Artificial Intelligence and the Future of Operational Art

A Monograph

by

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Abstract

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Artificial Intelligence (AI) will influence the future of war. Like AI, technology has played a tremendous role in the evolution of warfare to date. History is littered with examples of how technology has shaped the course of warfare. Whether it is Napoleon, leveraging the industrial revolution to enhance his ability to convert mere possibility into cast iron achievements of the *French Armee*, General Helmuth von Moltke's use of the telegraph and railroad to communicate with and mobilize the Prussian Army, or the employment of belt-fed machine guns on a large scale to force the dispersion of western armies in World War I, history is replete with examples. Like the technologies of the past, AI will likely serve as a catalyst for change in the Modern System. This study aspires to contribute to the body of knowledge surrounding AI. It intends to do so by providing the historical context that will serve as a foundation on which to build, create a shared understanding about the current state of AI, and anticipate the potential role of AI in the future of war.

Acronyms

AAR	After Action Review
AI	Artificial Intelligence
CDID	Capabilities Development Integration Directorate
CPU	Central Processing Unit
DNC	Differential Neural Computer
DoD	Department of Defense
IBM	Information Business Machines
IO	Information Operations
MCBL	Mission Command Battle Lab
OODA	Observe, Orient, Decide, Act
RKKA	The Worker's and Peasant's Red Army
RL	Reinforcement Learning
TTP	Tactics, Techniques, and Procedures
UAV	Unmanned Aerial Vehicle
WfF	Warfighting Function
WWI	World War I

Introduction

Since the discovery of Artificial Intelligence (AI), the aim has been the development of an intelligent agent that is capable of achieving human-level intelligence to improve human performance and increase human productivity. John McCarthy first coined the term artificial intelligence in 1955 when he proposed the first AI conference in 1956. The expressed goal was to explore ways to create machines capable of reasoning on a human level to engage in abstract thought, solve problems, and learn on their own.[1] McCarthy believed that the ability to learn along with intelligence itself could be written in such a way that a machine could replicated it. This became commonly known as machine learning and it is written into modern algorithms.[2]

AI is no longer a fantasy relegated to science fiction novels and movies. Moore's law described the continuous doubling of technology.[3] As a result AI is here; it is a part of our everyday lives and most of the modern world is immersed in it. Ray Kurzweil, a pioneer in the field of AI and engineer for Google, refers to this phenomenon as "the law of accelerating returns."[4] The majority of people, however, are not even aware of the many ways in which they use AI.

Some examples of AI in our daily lives are facial recognition, google translate, Siri, and the algorithm that determines what product to advertise on people's webpages. The continuous reduction in advanced software technology has made the majority of AI technology possible. Smartphones and wireless technology allow its users to stay connected all day. The speed of the

[1] John McCarthy, "Computing Science," January 1, 1970, accessed September 26, 2018, jmc.stanford.edu/computing-science/index.html.

[2] World-Information.Org, accessed November 02, 2017, http://world-information.org/wio/infostructure/100437611663/100438659360.

[3] Max Tegmark, *LIFE 3.0: Being Human in the Age of Artificial Intelligence* (VINTAGE, 2018), 69.

[4] Ray Kurzweil, "Kurzweil AI | Accelerating Intelligence," 26 January 2016, accessed September 26, 2018, www.kurzweilai.net/ray-kurzweil-biography.

internet gives users access to information, pictures, movies, music, and even video conferences from anywhere in the world at any time.

The same holds true for the military, whether its twenty-four-hour access to the internet, through our smartphones, tablets, smartwatches, or computers. Social media has proven a powerful tool to spread IO themes and messages. This new information environment has contributed to the creation of a gray zone that is reminiscent of the cold war. A zone in which adversarial forces conduct subversive operations across the range of military operations. This new gray zone allows adversaries to operate just below the threshold for open armed conflict.[5] This new technology also presents tremendous opportunity to optimize performance on both an individual and collective level. Countless apps make it easy to organize and manage many aspects of our lives. From calendars and emails to nutrition and physical fitness programs, Soldiers can optimize their performance in both physical fitness and professional lives. Smart chips embedded in our credit card, military ID cards, and in some cases under our skin has enabled increased operational and physical security.[6]

Now that the technology is affordable and readily available, a pressing question remains: how will the military harness this new technology? It is a question that movies and science fiction novels have been exploring for decades. A major goal of this research paper is to explore existing AI to determine how the military could employ it. This paper will focus on how AI can contribute to the increased cognitive and mental agility of commanders and their staffs. Commanders can leverage this asymmetrical advantage in operational art and mission command through times of peace and war. The scope of this paper will be limited to the tactical and operational level.[7] To

[5] Nora Bensahel, "Darker Shades of Gray: Why Gray Zone Conflicts Will Become More Frequent and Complex," Foreign Policy Research Institute, February 13, 2017, accessed February 19, 2018, https://www.fpri.org/article/2017/02/darker-shades-gray-gray-zone-conflicts-will-become-frequent-complex/.

[6] "Microchips implanted in humans: Practical or perilous," CBS News, CBS Interactive, April 12, 2017, accessed September 26, 2018, www.cbsnews.com/news/microchips-privacy-implants-biohacking/.

do this, the US Army must leverage emergent technologies in Artificial Intelligence to enhance commanders' and their staffs' ability to function as operational artists. Streamlining aspects of mission command as both a Warfighting Function (WfF) and as a philosophy will facilitate operational art within the modern system. The employment of human-machine collaboration will enhance the Army's ability to conduct operational art through increased situational understanding and improved cognition.

Statement of The Problem

The power of computing is rapidly expanding all around us, fundamentally changing the way we work, play and communicate. Moore's Law foreshadowed these breakthroughs in many facets of daily human life.[8] The exponential rate of technological advance has resulted in an evolution to the modern system. The modern system is, "a tightly interrelated complex of cover and concealment, dispersion, suppression, small unit independent maneuver and combined arms at the tactical level and depth, reserve, and differential concentration at the operational level of war."[9] Within this system autonomous weapons will take on greater roles in war, leading to the robotic age.

DoD's third offset strategy has spurred on a robotic age which calls for increased innovation.[10] The presence of unmanned vehicles has become exceedingly pervasive on the modern battlefield. Today, UAVs piloted from a safe distance, thousands of miles away carry out

[7] US Department of the Army, Field Manual (FM) 3-0, Operations. (Washington, DC: Government Printing Office, 2017). 1-5.

[8] "50 Years of Moore's Law," *Intel*, accessed January 18, 2018, https://www.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html.

[9] Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton: Princeton University Press, 2010), 3.

[10] Andrew Ilachinski, *AI, Robots, and Swarms Issues, Questions, and Recommended Studies.* (Technical paper, January 26, 2017) 27.

strikes on enemy targets.[11] Robert Work, who served as a lead the architect of the third offset strategy, said that the focus is not on the autonomous system. According to Work, the focus is on human-machine collaboration to help humans make better decisions much faster.[12] Research and development on artificial intelligence is taking place at a blistering pace and are achieving many of these goals decades ahead of schedule.

The pace of technological advancement during the second offset during the Cold War, which sought an asymmetrical advantage against the Soviet Union, pales in comparison to the pace of technological development in the third offset. Leading up to and throughout the second offset, DoD-funded research developed the majority of advanced technology. The development of robotic technology and AI (third offset strategy), will require DoD collaboration with the private sector companies in the Silicon Valley.[13] To keep pace with artificial intelligence technology, the US would be best served by partnering with many of these private businesses. The key is to fund specific initiatives that meet their needs and the needs of the US Army.

Another major problem that the United States currently faces is other major states and non-state actors. They are investing heavily in the development of artificial intelligence and autonomous robots for their militaries to employ. Russia and China are investing heavily to develop autonomous weapons, artificially intelligent systems and robots.[14] They are also notorious for committing intellectual property theft. In addition to the direct threat posed by the

[11] Jessica Purkiss and Jack Serle, "Obama's Covert Drone War in Numbers: Ten Times More Strikes Than Bush," *The Bureau of Investigative Journalism*, March 28, 2017, accessed January 18, 2018, https://www.thebureauinvestigates.com/stories/2017-01-17/obamas-covert-drone-war-in-numbers-ten-times-more-strikes-than-bush.

