society. Peter Checkland describes both systems as human activity systems where self-consciousness and freedom of action creates human intervention.[97] These systems are inherently complex because you cannot always predict the system's interactions due to human action. Problems within a complex system are often unfamiliar where you cannot use a specific model to analyze the problems and

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[94] Thomas J. Czerwinski, *Coping with the Bounds: Speculations on Nonlinearity in Military Affairs* (Washington DC: National Defense University, 1998), 3.

[95] Ibid, 31.

[96] Ibid, 4.

[97] Peter Checkland, *Systems thinking, Systems Practice* (Chichester, UK: John Wiley and Sons, 1981): 115, quoted in Alex Ryan, "What is a Systems Approach." *arXiv by Cornell University*, (10 Sep 2008), 20, Accessed 4 September 2019, https://arxiv.org/abs/0809.1698#.

subsequently use quantitative methods to solve the problems. International relations theory is a good example of a complex socio-political system. Stephen Walt states that no single model or approach can capture the complexity of world politics, therefore, one understands the study of international politics by understanding the relationships between traditional ways of thinking.[98] Robert Jervis also highlights the complexity of socio-political systems by stating states will often infer how another state is going to act by how they act towards others, but if those relationships are only viewed in isolation, observers will often mis-understand the state's policy and intentions.[99] Therefore, we use systems thinking to better understand the complexity of the system, frame the real-world problem, and generate solutions. Because military systems reside within social and political systems, military professionals can use also systems thinking to approach military problems.

Military strategy and operations are prime examples of complex problems within the military system because of the increasing number of elements or components and therefore the potential number of interactions. Although he lived long before the information age, the way Clausewitz thought about military operations is an example of how military professionals use systems thinking in military operations. Alan Beyershen asserts in his essay that change and uncertainty are emphasized in Clausewitz's work as he understood that finding an exact analytical solution to the non-linear problems war poses was unrealistic and that war is in inseparable from its context and is characterized by feedback between its conduct and its ends.[100] Shimon Naveh also uses systems thinking to underpin his theory of operation art, which has transformed our modern-day thinking of military operations. He states military operations are like open systems as

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[98] Stephen M. Walt "International Relations: One World, Many Theories." *Foreign Policy*, no. 110 (Spring 1998), 30.

[99] Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton: Princeton University Press, 1998), 33.

[100] Alan Beyershen, "Clausewitz, Nonlinearity, and the Unpredictability of War" *International Security* 17, no. 3 (Winter 1992/93), 7-8.

they are self-organizing and are dominated by their aim as it provides the focus for the system's performance.[101] He states that because military operations are like systems, it is important to harmonize the dichotomy of steering towards achieving an aim while preventing the dangers of the segregation of separate concrete actions from its various components.[102] For military professionals to arrange separate tactical missions to meet an aim and fuse abstract and mechanical extremes requires the use of cognitive tension and a different mode of thinking.[103] To conduct operational art, leaders' plans must reflect the cognitive tension between the general orientation towards the aim and adherence to the tactical missions by expressing the dynamic interactions between the various elements of action and the aim.[104]

Lastly, the US Army has recently implemented systems thinking as a key concept into its design methodology to assist leaders in the conduct of operational art. ATP 5-0.1 prescribes that leaders use systems thinking to view and learn about the operational environment. It helps leaders understand how a system receives inputs, adapts to those inputs according to its internal logic, and provides outputs to the surrounding environment.[105] Some may argue that military professionals can use traditional analysis processes and thinking skills such as intelligence preparation of the battlefield (IPB) and critical thinking to understand an unfamiliar problem, however, this process only analyzes the function and process and does not allows for the analysts to see the whole. Therefore, military professional should know how to think in systems and apply the skill to solving problems.

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[101] Shimon Naveh, *In Pursuit of Military Excellence: The Evolution of Operational Theory* (London: Frank Cass, 1997), 5.

[102] Ibid, 6.

[103] Ibid, 7.

[104] Ibid, 13.

[105] US Army, ATP 5-0.1, 1-8.

Recommendations and Conclusion

Leveraging PME

The US Army relies on its PME system to continually educate its force and prepare leaders for a constantly changing environment, therefore, PME must also adapt to the changing environment. Its goal is to provide progressive education that prepares leaders to operate in multi-domain environments that are complex, ambiguous and rapidly changing.[106] The US Army's PME system is essential in creating shared understanding and creating a common language amongst leaders. This common language allows for the execution of mission command and allows for commanders to capitalize on subordinate leader's ingenuity, innovation, and decision making.[107] The US Army must introduce the systems thinking language early in the education system to allow for the concepts to grow and mature with a leader's experiences as the leader progresses in their career. In an Army Research Institute (ARI) study about visualizing and understanding complex problems, they found that most participants suggested that the US Army introduce thinking skills such as systems thinking early in the officer's career when they are second lieutenants and continue to develop those skills throughout their career to better visualize and understand complex problems.[108] To stay first-rate, the US Army must create a superior cognitive force by implementing systems thinking skills into PME that gives leaders the skills needed to make sense of information and connect their knowledge to foster better understanding.

