Artificial Intelligence and Operational-Level Planning: An Emergent Convergence

A Monograph

by

MAJ William A Branch
US Army

School of Advanced Military Studies
US Army Command and General Staff College
Fort Leavenworth, KS
2018

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
24-05-2018

2. REPORT TYPE
Master's Thesis

3. DATES COVERED *(From - To)*
JUL 2017 - MAY 2018

4. TITLE AND SUBTITLE
Artificial Intelligence and Operational-Level Planning: An Emergent

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
MAJ William A. Branch

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Advanced Military Studies Program

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; Distribution is Unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Artificial Intelligence invades every aspect of our life in the 21st century. It helps the user build a better understanding of the world around them by gaining, storing, and recalling information. Most astoundingly, the processing power readily available to every cell phone owner exceeds that capacity of the first generation computers. With this computational capacity so prevalent in the private industry, how can the Army integrate this technology into its planning methodology, the Military Decision Making Process?

15. SUBJECT TERMS
Artificial Intelligence invades every aspect of our life in the 21st century. It helps the user build a better understanding of the world around them by gaining, storing, and recalling information. Most astoundingly, the processing power readily available to every cell phone owner exceeds that capacity of the first generation computers. With this computational capacity so prevalent in the private

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
(U)	(U)	(U)	(U)	42	MAJ William A. Branch
					19b. TELEPHONE NUMBER *(Include area code)*

Monograph Approval Page

Name of Candidate: MAJ William A. Branch

Monograph Title: Artificial Intelligence and Operational-Level Planning: An Emergent Convergence

Approved by:

__________________________________, Monograph Director

Daniel G. Cox, PhD

__________________________________, Seminar Leader

Richard A. Martin, COL

___________________________________, Director, School of Advanced Military Studies

James C. Markert, COL

Accepted this 24th day of May 2018 by:

___________________________________, Director, Graduate Degree Programs

Robert F. Baumann, PhD

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the US Army Command and General Staff College or any other government agency. (References to this study should include the foregoing statement.)

Abstract

Artificial Intelligence and Operational-Level Planning: An Emergent Convergence, by MAJ William A. Branch, US Army, 46 pages.

Artificial Intelligence invades every aspect of our life in the 21st century. It helps the user build a better understanding of the world around them by gaining, storing, and recalling information. Most astoundingly, the processing power readily available to every cell phone owner exceeds that capacity of the first generation computers. With this computational capacity so prevalent in the private industry, how can the Army integrate this technology into its planning methodology, the Military Decision Making Process?

This research explores human-machine teaming as it relates to planning at the Army Division level. This research deconstructs MDMP and offers suggestions of integration with existing AI technology and its computational capacity, along with human understanding, and its creative capability. This analysis illuminates some efficiencies within process gained through the concept of partnered understanding; as AI learns how to be process information for the users, users attain deeper cognitive understanding with their operating environment. This body of work also explores the cost of this integration.

Acknowledgements

I would like to give sincerest thanks to God for giving me the focus and perseverance to carry this work. Special thanks goes to my family for their help and support throughout the process. Thank you to my colleagues, most specifically Elizabeth Marlin for helping develop concepts, dialogue ideas, and ‘right-size’ the scope of this endeavor. Thank you to Richard Martin for your guidance and oversight. You were instrumental in developing the applicable of this project to the current state of the Army. Lastly, I give special thanks to the Mission Command Battle Lab for the collaboration and illumination of the Combined Arms Center’s current efforts in artificial intelligence.

Contents

Acronyms

ADP	Army Doctrine Publication
ADRP	Army Doctrine Reference Publication
AI	Artificial Intelligence
ATTP	Army Tactics, Techniques and Procedures (Publication)
COA	Course of Action
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities
FBCB2	Force Battlefield Command Brigade and Below
FM	Field Manual
MDMP	Military Decision Making Process
WIN-T	Warfighters Information Networks-Tactical

Illustrations

Introduction

Background/Overview

> On 21 May 2025, the Division Commanding General initiated an Operational Planning Team (OPT) in response to an emerging crisis. Just hours prior, this Army division received notification of an imminent deployment within the coming weeks. This occurrence in early summer accompanies a host of unique personnel challenges—the summer permanent-change-of-station (PCS) season. With outgoing key staff members departing, and replacement personnel yet to arrive, the staff is not fully manned. Of the remaining members, some have limited experience in their assigned positions or have never planned at the Army division level. This OPT is required to review the operations order (OPORD), while also adding the necessary details to make the plan executable. They have insufficient time to present feasible options to the Commanding General, the leader and decision-maker of the organization. Outside of reviewing the OPORD, orienting new members of the team, and gaining a better understanding of the operational environment, the OPT also has to understand the dynamics of the evolving crisis and suggest the appropriate, effective response.

The example above is not a seldom occurrence in the world of operational staff members. The operational planning team has to use their available resources, most importantly their professional military judgment and time, to create a plan for approval by the commanding officer. Many of their calculations, estimates, and assessments will be solely dependent upon their collective experience, doctrinal knowledge, and some best guesses. National assets aligned against these plans and estimates of operational planning teams across the Army and larger United States Department of Defense, are largely data-driven. Correlating this data to provide more precise staff estimates in a timelier manner can undoubtedly help the staff orient to the operational environment and create more quality courses of action, branches, and sequels. Additionally, as the pace of battle and complexity continues to increase over time, due to the interconnectedness through technology, the human cognitive ability to react, plan, and execute enduring operations will struggle to keep pace. Artificial intelligence technologies, collectively, may present the best opportunity to enhance and augment computational problem-solving tasks and reduce cognitive overload currently experienced by operational-level planning staffs. This technology has the potential to affect how US Army forces plan and execute warfare.