[12] "Getting to Grips with Military Robotics." *The Economist*, January 25, 2018, accessed February 01, 2018, https://www.economist.com/news/special-report/21735478-autonomous-robots-and-swarms-will-change-nature-warfare-getting-grips.

[13] Ilachinski, 31.

[14] Patrick Tucker, "Welcome - Defense One," November 8, 2017, accessed January 18, 2018, https://cdn.defenseone.com/a/defenseone/interstitial.html.

two major powers, both have ties to other states that are known enemies of the United States; namely Iran and North Korea.

In the case of Iran, eleven Arab countries have accused it of being to be the largest state sponsor of terrorism in the Middle East.[15] It is with these very real problems in mind that the United States must continue to invest in the development of artificial intelligence. Collaboration with private companies at the leading edge of innovation in artificial intelligence is critical to its success.

Purpose of The Study

The intent of this paper is to evaluate the ways in which artificial intelligence can facilitate the operations process using prevailing AI technology. Additionally, this paper will examine how the US Army can employ AI to enhance a commander's ability to exercise mission command. The Mission Command Battle Lab (MCBL) in the Capability Development Integration Directorate (CDID) is taking the lead in this area. They are currently focused on developing tools that the US Army can use to enhance human capacity and capability through AI.[16]

The MCLB is keeping a keen eye on developments with the potential to enhance mission command and facilitate the operations process. This study will introduce and examine two existing programs, IBM's Watson and Alpha Go. It will assess them through a structured, focused case study analysis that evaluates their stated purpose, the echelon they are intended to operate at, and how the system will accomplish its purpose. [17] It will then look at how they can potentially

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[15] "Iran is 'state sponsor of terrorism,' 11 Arab countries tell UN," *UN Watch*, November 14, 2016, accessed January 18, 2018, https://www.unwatch.org/iran-state-sponsor-terrorism-11-arab-countries-tell-un/.

[16] "Mission Command Battle Lab (MCBL) | US Army Combined Arms Center," accessed September 26, 2018, usacac.army.mil/organizations/mccoe/cdid/mcbl.; US Department of the Army, Training and Doctrine Pamphlet (TRADOC Pam) 525-3-7, The US Army Human Dimension Concept. (Washington, DC: Government Printing Office, 2014).

[17] Detlef F. Sprinz, and Yael Wolinsky-Nahmias. *Models, Numbers & Cases Methods for Studying International Relations.* (Ann Arbor, MI: The University of Michigan Press, 2011), 32.

increase the capacity of a commander and his staff to conduct the operational art throughout the operations process using mission command.

Significance of The Study

With the increasing availability of AI, it is no longer a matter of if militaries will employ it in the future wars but when. The US Army has made it clear that the human dimension is the most important aspect of the future.[18] This means that the US Army will focus efforts on human-AI teaming. What systems will the Army develop to increase the lethality of the modern Soldiers while simultaneously increasing their survivability in the modern system? Just how does the US Army plan to employ this capability? This study plans to serve as the conduit for that conversation to contribute to further understanding and spur curiosity about the future of AI in the execution of the operational art.

Operational art together with mission command and the modern system provide a theoretical framework that serves as the blueprint for this study. This theory provides basic concepts that are valuable in pursuit of increased understanding. The central concepts within operational art that are invaluable to this study include the cognitive aspect, inherent collaboration between a commander and his staff, the need for synchronization across both space and time, and the art of command. Lastly, incorporating the modern system provides an understanding of the space within which leaders must conduct operational art.[19]

This study will explore the benefits of narrow AI on the elements of operational art and on a commander's ability to exercise mission command. [20] Mission command is the doctrinal concept that explains the most effective way to manage an operation.[21] AI has enormous potential

[18] US Army, TRADOC Pam 525-3-7 (2014), 5.

[19] Biddle, 33.

[20] US Army, FM 3-0 (2017), 1-19.

[21] US Army, ADRP 6-0 (2015), 1-2.

to serve as an enabler in many aspects of mission command and operations. The theoretical framework consisting of operational art, mission command, and the modern system provides the requisite context within which this study can explore the potential role of AI in future wars.

Limitations

Given the breadth of information available on the topic of artificial intelligence, this paper will be limited to the evaluation of narrow artificial intelligence that is currently in existence. Additionally, the study will be limited to the concepts that the MCBL within CDID is developing.

Given the historical nature of technologically induced evolutions in war there is little doubt that militaries will weaponize AI. In fact, China and Russia have already begun conducting extensive research and development in AI. They have begun experimenting with autonomous weapons, electromagnetic spectrum warfare and cyberspace.[22] Adversaries are already leveraging this technology to consolidate gains and shape the operational environment while operating in the gray zone.[23] To maintain a competitive edge, the US Army must collaborate with private sector companies to leverage the available technologies that are being developed. If the US Army, does not collaborate with the private sector it will likely fall behind and lose the advantage it currently possesses.

Literature Review

Since the late eighteenth century, war has undergone many evolutions. The technological advent of AI has spurred changes in how the western world lives, from the ways we communicate, interact, shop, and learn. It is now just a matter of time before the proliferation of this new technology will spur the next evolution in the way militaries prosecute wars. How will AI contribute to the next evolution in warfare? To answer this question, this literature review

[22] "Getting to Grips with Military Robotics," *The Economist* (January 25, 2018).

[23] US Army, FM 3-0 (2017), 1-35.

looks at the impacts of cultural and technological discoveries of the nineteenth and twentieth century that spurred previous evolutions.

The American and French Revolutions changed the way nations manned, trained, and equipped their militaries, shaping the western way of warfare. Advances in technology were another major contributor to the evolution in the western way of war. This study will focus on three specific phenomena that occurred as a result of the cultural and technological evolutions that occurred throughout the last two centuries. The theoretical framework will be the operational art, the modern system, mission command. This paper will study the potential role of AI within this theoretical framework.

The conditions that existed throughout the world at the turn of the twentieth century share a striking resemblance to many of the conditions present today. At the turn of the twentieth century, the west found itself in a period of rapid technological change. It is as difficult today as it was then to determine the impact technology would have on warfare.[24] The western world is, as it was then, in the midst of an arms race that is producing complex, costly, and destructive weapons. The specialization of labor within the agencies designed to address these problems reinforces these conditions.[25]

Theories

The three major theories that serve as the framework for this study are the theory of operational art, the modern system, and mission command. It is important to evaluate each theory for the individual contributions they provide. This review will then assess how the individual aspects of each theory respond in relation to one another in order to provide the context within

[24] V.K. Kool, and Rita Agrawal. *Psychology of Technology* (Cham, Switzerland: Springer International Publishing, 2017), 4.

[25] Arden Bucholz. *Moltke, Schlieffen and Prussian War Planning* (Providence R.I.: Berg, 1993), 1.

which militaries conduct modern warfare. The intent is to provide a comprehensive understanding as to the future role of artificial intelligence in warfare using the theoretical framework.

Operational Art

Victory in the modern system is never the result of a single factor. Modern weapons and a professional military are not enough when confronting a near-peer threat. Operational art is the key to a decisive victory. To comprehend operational art, it is essential to understand the area to apply this concept as well as the attributes common to the officers and the operational artists responsible for executing operational art.

Operational Dimension

The Prussian General Helmuth von Moltke the elder first discovered this new dimension.[26] Through extensive professional military education and extensive self-study, General Moltke came to recognize and appreciate the changes occurring on the battlefield in real time. Robert Cotino said, "The elder Helmuth von Moltke emphasized an intermediate level of warfare known as the operational level. It exists in a conceptual space between tactics and strategy. It involves the movement of large units: armies, corps and divisions. Prussian and later German commanders sought to maneuver their operational units in a rapid and daring fashion."[27] Moltke made the requisite changes to Prussian doctrine long before they became conventional military wisdom.[28]

The Soviet Army's chief of staff, Mikhail Tukhachevskii first described the operational dimension in an essay published in 1926.[29] He arrived at this realization by recognizing that the

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[26] Gordon, 291.

[27] Robert Michael Citino. *The German Way of War: From the Thirty Years War to the Third Reich*. (Lawrence, KS: University Press of Kansas, 2012), 306.

[28] Gordon, 513.