To implement the systems thinking skill into PME using the outcome-based approach, the US Army educators use the ADDIE method, which is a deliberate model to design or refine a curriculum that falls under one or more ALAs and supports a specific GLO. Systems thinking

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[106] US Army, AR 350-1, 70.

[107] US Army, ADP 6-0, 1-4.

[108] James Greer, William Weyharauch, Elena Knyshev, et al, *Visualizing Complex Problems* (Fort Belvoir, VA: Army Research Institute, 2018), 27.

would reinforce the human dimension and mission command ALAs and would support the GLOs of soldiers being able to demonstrate competencies of leader and staff roles in mission command. The first phase of the ADDIE process involves analysis of the expected outcome of the development efforts while determining what information to draw upon. This includes conducting a needs analysis for systems thinking, which one can read in sections one, two, and three of this paper. From the need's analysis, the educator determines the outcomes and goals of implementing the skill throughout a soldier's career, which one can see in figure 5. After the analysis phase, the educator enters the design or refinement phase of the process.[109] During this phase, the educator develops objectives, also seen in figure 5, that meet each goal and lay the groundwork for the remainder of the systems thinking curriculum design.

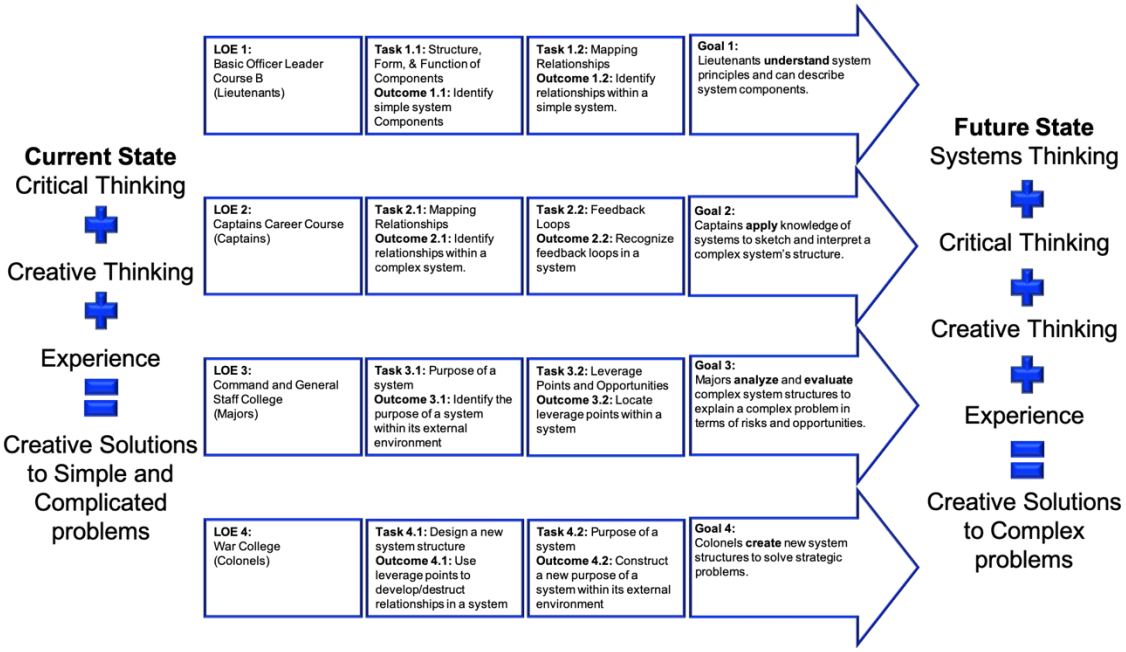

Figure 5. An Approach for Implementing Systems Thinking into PME. Created by Author.

The overall end state of implementing systems thinking would be to teach leaders all the necessary skills in the institutional domain needed to understand the environment well enough to develop creative solutions to complex problems. The need to implement systems thinking into all

[109] US Army TRADOC, TP 350-70-14, 12.

echelons of PME clearly exists and the above chart identifies outcomes and goals that educators can achieve at each of those level. However, educators do not need to design a completely new curriculum to implement this skill. With a short introductory or refresher block of instruction, educators can apply the skill within existing blocks of instruction at each PME echelon.