[29] Shimon Naveh. *In Pursuit of Military Excellence: The Evolution of Operational Theory*. (London: Frank Cass, 2005), 10.

nature of modern weapons and the increasingly lethal nature of the modern battlefield required armies to operate dispersed and decentralized in order to survive. The increased size of the modern battlefield was such that the destruction of an enemy's army in a single day of battle was no longer possible. Instead, armies would have to execute through a series of battles that would ultimately result in the defeat of the enemy.[30]

Following Tukhachevskii's death, Isserson adopted the concept and continued its theoretical development, authoring *The Evolution of Operational Art*. In the aftermath of Germany's defeat during World War I, he observed that militaries could not convert tactical breakthroughs of the enemy's defensive front into strategic victories. The reason German victories in WWI lacked any military significance was their inability to combine tactical breakthroughs into operational victories.

It was clear that the size and scale of future wars meant that militaries could no longer defeat an enemy force with a single blow, massing a force at a single point at the enemy line. "As a result, the decision was made in the summer of 1931 to create an 'operational department.' The new department was tasked with preparing commanders and staff officers at the Corps, Army, *front* (military district) level, and for the RKKA staff. As this list makes clear, the department's mission was to prepare students for the operational level of war."[31]

Isserson believed that success at the operational level was only possible through combined-arms battle across the entirety of the enemy's front simultaneously.[32] The Red Army developed the concept of deep battle during the interwar period. At the heart of this new approach was the tank.[33] It represented an offensive weapon that had evolved significantly since the end of

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[30] Ibid.

[31] Harrison, Richard W. *Architect of Soviet Victory in World War II: The Life and Theories of G.S. Isserson*. (Jefferson, NC: McFarland & Co., 2010), 93.

[32] Ibid.

[33] Harrison, 66.

WWI. The tanks' increased mechanical reliability, mobility and firepower meant an end to the stalemate that defined the western front for much of WWI. Success at this level would require more than just superiority of men and materiel.

The operational dimension also requires a great deal of critical and creative cognition from army commanders tasked with organizing operational victories.[34] Today's doctrine describes the operational level as a multi-domain extended battlefield. It is an 'interrelationship of the air, land, maritime, space, and the information environment (including cyberspace) …Commanders and staffs are now required to understand the cross-domain capabilities that friendly, enemy, and neutral actors possess within an operational environment.'[35]

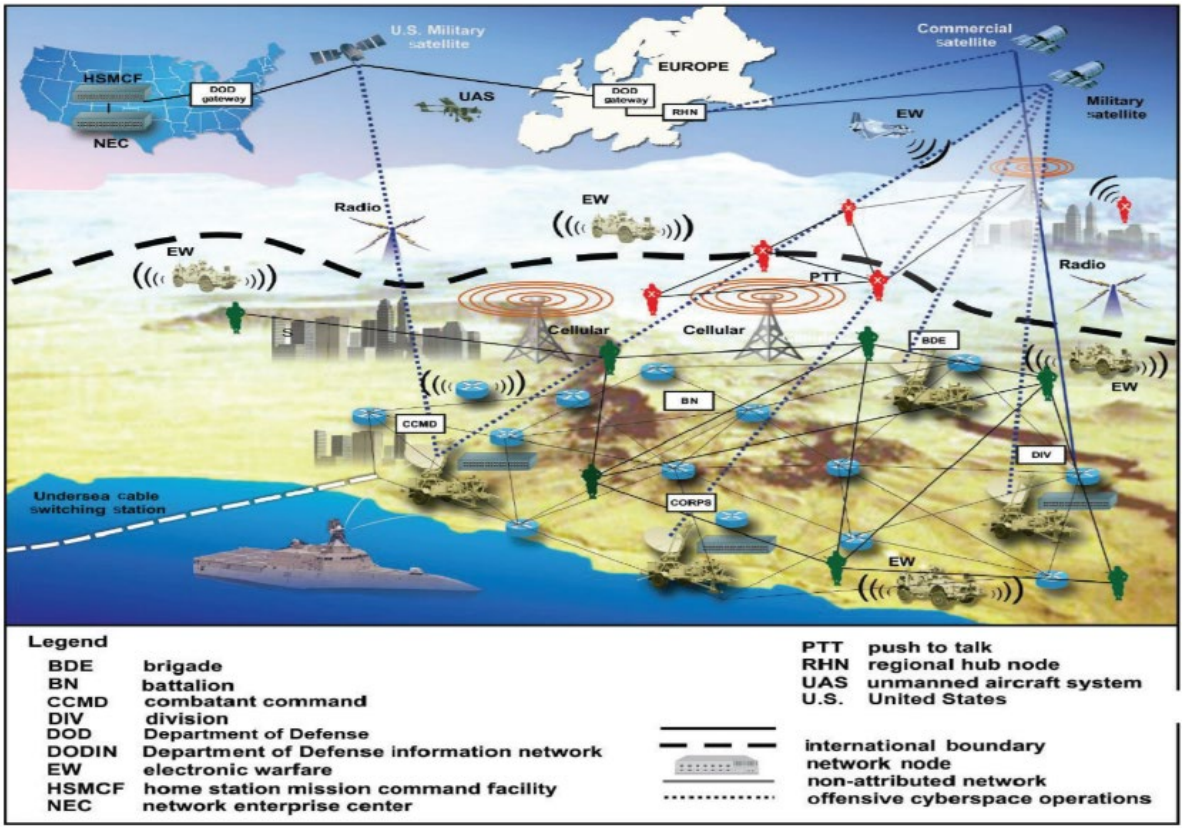

Figure 1: Cyberspace in the multi-domain extended battlefield, United States, *FM 3-0: Operations* (Washington, DC: Headquarters, Dept. of Defense, 2017).

[34] Ibid.

[35] US Army, FM 3-0 (2017), 1-6.

Operational Art

To succeed in the operational dimension, a commander and his staff must synchronize available resources across time and space leveraging experience, judgment, and creativity to convert tactical victories into operational victories. This cognitive exercise is operational art. The term operational art was first introduced into US Army doctrine in 1986, recognizing the creativity required by an operational commander. Connecting the tactical dimension of warfare with the strategic aims established in policy requires a cognitive process.[36]

Army operations manual, FM 3-0, identifies operational art as the key that enables an army commander to arrange the systematic defeat of an opposing force on multi-dimensional battlefield. Multi-domain extended battlefield represents a degree of complexity not experienced in previous generations. It is an evolution spurred by accelerated technological discoveries. In addition to the domains familiar to twentieth-century warfare, an operational artist must now also consider the space domain and information environment.[37] The information environment presents a host of new challenges and opportunities for consideration during operational art. AI is the tool best suited to exploit these opportunities to reduce obstacles and mitigate operational risk associated with this gray zone.[38]

The operational artist must then translate these ideas into military operations across all of the domains with the capability to influence a theater of war.[39] The operational artist is the officer responsible for working with politicians to develop a campaign plan that achieves political aims. This requires a cognitive exercise inherent in the operational art. The challenge is identifying the

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[36] Naveh, 11.

[37] US Army, FM 3-0 (2017), 1-6.

[38] "The Growing Danger of Great-Power Conflict," *The Economist*, January 25, 2018, accessed January 28, 2018, https://www.economist.com/news/leaders/21735586-how-shifts-technology-and-geopolitics-are-renewing-threat-growing-danger.

[39] US Army, FM 3-0 (2017), 1-7.

intangible qualities that make an operational artist successful. According to Clausewitz, it is military genius, which consists of intellect and courage.[40]

Although these attributes alone do not guarantee success, the command cannot attain success without them. "If they…reveal themselves in exceptional achievement, their possessor is called a 'genius'."[41] There are many operational artists, throughout history, whose exceptional achievements have contributed to the evolution of operational art.

Mission Command

The Roots of Mission Command

Once military execution begins, it is very difficult for an army level commander to direct all of his subordinate units. Decentralized execution and dispersion of the higher headquarters are critical to survival in the modern system.[42] To decentralize effectively, the US Army employs a leadership philosophy known as mission command. It derived mission command from a German concept known as *Bewegungskrieg*. It is a flexible system of command that gives subordinate commanders a great deal of initiative.[43]

Nineteenth-century Prussian, General Helmuth von Moltke the elder conceptualized this term. As early as 1866, Moltke identified a need to provide subordinate commanders with the freedom to make their own decisions. Moltke believed that developing leaders capable of exercising initiative within the commander's intent would prove to be a tremendous advantage. He did this by providing guidance through verbal directives.[44]

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[40] Carl Von Clausewitz, *On War*. (Priceton, NJ: Princeton University Press, 1991), 101.

[41] Idem, 100.

[42] Biddle, 33.

[43] Citino, 311.

[44] Daniel J. Hughes, *Moltke on the Art of War: Selected Writings* (Novato, CA: Presidio Press, 1995), 11.

Moltke also implemented a system of issuing orders that emphasized the "why" instead of the "how" to encourage freedom of action in the absence of orders.[45] During the Franco-Prussian war, "he devised a simple operational framework that created a shared understanding. He provided his subordinate commanders with maximum leeway and, despite several mistakes throughout the campaign, when the time came Moltke managed to direct the crucial maneuvers needed to defeat the French Army in a *kurtz and vives* (short and lively) war."[46] This concept is often confused with *Aufstragstaktik,* which was not introduced until after World War II.[47] *Bewegungskrieg* is considered the precursor to US Army's Mission Command.

The Philosophy

Mission Command serves two distinct functions; it is a leadership philosophy as well as a WfF. Much like the Germans, the US Army sees the mission command philosophy as a way to increase the tempo of a ground force commander by allowing leaders to exercise a degree of control tailored to the specific mission requirements.[48] There are six principles that are key to the successful implementation of this philosophy: build cohesive teams through mutual trust, create shared understanding, provide a clear commander's intent, exercise disciplined initiative, use mission orders, and accept prudent risk.[49]

A fundamental principle, is to build a cohesive team through mutual trust. Leaders must also create a shared understanding of the situation and mission. Leaders accomplish this through a commander's intent and communicated through mission orders. Lastly, the mission command

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[45] Michael J. Gunther, *Auftragstaktik: The Basis for Modern Military Command?,* SAMS Monograph, 2012, accessed September 5, 2017, htttp://cgsc.contentdm.oclc.org/u?/p4013coll3,2963, 2.

[46] Citino, 311.

[47] Gunther, 2.

[48] US Department of the Army, Army Doctrinal Reference Publication (ADRP) 6-0, Mission Command. (Washington, DC: Government Printing Office, 2015). 1-3.

[49] Ibid.

philosophy calls for leaders capable of accepting prudent risk.[50] If used correctly, mission command makes leaders and their units far more flexible, agile, and adaptive at operating dispersed and independent within the operational environment.[51]

The Warfighting Function

As a WfF, mission command is a series of tasks and systems that helps the commander balance the art of command with the science of control. It is the operational framework that enables the integration of other WfFs across multiple domains.[52] It helps a commander drive the operations process and enables him or her to execute the commander's activities.

The staff works through mission command to facilitate the commander's ability to lead and assess. The staff is responsible for conducting the operations process, knowledge management, synchronizing information-related activities, and conducting cyber electromagnetic operations.[53]

Together the commander and his or her staff enables their subordinate units' success through the integration of the mission command philosophy and the WfF. If done effectively, mission command can increase agility, adaptability, and survivability of an organization. AI will serve to enhance a commander and staffs' effectiveness in mission command as both a philosophy and a WfF.

The Modern System

During the Austro-Prussian War, the Austrians possessed new rifled muskets with increased accuracy and lethality. Moltke witnessed firsthand the devastating effects this weapon had on the closed formations employed by the armies of the time. He realized immediately that

[50] Ibid.

[51] Biddle, 31.

[52] US Army, ADRP 6-0, (2017), 1-3.

[53] Ibid.

this technology would increase the lethality of future battlefields.[54] Moltke understood that the increased lethality would decimate closed formations.

As a result, the Prussian army revised its doctrine and began moving in open formations to increase survivability in the face of the deadly new weapons. The Prussian's began to have their second line disperse just as the first line did.[55] The armies of other European countries had the same experience but were reluctant to change. The British and the French also rewrote their doctrine following the Boer War. Unlike the Germans, the French did not implement these changes. Changes they regarded as cowardice and bad for morale.[56]

The invention of the machine gun, however, made change necessary for all armies. Mass production of modern weapons resulted in a storm of steel.[57] The increased lethality made it impossible to survive long enough to accomplish anything of value. Long before WWI, Jan Bloch predicted increasing battlefield lethality in his book *La Guerre Future*.[58]

He stated that, "between the combattants [sic] will always be an impassible zone of fire deadly in equal degree to both foes."[59] He was referring to, what Soldiers would later call, no man's land. "From the very first days of the war, the professional soldiers of Europe were trying to adjust themselves to the new realities of the battlefield. It took them a tragically long time to solve the tactical problems that confronted them."[60] The solution to the problems was the modern system and it is still the way to victory today.

The modern system is, "a tightly interrelated complex of cover and concealment, dispersion, suppression, small unit independent maneuver and combined arms at the tactical level

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[54] Gordon, 513.

[55] Ibid.

[56] Gordon, 516-518.

[57] Biddle, 30.

[58] Gordon, 512

[59] Ibid.

[60] Ibid.

and depth, reserve, and differential concentration at the operational level of war."[61] The modern system requires large standing armies. The disadvantage to large standing armies is twofold. They are manpower heavy and manpower is the single most expensive resource. Secondly, sending men to war on a large scale means the potentially high number of casualties. Both are considered disadvantages because they are politically unpopular.

There are those in the US Department of Defense who offer an alternative, one centered on technology. They argue that technology is causing a revolution in military affairs. This technology would make it possible to achieve victory from standoff distances without having to put Soldiers in harm's way. If true, the Modern System would be obsolete. Proponents of this thinking are advocating for increases in the purchase of new technology and equipment in lieu of a larger military force.[62]

This would have negative implications on future wars, if it turns out that new technology cannot, alone, win wars. Biddle argues that a preponderance of force does not determine victory on the modern battlefield but force employment.[63] The modern system remains the most effective way to achieve a military victory in the physical environment. Victory in the information environment requires the use of technology. AI could provide commanders and staffs with an asymmetric advantage with which to maneuver in this emergent environment.

Artificial Intelligence

AI is synonymous with computers and the increased ability to process information and provide answers to questions ranging from math problems to playing the game "Go." [64] Sentient beings have "human" level intelligence. Intelligence is a human's genetically determined ability

[61] Biddle, 3.

[62] Biddle, 16.

[63] Ibid, 33.

[64] Peter Norvig and Stuart Russell, *Artificial Intelligence: A Modern Approach*, third ed. (Edinburch Gate: Pearson Education, 2016), 5.

to learn or perceive from its environment. In humans, intelligence can be improved throughout a person' life. The same is true about AI, which can increase or enhance intelligence through advances in technology.

In 1950, Alan Turing asked, "can machines think?"[65] Scientist still debate the answer to this question. To answer this question, they must first answer another question. What does it mean to think? Webster's dictionary defines think as "to form or have in the mind." Another definition is "to have an intention."[66]

Armed with these definitions the answer is clear, so long as the Central Processing Unit (CPU) in a computer is considered a brain. Machines have not only demonstrated the ability to think but they have also demonstrated intent. A prime example of this is IBM's Watson playing Jeopardy, or Alpha Go playing the game go.

In Watson's case, a machine used information stored in a CPU, applied reasoning and constructed an answer to questions.[67] Alpha Go also demonstrated the ability to form a solution, anticipate its opponent's moves and act with the intent to win the game. In both cases, the AI competed against the best humans in the respective field and performed well enough to win handily. Algorithms that computer programmers wrote made it possible for a computer to think.

Machine Learning

In order to provide the level of shared understanding that this study warrants it is crucial to understand machine learning. Arthur Samuel first defined Machine Learning in 1959 as a "Field of study that gives computers the ability to learn without being explicitly programmed." It

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[65] Douglas R. Hofstadter, *Gödel, Escher, Bach: An Eternal Golden Braid* (New York: Vintage Books, 1983), 26.

[66] "Dictionary by Merriam-Webster: America's most-trusted online dictionary," Merriam-Webster, accessed December 16, 2017, https://www.merriam-webster.com/dictionary.