Implementing Systems Thinking into Current Curriculums

To successfully insert the systems thinking skill into Army PME, educators and instructors would first need to develop an adaptable block of instruction that introduces the basics of the systems principles and how to visualize them. Instructors should use the current model for teaching critical thinking in US Army PME which includes a short block of instruction on the basics of the thinking skill followed by a short practical exercise. Instructors can use this block of instruction to teach or refresh students on the basics of systems and how to visualize them at all PME levels. There are many tools and methods educators can use to add systems thinking into current curriculums. Donella Meadows states that words and sentences come only one at a time in linear, logical order and systems happen all at once and they are connected in all directions; so, to discuss them properly it necessary to use a language that shares some of the same properties: pictures.[110] Drawing is one of the simplest and most common ways to visualize and better understand a system. Dan Roam, a business consultant who helps businesses solve problems faster, states visual thinking is all about solving problems with pictures as it allows one discover ideas that are otherwise invisible and to develop those ideas quickly and intuitively, then simply communicate those ideas.[111] In the same ARI study mentioned above, the second most noted strategy for visualization was drawing as different drawing tools allowed participants to arrange actors, events, and connections to both reflect on their thinking and collaborate with others.[112]

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[110] Meadows, *Thinking in Systems: A Primer*, 5.

[111] Dan Roam, *The Back of the Napkin: Solving Problems as Selling Ideas with Pictures* (New York: Penguin, 2009), 3-4.

[112] Greer et al, *Visualizing Complex Problems*, 13-18.

Teaching students system principles and how to visualize systems early in their career and refreshing these perishable skills permits for instructors to assess these skills in future curriculum blocks. It also allows for instructors to build on these skills and increase the complexity of the problem set as the officer progresses in their career.

There are many opportunities to apply systems thinking to existing curriculums at all levels of officer PME. After commissioning, an officer's PME progression begins with Basic Officer Leadership Course (BOLC) B where each branch proponent produces technically/tactically competent and confident officers by teaching common military skills and branch specific skills. Common military skills include preparing, leading, managing, and training platoons, squads, and teams using Army processes such as TLPs and training management.[113] Army educators can accomplish outcome 1.1 and 1.2 seen in figure 5 by having students identify the different components of a simple company level training system and what each components purpose is in relation to the training system. Additionally, educators can use the basic principles of systems thinking to teach branch specific systems such as artillery fire support systems and intelligence collection systems. For both blocks of instruction, students must use the correct systems language of structure, form, and function as well as a graphic to show the basic components and their basic relationships, which will lay the groundwork to mapping more complex relationships within a system.

As an officer progresses in their career, the scope and scale of their influence and responsibility increases. Once an officer achieves the rank of captain, they attend the Captain's Career Course (CCC) where they receive mid-grade level education and branch specific instruction that integrates their experiences while developing them into critical and creative thinkers who can address complex problems and who are prepared to serve on battalion and

[113] US Army, AR 350-1, 73.

brigade staffs.[114] Army educators can build off the basic systems principles learned in BOLC B by introducing more complex systems where the officer must not only identify system components, but also must identify how the simple systems relate to the larger more complex systems and how those systems improve or balance themselves. Educators can accomplish outcomes 2.1 and 2.2 seen in figure 5 when introducing the officer to battalion and brigade level operations, the operations process, and more complicated planning processes such as MDMP. Educators can use the officer's experience in company level operations to show how those operations interact within larger (battalion and brigade) operations and the feedback loops that exist within the Operations process and MDMP. Additionally, educators can use the systems language to describe both friendly and enemy systems within the MDMP process and evaluate student's ability to recognize how actions both positively and negatively affect a system. This will allow students to apply this skill set at the tactical level and will prepare them to also apply the skill at the operational level of war.

As a major and field grade officer, an officer's responsibility shifts from planning strictly tactical operations and practicing direct leadership to integrating tactical plans into operations and practicing organizational level leadership. At this point in their career, an officer receives intermediate level education (ILE) where instructors educate and train officers for leadership and staff roles at the battalion and higher and advances the art and science of the profession of arms to support operational requirements of the Army.[115] Within ILE there are ample opportunities to integrate systems thinking into the curriculum as officers now have the experience understand how to integrate company and battalion operations into the larger national security system. To do this, students must know the purpose of a system within its external environment (outcome 3.1 in figure 5). This allows for students use systems thinking to locate leverage points within small and

[114] US Army, AR 350-1, 73-74.