[67] Jo Best, "IBM Watson: The inside story of how the Jeopardy-winning supercomputer was born, and what it wants to do next," *Tech Republic*, accessed December 22, 2017, https://www.techrepublic.com/article/ibm-watson-the-inside-story-of-how-the-jeopardy-winning-supercomputer-was-born-and-what-it-wants-to-do-next/.

is an automation of analytics that allows its application at scale."[68] Machine learning now operates within the parameters of an algorithm that defines its purpose.

In most instances, once the algorithm is written, developers upload large volumes of human data that enables machine learning. This is a process known as deep reinforced learning and it is a similar process to that of the human brain. The algorithm can then conduct iterations of the task for which scientist designed it.[69] Throughout the process, it records all of the different possible outcomes and determines optimal responses for these infinite possibilities. Developers upload additional data periodically to enable the algorithm's continued evolution.

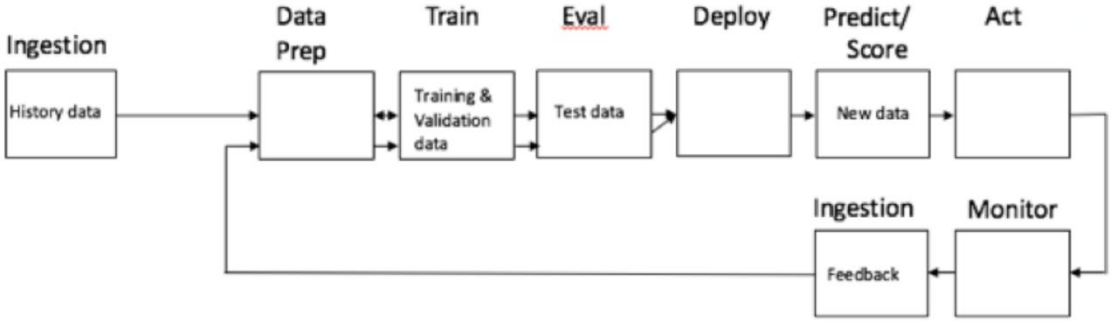

Figure 2: Machine Learning Diagram. Rob Thomas, *"A Practical Guide to Machine" Learning: Understand, Differentiate, and Apply."* May 2015.

The machine's advantage over its human counterpart in learning is twofold; unlimited bandwidth and a narrowly defined focus with unlimited time. Machine learning has now proven that, within a clearly defined structure, it can easily outperform the best human counterpart in its field. Machine learning represents a remarkable evolution in the field of AI and one with the potential to revolutionize the way humans learn and consume information.

Is AI Dumb?

[68] Rob Thomas, "A Practical Guide to Machine Learning: Understand, Differentiate, and Apply," Medium, May 15, 2017, accessed January 28, 2018, https://medium.com/inside-machine-learning/a-practical-guide-to-machine-learning-understand-differentiate-and-apply-b800bb4c4942.

[69] Ibid.

There are those who argue that AI is very far from human-level functioning and therefore dumb.[70] The rationale behind this sentiment is logically sound. Imagine for a moment a human being, isolated from the world and directed to focus all of his time and energy on playing thousands of iterations of a game. This person would achieve an expert level of knowledge in the game quite similar to the way that Alpha Go did. Most people would likely consider this person autistic for his inability to interact with the world and therefore incapable of fending for himself, much less surviving. Yet when operators allow a computer program to focus solely on becoming an expert at a game people hail it as revolutionary. Add to this that the computer receives large volumes of bandwidth that are unavailable to humans. Imagine for a moment what would be possible if humans could increase their capacity or bandwidth infinitely?

When put into context, Alpha Go's accomplishment, although monumental in the field of AI, is far from the achievements of a human brain. Until the day that AI can interact with its environment and perceive social cues both implicit and explicit and still execute a task, it will remain stupid at best.[71]

Summary

Throughout military history, developments in technology have required an evolution in warfare. These evolutions progress and occur over time. For this reason, it is critical that a counterfactual be identified. The literature points to the Austro-Prussian war as the moment when an evolution in warfare became evident to its participants.

The rifles that the Austrians possessed were the antecedent to the modern system that has defined warfare since WWI.[72] The increased lethality of the rifle created a need for greater

[70] Christopher Mims, "Without Humans, Artificial Intelligence Is Still Pretty Stupid." *The Wall Street Journal*, November 12, 2017, accessed January 28, 2018, https://www.wsj.com/articles/without-humans-artificial-intelligence-is-still-pretty-stupid-1510488000.

[71] Mims.

[72] Gordon, 516.

dispersion on the battlefield. The industrial revolution made mass production possible. This coupled with the introduction of the machine gun meant armies could no longer fight in closed formations and survive long enough to accomplish anything meaningful. Armies learned this painful lesson on the western front during the First World War at the cost of tremendous blood and treasure. The result of that experience is the modern system of small independent maneuvers that employ complex terrain to survive on the modern battlefield.

The western world is in the midst of a similar evolution in the way it conducts warfare. This is a result of the proliferation of artificial intelligence. Like the modern system, it did not occur overnight. It is a modern phenomenon that began to evolve with the creation of the first computer. Today the average person in the United States owns a smartphone with built-in artificial intelligence that can assist in addressing a wide range of challenges by simply asking the device a question. There is no question that an evolution is occurring. The question is how will it change the way militaries conduct modern warfare.

Research Methodology

This study conducts a structured, focused case study comparison because of its increased rigor and reliability. This will prove to be invaluable to the study given the somewhat unquantifiable and fluid nature associated with emergent technologies. The comparative case study method is, therefore, better suited to capture the effects of AI on the conduct of military operations. This structured approach will also allow others to easily replicate the study in the future thereby enhancing the validity of the findings.

The case studies will consist of four sections with the intent of answering the research questions. The opening section will provide a description of what the technology is and the stated goals of the parent company. The next section will provide a brief history that describes the creation of the technology and a chronological summary of its major milestones. The third section will evaluate recent developments in the technology and the ways in which the company is

marketing the technology in both the public and private sectors. The fourth and final section will use the empirical data collected in the case studies to answer the research questions.

The theories of operational art, mission command, and the modern system will guide the case studies. The characteristics of each theory will serve as a framework to evaluate if and how narrow AI can benefit a commander and his or her staff throughout the operations process. The study will assess this through the empirical data provided in the case studies.

The following case studies represent comprehensive, cutting-edge, machine learning capable AI platforms. These platforms have demonstrated the ability to outperform their human counterparts in complex game scenarios, exceeding all expectations well in advance of anything previously thought possible. Alpha Go and Watson are widely considered the leaders in the field of narrow AI and machine learning.

These two cases represent the best examples from which this study can gain the necessary empirical data to shed light on possible military applications. Although they shared similar visions, the companies adopted unique approaches in pursuit of their objectives. The goal of this study is to assess the benefits and challenges presented by their respective approaches.

Watson is IBM's AI platform, capable of machine learning, guided by a unique algorithm. Watson's introduction to the world happened in 2011 on Jeopardy. The private sector has employed Watson's AI capability ever since. Much like Watson, Alpha Go employs machine learning guided by an algorithm to perform its function. Alpha Go's major accomplishment was its four games to one victory over a world champion Go player in 2016. The most recent version, Alpha Go Zero, defeated previous versions of the program within days. Unlike IBM, Deep minds is only now developing an application for use by the private sector. The preponderance of its focus is still in research and development.

Research Questions

The intent is to determine the extent to which narrow AI, in its current capacity, can enhance, enable, or facilitate operational art by streamlining the operations process and mission command. The study will analyze the information the case studies provided through a series of focused questions. The following questions seek to confirm or deny the thesis:

Primary (1) – How can narrow AI software enhance a commander and his or her staff?

Secondary (2) – What can narrow AI, contribute to the military?

Secondary (3) – What does human–AI teaming look like?

Secondary (4) – How can machine learning benefit the military?

Case Studies

Case Study #1: IBM's Watson

Introduction: What AI is and what it's built for.

Watson is IBM's supercomputer that fuses the latest AI technology with software capable of analyzing large volumes of information to provide its users with solutions. Watson's capability is defined by a unique algorithm that was specifically written for it. This algorithm enables IBM's supercomputer to decipher between the information pertinent to its assigned task and information that is irrelevant. Developers then feed Watson large volumes of relevant historical data that it uses to learn through a process called deep reinforcement learning. To accomplish this task, Watson has eighty teraflops at its disposal enabling it to operate at the rate of a highly functioning human.[73]

History: The events that led here.

[73] "What is IBM Watson supercomputer? - Definition from WhatIs.com," *WhatIs.com*, accessed December 22, 2017, http://whatis.techtarget.com/definition/IBM-Watson-supercomputer.

This technology was on display for the world to see when Watson made its public debut on Jeopardy in 2011. During the gameshow, Watson demonstrated the speed of its analytical processor by competing against the two greatest players ever to play on the gameshow. It went on to defeat its human competitors with relative ease.

The story of Watson, however, begins over a decade earlier when the first computer took on a human competitor in a game of chess. Like Jeopardy, the competitor was the reigning champion, the grandmaster in the game since 1985. His name was Garry Kasparov and his competitor was Deep Blue.[74] The machine went on to win handily over its human counterpart in a six-game series. This event marked the first time in history that a computer beat a human at a complex game.[75]

IBM's continued development of this technology is resulting in a program known as Deep QA. This program is specifically designed to recognize relevant language in a given data set to provide answers and solutions. Doing this requires Deep QA to begin by deciphering what the question is asking, then identify what information it has on hand and organize the information into relevant threads. Then using thousands of algorithms, it organizes each thread to determine its value.

Larry Greenemeier said that, "algorithms study the evidence, looking at factors including what the information says, what type of information it is, its reliability, and how likely it is to be relevant, then creating an individual weighting based on what Watson has previously learned about how likely they are to be right."[76] This is the technology that would eventually enable Watson to defeat the world's best human Jeopardy players.

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[74] Larry Greenemeier, "20 Years after Deep Blue: How AI Has Advanced Since Conquering Chess." *Scientific American*, June 02, 2017, accessed January 28, 2018, https://www.scientificamerican.com/article/20-years-after-deep-blue-how-ai-has-advanced-since-conquering-chess/.

[75] Ibid.

[76] Best.

Applications: Recent developments

On the heels of Watson's remarkable victory in Jeopardy, IBM began an aggressive marketing campaign to sell the technology for use in various different fields. Scientists refer to this technology as cognitive computing and is unique in its ability to understand unstructured data. Most notably Watson is applying this new technology in the field of oncology. Oncologists are employing Watson to assist in the development of comprehensive treatment plans for existing cancer patients.

Watson's primary contribution is in knowledge management and real-time access to relevant, up to date information. It stores the information in a large repository that it continuously refines based on feedback.[77] This enables doctors to make decisions armed with the most updated information in the field. Watson is not capable of making predictions nor can it cure cancer. This resulted in strong criticism among some in the field.

In here lies the disparity between the reality of existent narrow AI and the promise of general AI often captured in science fiction novels. Although Watson cannot cure cancer, it is an excellent tool that many fields use, ranging from fiscal efficiency to insurance companies reducing risk and increasing savings.[78]

Watson is also currently partnering with the US Army to develop a comprehensive database that will increase shared understanding.[79] They will accomplish this by uploading lessons learned, tactics, techniques, and procedures along with the most recent doctrine to

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[77] Thomas.

[78] IBM, "IBM Cognitive Stories - H&R Block with Watson," October 15, 2017, accessed September 26, 2018, www.ibm.com/watson/stories/hrblock/; IBM, "Insurance company employees are working with Watson to assess insurance claims 25% faster," IBM Cognitive Stories - Insurance with Watson, October 15, 2017, accessed September 26, 2018, www.ibm.com/watson/stories/insurance/.

[79] MCBL.

facilitate effective planning and execution through an improved mission command infrastructure. This technology will help commanders and their staffs with operational art by enhancing the cognitive process.

Case Study #2: Alpha Go

Introduction: What it is and what it's built for.

In 2010, a group of entrepreneurs based in London founded Deep Minds. This company was dedicated to the development of artificial intelligence. The company received many awards for its significant accomplishments in the field of machine learning. The company remained largely anonymous until Google acquired them in 2014. Since their acquisition, they have applied themselves to the development of machine learning through reinforced learning.

History: The events that led here.

The company introduced the first concept of reinforced learning known as deep reinforcement learning or DeepRL. It was the first of its kind in 2015. The program's major accomplishment was the superhuman level of play achieved in Atari 2600 games.[80]

Following their first major accomplishment, Deep Minds continued to innovate. In a year and a half, the company presented the next major development that created a neural network enhanced with increased memory. They named this new technology Differentiable Neural Computer (DNC), and it "demonstrated that it could learn to use its memory to answer questions about complex structured data, including artificially generated stories, family trees, and even a map of the London Underground." [81]

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[80] Volodymyr Mnih, et al, "Human-Level control through deep reinforcement learning," February 26 2015, accessed September 26, 2018, storage.googleapis.com/deepmind-media/dqn/DQNNaturePaper.pdf.

[81] Alex Graves, et al. "Hybrid computing using a neural network with dynamic external memory," *Nature News,* Nature Publishing Group, October 12, 2016, accessed September 26, 2018, www.nature.com/articles/nature20101.

In 2016, Deep Minds accomplished its greatest achievement to date with a program called Alpha Go. Alpha Go used a form of machine learning, known as supervised learning to evolve into an expert at what many consider the world's most difficult game, Go. Alpha Go shocked the world when it defeated, top ranked Go player, Lee Sedol in four out of five games.[82] Later versions of the Alpha Go program went on to defeat the best Go players in China and Japan. The form of learning, however advanced, proved limited due to its dependency on data derived from human experience as the foundation for learning. Dependence on human examples, places human limitations on Alpha Go.[83]

Applications: Recent developments

Deep minds recently developed the next evolution of machine learning, one no longer reliant on human data, known as Alpha Go Zero. Deep Minds describes it saying, "the program is only given the rules to a specific game and a 'reward function' that awards a point for every win and deducts a point when it loses."[84] After two days of training, Alpha Go Zero advanced beyond the version of the program that defeated Lee Sedol in 2016. Within forty days, Alpha Go Zero beat the version of Alpha Go that beat Lee Sedol, 100 games to zero.[85]

As intelligent and human-like as this may seem, this is still a form of narrow AI. Deep Mind calls this evolution in machine learning first principle or tabula rasa which refers to its ability to learn from scratch. The algorithm starts with the rules to the game and it learns by

[82] "The Google DeepMind Challenge Match," *DeepMind*, March 2016, accessed September 26, 2018, deepmind.com/research/alphago/alphago-korea/.

[83] Best.

[84] "AlphaGo Zero: Learning from scratch," DeepMind, October 18, 2017, accessed September 26, 2018, deepmind.com/blog/alphago-zero-earning-scratch/.

[85] David Silver, "Mastering the game of Go without human knowledge," *Nature News*, Nature Publishing Group, October 18, 2017, accessed September 26, 2018, www.nature.com/articles/nature24270.

playing itself. The downside to this technology is that it is dependent on 25 million dollars of hardware, which is neither cheap nor portable.[86]

The major hurdle that confronts Deep Mind now is developing a way to make this technology available for application in the public and private sector, to companies that can take advantage of the benefits. They have already begun this process. Following in Watson's footsteps, Deep mind is currently involved in health, ethics, and other uses within Google.[87]

Findings

How can narrow AI software enhance a commander and his or her staff?

The creation of the internet amplified the information age that started with the introduction of the home computer. Today the internet provides instant access to volumes of information. It is important to harness this information environment in ways that will make commanders and staffs more informed and cognitively agile. AI, such as Watson or Deep Minds, provides the tools that will help humans leverage this information and use it to their advantage.

Various industries already leverage recent technological developments in AI like IBM's Watson or Deep Mind's Alpha Go to increase efficiency, reduce risk, and promote shared understanding. Programs like Watson consist of a large repository of information combined with machine learning algorithms that provide answers. It evaluates several sources of information through reason and presents potential solutions to complex problems.