[115] US Army, AR 350-1, 75.

larger systems and identify if those points pose risks or provide opportunities when conducting planning processes such as ADM and MDMP to solve operational level problems. Systems thinking helps planners break away from linear and compartmentalized ways of addressing problems; it allows planners to see subtleties, indirect influences, and interactive effects that are important to understanding the complexity of the problem.[116] Additionally, systems thinking helps a field grade officer in transitioning from direct leadership to organizational leadership as they have the skill sets to view their organization as system and can identify how to influence individuals to achieve goals. John Kotter states, the skills needed to lead and influence are both cognitive and interpersonal in nature as they involve the capacity to assess correctly the differences among people and the ability to see the subtle interdependencies among those people.[117] There are numerous opportunities to integrate systems thinking in the current PME system, however, US Army educators and instructors will still need to conduct further research to finalize the development, implementation, and the evaluation phases of the ADDIE process.

With the rise of the information age and the digitization of education, there are many new resources to introduce, teach, and assess the use of systems thinking within the Army's PME system. The US Army already uses wargaming within its planning processes to analyze the systemic effects of decisions on the operational environment, however there are now digital programs within a synthetic training environment that can further illustrate the operating environment as a system so learners can visualize the system and assess the impacts of actions. Additionally, the business community offers simulations in organizational leadership that assist learners in visualizing their organization as a system and assesses their ability to make decisions that influence the organization. With the ability to integrate systems thinking into existing

[116] US Army, ATP 5-0.1, 1-8.

[117] John P. Kotter, *Power and Influence: Beyond Formal Authority* (New York: Free Press, 1985), 38.

curriculums using both traditional and digital methods, the systems thinking skill can improve throughout an officer's career and it can help as the officer faces more complex problems.

Conclusion

US Army doctrine and operating concepts demand that all soldiers and leaders train for uncertainty and be able to exercise disciplined initiative and accept risk. The US Army has highlighted a complex problem to solve, therefore they must rely heavily on subordinate leaders to not just follow orders, but to also think and understand the complex environment enough to converge capabilities in a multi-domain environment. Albert Einstein once said that we cannot solve our problems with the same thinking we used when we created them. Technology cannot be a reason we slight intellectual preparation and it cannot abolish the fog of war and uncertainty. They must think intensely about friendly and enemy systems and how to generate non-linear and innovative options. To do this the US Army must shift training paradigms, educate, equip, and support their most valuable capability, their Soldiers, to execute MDO in all its intensity, rigor, and complexity.[118] The US Army must evolve the way it thinks to match the evolution of warfare. The US Army must develop new ways to better understand the operating environment and the complex problems they will face.

Within its PME system, the US Army currently teaches leaders how to critically think, but it does not teach them how to see the whole picture and visualize the environment as system. When we view the environment as a system we understand that there are initial, secondary, and tertiary effects of our decisions and actions. It forces us to reassess our understanding of the environment and the problem. System thinking precedes critical thinking and sensemaking and is necessary to facilitate situational understanding, view a problem, and generate solutions that allow leaders to harness the current complexity of the environment.

[118] US Army TRADOC, TP 525-3-1, *The United States Army in Multi-Domain Operations: 2028*, 20.

In a time of constant change, agility is vital to forward thinking and producing products that not only meet current requirements but also future requirements. Finding the right balance between variety and uniformity; deciding what interacts with what and when; and deciding what elements we copy or destroy allow one to harness complexity.[119] Within the context of military planning and operations, it is important to consider changing these elements for both friendly and adversary systems to maximize opportunities and options.

Training and educating leaders for uncertainty must always be a key part of the Army's learning strategy, however, it now must go beyond the cultivation of critical and creative thinking skills. The US Army charges leaders with accepting that uncertainty will never be eliminated and to continually strive to maintain situational understanding as the situation evolves.[120] As the operating environment becomes more complex, a leader's ability to combine thinking skills with their experiences to anticipate and make decisions becomes increasingly important. Schwartz says the point is to make strategic decisions that will be sound and no matter what future takes place, you and your organization will be ready for it and influential in it.[121] Only using intuition and experiences will not work in uncertain environments. The illusion of understanding the past quickly feeds the illusion that one can predict and control the future by using intuition.[122] Leaders must use multiple thinking methods including systems thinking to see the whole environment, critical thinking to analyze assumptions, and sensemaking to gain and maintain situational understanding during uncertain environments. And when leaders understand and learn faster than the adversary, they make decisions that keep options open, maintain the initiative, and win future wars.

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[119] Axelrod and Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, 156-157.

[120] US Army, ADP 6-0, 2-3.

[121] Schwartz, *The Art of the Longview: Planning for the Future in an Uncertain World*, xiv.

[122] Kahneman, *Thinking Fast and Slow*, 205.

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