AI will place large volumes of information at the fingertips of commanders and their staffs, provide access to the experience of others, and make it useful to enhance cognition. The AI helps to do this by organizing large volumes of information and presenting only what pertains to the situation. In short, this technology will enhance the commanders' and the staffs' expertise and

[86] Murphy, Mike, "This is how much Google is spending on cutting edge AI research." Quartz. October 05, 2017, accessed February 13, 2018, https://qz.com/1095833/how-much-googles-deepmind-ai-research-costs-goog/.

[87] "AlphaGo," DeepMind, accessed February 13, 2018, https://deepmind.com/research/alphago/.

in so doing, it will increase their ability to conduct operational art and facilitate the operations process.

What can narrow AI, contribute to the military?

If employed correctly, AI provides the military an asymmetrical advantage by gaining greater access to the information environment. Access to this emergent domain presents the commander with a menu of options not previously available. It is in the information environment that commanders could employ AI, to shape the operational environment. Because this shaping effort does not require the deployment of forces, operations can begin long before troop movements begin. This also allows our military commanders to conduct operations deep behind enemy lines with little to no political risk.

The information environment is a part of the greater multi-domain extended battlefield concept. It is a domain within which militaries conduct grey zone warfare. The grey zone refers to a form of conflict that remains below the threshold that would insight a retaliation from another state.[88] The Grey zone consists of misinformation, cyberwar, economic coercion, force, and infiltration. These measures could also include counterintelligence, the use of social media to collect information, determine adversary locations, establish patterns of life, and develop network analysis.

How does human-AI teaming enhance the cognitive process?

Commanders and members of a staff all go through a cognitive process when presented with new information. This cognitive process can be broken down into four basic steps: observe, interpret, evaluate, and decide.[89] John Boyd described another way of approaching the decision-making process. Similar to the cognitive process, Boyd's model also consists of four steps:

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[88] Peter Pomerantsev, "Brave New War," *The Atlantic*, December 29, 2015, accessed January 29, 2018, http://www.theatlantic.com/international/archive/2015/12/war-2015-china-russia-isis/422085/.

[89] Mashable Brand. "Hello, Watson: How AI actually learns how to think (Paid Content by IBM)," *Mashable*, January 17, 2018, accessed February 23, 2018, https://mashable.com/2018/01/17/how-watson-ai-works/#vnxQAP8ncPqZ.

Observe, Orient, Decide, and Act.[90] In military circles know it as the "OODA loop." The main point behind Boyd's model is to express the importance of getting ahead of an adversary's decision-making.

Human-AI teaming can serve as a force multiplier for a commander and his staff. When they discuss human-AI teaming they often describe it in relation to "the loop" which refers to Boyd's OODA loop. There are three major relationships that describe human-AI teaming. They are human-in-the-loop (humans are the primary agent assisted by AI), human-on-the-loop (humans make the final decision), or human-off-the-loop (AI completely autonomous).[91] The human-in-the-loop is likely to remain the primary relationship for the foreseeable future. The incorporation of AI into the loop will accelerate and enhance the commander and OODA loop process resulting in an enhanced OODA loop process.

The use of AI also enables commanders and their staffs can gain access to the wide range experience of others by presenting Watson with a question and gaining access to the experience of previous units. Technology doesn't just supply the stuff of thought but it also shapes the process of thought.[92] Human-machine teaming will certainly have the same effect on the cognitive process and it will change the way commanders and their staffs interpret and evaluate information.

How can machine learning benefit the military?

War is shrouded in uncertainty, in order to see through this fog a military officer must bring the power of intellect to bear. A sensitive, discriminating judgment coupled with a skilled

[90] Paul Tremblay, Jr., "Shaping and Adapting Unlocking the power of Colonel John Boyd's OODA Loop," Master's thesis, Marine Corps, University, April 22, 2015, accessed January 30, 2018, http://www.pogoarchives.org/straus/shaping-and-adapting-boyd-20150422.pdf.

[91] "Autonomous weapons are a game-changer," *The Economist*, January 25, 2018, accessed January 30, 2018, https://www.economist.com/news/special-report/21735472-ai-empowered-robots-pose-entirely-new-dangers-possibly-existential-kind-autonomous.

[92] Nicholas G. Carr, *The Shallows: What The Internet Is Doing To Our Brains,* (W.W. Norton, 2011.), 2.

intelligence brings the truth in sight.[93] AI capable of learning and reasoning can assist a commander in gaining this requisite clarity sooner and more often than he otherwise could. It is a quick recognition of the truth the mind would ordinarily miss or would perceive only after long study and reflection.[94]

If this technology was readily available to commanders and their staffs on a large scale, it would provide an asymmetric advantage to the owning military. The result would be cognitive dominance over the enemy through accelerated understanding and visualization which leads to greater speed and tempo throughout all phases of the operations process. Through increased tempo, a military could overwhelm the enemy's capacity to generate combat power. This would force the enemy to surrender bringing the war to a rapid conclusion, thereby reducing the loss of the nation's blood and treasure. The following section will provide an example that illustrates how AI will work.

Analysis

The results of the study support the hypothesis that human-AI teaming will enhance the cognitive process and situational understanding of commanders and their staffs. Due to the cognitive nature that serves as the core of the operational art and the artist. Human-AI collaboration will give militaries an asymmetrical advantage in speed, tempo and lethality. The evolution of artificial intelligence is such that commanders and staffs can employ it to streamline the analysis of large volumes of available data at an accelerated rate.

The advent of cognitive computing and machine learning makes this possible. An evolution in technology will lead to an evolution of the human mind and the cognitive process. Human intelligence will evolve and humans will develop new habits that will increase the speed

[93] Clausewitz, 101.

[94] Ibid, 102.

and efficiency of cognition processes, creative thinking, and critical thinking.[95] AI will serve as a force multiplier for the commander and his staff as they work to conduct operational art and exercise mission command across all domains.

As the armies of the nineteenth century expanded beyond a million men, they spanned enormous distances and increasing lethality brought on by the weapons of the industrial revolution created the modern system.[96] The modern system, in turn, created the need for a new level of war. Military practitioners know this as the operational level. This new operational dimension brought with it the need for operational art.

The operational art is a cognitive process that is dependent on a commander and his staffs' experience, judgment, and critical and creative thinking. This is where human-AI pairing will provide an asymmetrical advantage. It will enhance the OODA loop process for the commander and his staff by leveraging large volumes of data on databases. Databases loaded with doctrine; theory; history; current tactics, techniques, and procedures (TTP); and relevant after-action reviews (AARs).[97] This database of information will lead to greater understanding and serve as a conduit for mission command to facilitate the other WfFs throughout the operations process.

This new-found economy of time will allow the staff to focus on the development of a comprehensive course of action that addresses all enemy courses of action sooner. As a result, the commander will understand and visualize the operation sooner. They will be able to execute their commander's activities to gain the initiative through the rapid deployment of troops while reducing risk. During execution, greater access to real-time information will enhance the commander's ability to maintain situational understanding and respond appropriately.

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[95] Carr, 222.

[96] Biddle, 31.

[97] MCBL.

AI and Our Peers: A Real-World Application

History has demonstrated that the first army to successfully incorporate emergent technology, is rewarded with an asymmetrical advantage over its adversary. This race, like all others, is a zero-sum game and the country that fails to seize the technological advantage will face a tremendous disadvantage. An evolution in the prevailing military theory and doctrine often joins technology. For example, the Chinese People's Liberation Army (PLA) now considers warfare a confrontation between various adversarial operational systems.[98] Known as systems confrontation within the PLA, it is the equivalent to the US Army's concept of multi–domain extended battle. Both concepts recognize the importance of the non-physical cyberspace and the psychological domain.[99]

The increased complexity inherent in a systems–based approach presents commanders and their staffs with an increased demand on their cognitive capacity. To compensate, the Chinese military is working to develop AI software for their nuclear-powered submarines. This example of human-AI teaming, once operationalized, will enhance the commanders' and their staffs' ability to process information. The software will assist with the analysis and synthesis of available information, saving the commanders' and their staffs' time and increasing efficiency of decision making.[100] This application of narrow AI is a real-world example of the potential for the employment of AI in future war. This system, however, is in its infancy and will require modifications to work on nuclear submarines. The most significant hurdle being the large amount

[98] Jeffery Engstrom, "Systems Confrontation and System Destruction Warfare: How the Chinese People's Liberation Army Seeks to Wage Modern Warfare," Santa Monica, CA: RAND Corporation, 2018, accessed September 26, 2018, https://www.rand.org/pubs/research_reports/RR1708.html. Also available in print form.

[99] Engstrom; US Army, FM 3-0 (2017), 1-7.

[100] "China's plan to use artificial intelligence on nuclear submarines," *South China Morning Post*, February 05, 2018, accessed February 18, 2018, http://www.scmp.com/news/china/society/article/131127/chinas-plan-use-artificial-intelligence-boost-thinking-skills.

of hardware required to run the AI algorithm.[101] These are the same challenges that the Army's MCBL is currently working diligently to resolve in an effort to gain the operational advantage.

The Army's Mission Command Battle Lab

The MCBL located in the US Army's Capability Development Integration Directorate CDID is leading this effort. Their mission is to "mitigate risk to current and future Army forces by examining and evaluating emerging concepts and technologies through experimentation, studies, prototyping, and network integration, while simultaneously informing the combat development and acquisition processes."[102]

The battle lab is responsible for evaluating how the Army will leverage emergent technologies in AI. The goal is to increase the Army's capacity to exercise mission command as both a philosophy and a WfF. They are currently working with IBM to create a system that employs Watson's capability in a program designed for the Army.

This technology will consist of a large database loaded with pertinent information on US doctrine, TTPs, AARs, policy, strategy, and law. This system would also include the doctrine, TTPs, historical battles, operational variables and AARs of multiple allies and potential adversaries.[103] It would then be available to the units as a tool to inform commanders and their staffs and facilitate operational art.

This will require further analysis to determine the size of organization best suited to leverage this kind of technology. The organization must have a staff large enough to perform the analysis associated with the military decision-making process. The organization would also require sufficient distance in both time and space to allow time to process the information,

[101] Ibid.

[102] MCBL.

[103] Ibid.

develop a plan, and disseminate the plan. The operational level seems to be the best suited to employ this technology.

Conclusion

Since the dawn of the industrial revolution, warfare has become exceedingly lethal. To compensate for the increased lethality, formations have dispersed in order to survive long enough to accomplish their missions.[104] It was the technology of the time that led to the creation of the modern system. The development of new technology continues to influence the ways in which militaries conducted warfare all throughout the twentieth century. The influence of technology remains prominent in the pursuit of an asymmetrical advantage in the emerging age of robotics.

Today's military analysts already find themselves overwhelmed by the volumes of information currently available in the information environment.[105] Whether it is data produced through reconnaissance or anonymous human sources from the local population, it is difficult to process it all in a timely manner. AI will prove invaluable in helping analysts sift through the volumes of information and identify the pertinent information.

Armed with this information, the commander and his or her staff can leverage AI to facilitate the operations process. AI will serve as a force multiplier through the planning, preparation, and execution.[106] It will also accelerate and enhance the cognitive process for both the commander and his or her staff as they conduct operational art. The increased capacity to process information at a rapid rate will have a cascading effect throughout the subordinate units resulting in greater shared understanding. This will enhance a commander's ability to exercise mission command through increased situational understanding. The resulting synergy across the

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[104] Biddle, 31.

[105] "Getting to grips with military robotics," *The Economist*, January 25, 2018, accessed February 01, 2018, https://www.economist.com/news/special-report/21735478-autonomous-robots-and-swarms-will-change-nature-warfare-getting-grips.

[106] US Department of the Army, Army Doctrinal Reference Publication (ADRP) 5-0, The Operations Process (Washington, DC: Government Printing Office, 2015), 1-2.

formation will reduce risk, and increase speed, tempo, and lethality providing an asymmetrical advantage for the United States.

This asymmetrical advantage will prove instrumental in prosecuting the wars of the future that range from large-scale ground combat to gray zone conflict designed to operate just below the threshold of armed conflict. It is in this gray zone, the enemy is constantly maneuvering to create a position of relative advantage against the United States. The gray zone uses misinformation, coercion, and blackmail during all operations, making it difficult for the western nations to match. The Ukraine is an example of Russia combing force, misinformation, cyberwar, and economic coercion in ways that democratic societies would not approve of and find difficult to counter effectively without risking escalation.[107] This is not the first time the United States has found itself in this position. The gray zone is not an emerging phenomenon but a reemergence of an old phenomenon. This is power politics between states on the international stage. The only major change that exists today is the cyber dimension. This emergent dimension along with the development of narrow AI has added a layer of complexity to the system.

The results of this study support the assertion that human-machine collaboration will enhance the Army's ability to conduct operational art. Human-AI teaming is a force multiplier for commanders to use against an adversary in the information environment. Human-AI collaboration will also enhance the commanders' and their staffs' ability to conduct operational art and exercise mission command. The increased agility will allow commanders and to establish cognitive dominance across the multi–domain extended battlefield. The resulting battlefield effect will be an increase in tempo and lethality that will overwhelm the enemy's ability to generate combat power. Narrow AI will be the weapon that gives the United States and its allies an asymmetrical advantage in future wars.

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[107] "The Growing Danger of Great-Power Conflict," *The Economist*, January 25, 2018, accessed January 28, 2018, https://www.economist.com/news/leaders/21735586-how-shifts-technology-and-geopolitics-are-renewing-threat-growing-danger.

Appendix

Terminology

Artificial Intelligence (AI)-

"General" AI that is one that is capable of learning, reasoning, and interacting within a given environment without the need for human assistance. This form of AI would surpass human intelligence and could function as an unbounded system.[108] General AI has not been realized as of the writing of this paper.

"Narrow" AI, on the other hand, is capable of learning within a set of parameters defined by a series of rules that the system then uses as a guide.[109] These guides are commonly referred to as algorithms. A perfect example is IBM's Watson which has made significant contributions to the field of oncology.[110] Another great example is Alpha Go, which defeated Lee Sedol, the world champion in Go. It did it by teaching itself how to play the game and then playing millions of games and learning as it progressed.[111] This paper will focus on the value and applicability of narrow AI.

Modern Battlefield- Toward the end of the nineteenth century, Jan Bloch published *La Guerre Future.* In it he described the modern battlefield as an impassible zone of increasing lethality that will be impossible for a human to survive long enough to accomplish any meaningful mission. [112] The mass production of machine guns, rifles, and rifled artillery canons, created the lethal storm of steel that Jan Bloch envisioned.

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[108] Kate Baggaley, "There Are Two Kinds Of AI, And The Difference Is Important," *Popular Science*, February 23, 2017, accessed November 08, 2017. https://www.popsci.com/narrow-and-general-ai#page-2.

[109] Ibid.

[110] Ibid.

[111] "AlphaGo," *DeepMind*, accessed November 08, 2017, https://deepmind.com/research/alphago/.

[112] Gordon, 512.

Modern System- “a tightly interrelated complex of cover and concealment, dispersion, suppression, small unit independent maneuver and combined arms at the tactical level and depth, reserve, and differential concentration at the operational level of war.”[113]

Mission Command Philosophy- commanders, assisted by their staffs, use the guiding principles of mission command to balance the art of command with the science of control. They use the art of command to exercise authority, provide leadership, and make timely decisions. Commanders and staffs use the science of control to regulate forces and direct the execution of operations to conform to their commander’s intent.[114]

Mission Command Warfighting Function (WfF)- the related tasks and systems that develop and integrate those activities enabling a commander to balance the art of command and the science of control in order to integrate the other WfFs.[115]

Operational Art- “cognitive approach by commanders and staffs — supported by their skill, knowledge, experience, creativity, and judgment — to develop strategies, campaigns, and operations to organize and employ military forces by integrating ends, ways, and means.”[116]

Operational Artist- The operational artist is the officer, acting as a commander or as part of a staff, who embarks on the cognitive exercise known as operational art.[117]

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[113] Biddle, 3.

[114] US Army, ADRP 6-0 (2015), 1-4.

[115] Ibid.

[116] US Department of Defense, Joint Staff. Joint Publication (JP) 5-0, Joint Operations Planning Process. (Washington, DC: Government Printing Office, 2017), III-1.

[117] US Army, FM 3-0 (2017), 1-20.

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