Significance of the Study

The research is important for two primary reasons. The US Army has used the same fundamental planning methodology, the Military Decision Making Process (MDMP), to conduct military operations for 46 years.[1] Since MDMP's inception, technologies such as personal computers and software have supported the process. Nevertheless, with increase of artificial intelligence in societal applications, the Army has yet to identify how artificial intelligence technologies can aid in decision-making beyond intelligent mission command systems such as Force XXI Battle Command Brigade and Below (FBCB2).

Secondly, the globalization of ideas has pushed artificial intelligence to the forefront of next technological revolution. Just as the race for space dominance in the 20th century spurred national investment by major world powers, artificial intelligence is starting to have the same investment priority in 21st century. Significant breakthrough in any one area of artificial intelligence may create an advantage that proves improbable to overcome in the near term. Most importantly, the Army and United States are at a disadvantage due our beliefs in government and private industry that run counter to adversarial nations. With focus and precision, the military can greatly benefit from the convergence of artificial technology and military planning.

Definitions of terms

Due to the technical nature of this discussion, a glossary of terms is most appropriate. The below terms are used throughout this monograph and provide a foundation for reference.

Cognitive Computing – Systems that learn at scale, reason with purpose, and interact with humans naturally using various artificial intelligence technologies.[2]

---

[1] US Department of the Army, Field Manual (FM) 101-5, Staff Officers' Field Manual: Staff Organization and Procedures (Washington, DC: Government Printing Office, 1972), 5-5.

[2] John E. Kelly, *Computing, Cognition and the Future of Knowing* (Somers: IBM Global Services, 2015), 2.

Corpus of Knowledge – A curated data set or body of data used as the baseline for machine learning and cognitive computational systems.

Curated Data Set – Data sets of fundamental knowledge for a deep learning network.

Deep Learning - An aspect of artificial intelligence concerned with emulating the learning approach that human beings use to gain certain types of knowledge.

Expert Systems – A form of artificial intelligence maintaining knowledge within a given field of study or area of expertise.

Ingestion – The process in which an artificial intelligence system receives data.

Natural Language Processing – The ability of a computer system, using world knowledge, to process and manipulate language via verbal inputs or written/typed text to dialogue with humans.[3]

Neural Networks – A set of processing units, structurally inspired by the human brain, that combine a set of input values to produce an output value in deep network learning.

Machine Learning – A statistical process that starts with a body of data and derives a rule or procedure that explains the data, while predict future data.

Partnered Understanding – An iterative dialogue between a user and AI system in which the user gains a greater depth of understanding from a system and the AI system gains be understanding for the use of its data set.

---

[3] Ben Coppin, *Artificial Intelligence Illuminated* (Sudbury: Jones and Bartlett, 2004), 573-574.

Strong AI / General AI – Artificial Intelligence systems capable of exhibiting apparently intelligent behavior at least as advanced as a human across a broad range of cognitive tasks.

Weak AI / Narrow AI – Artificial Intelligence systems capable of successfully completing simple or highly specific application.

Limitations

Artificial intelligence technology is rapidly advancing through research and development in private industry. As such, many of the capabilities and specifications of certain technologies are proprietary in nature. The release of this intellectual property was very limiting to this research.

Assumptions

This research assumes that an Army division's bandwidth allocations for will not be significantly reduced or increased with the cancellation of Warfighters' Information Network – Tactical (WIN-T).[4] This research also assumes that an Army division will remain doctrinally consistent with Field Manual 3-94 *Theater Army, Corps, and Division Operations* and Army Training Publication 3-91 *Division Operations* concerning employment, composition, and capability. This research assumes no significant breakthroughs in artificial intelligence technology during the period covered in this research over the next five years. Lastly, this research assumes the US Army Division offers a more robust network bandwidth, redundancy in personnel, and distance from the forward edge of the battlefield that would optimize the implementation of artificial intelligence technologies.

Organization of the paper

This monograph will provide a brief overview of artificial intelligence history and theory directly follows to provide a foundational understanding of this technology. Subsequently, historical integration of technical systems and military planning will provide the context relevant to suggest application in the future. An analysis of MDMP will determine if artificial intelligence technologies can be integrated using applications present in private industry. This monograph will discuss potential tradeoffs and side

---

[4] Paul Mcleary, "Army Looks to Replace $6 Billion Battlefield Network After Finding It Vulnerable," *Foreign Policy*, 21 November 2017, accessed December 26, 2017, http://foreignpolicy.com/ 2017/11/21/ army-looks-to-replace-6-billion-battlefield-network-after-finding-it-vulnerable/.

effects of integrating artificial intelligence technologies into operational planning. Finally, the conclusion provides the findings and recommendations for further research and application.

Literature Review

Artificial Intelligence

Artificial intelligence is a holistic concept encompassing a variety of technical capabilities that correspond to intelligence. Collectively, these capabilities capture the essence of machine intelligence. They include automated reasoning, expert systems, natural language processing, machine learning, neural networks, robotics, and machine vision.[5] Each of these sub-disciplines progress regularly, a feature that supplants published research of the topic. There are voluminous applications for artificial intelligence technologies in a number of different industries, many of which have altered our societal existence. Military planning application is the focal point of this research. Using the sub-disciplines illustrated in Figure 1, this research will conceptualize and explore their collaborative use in supporting military planning at the operational level of warfare

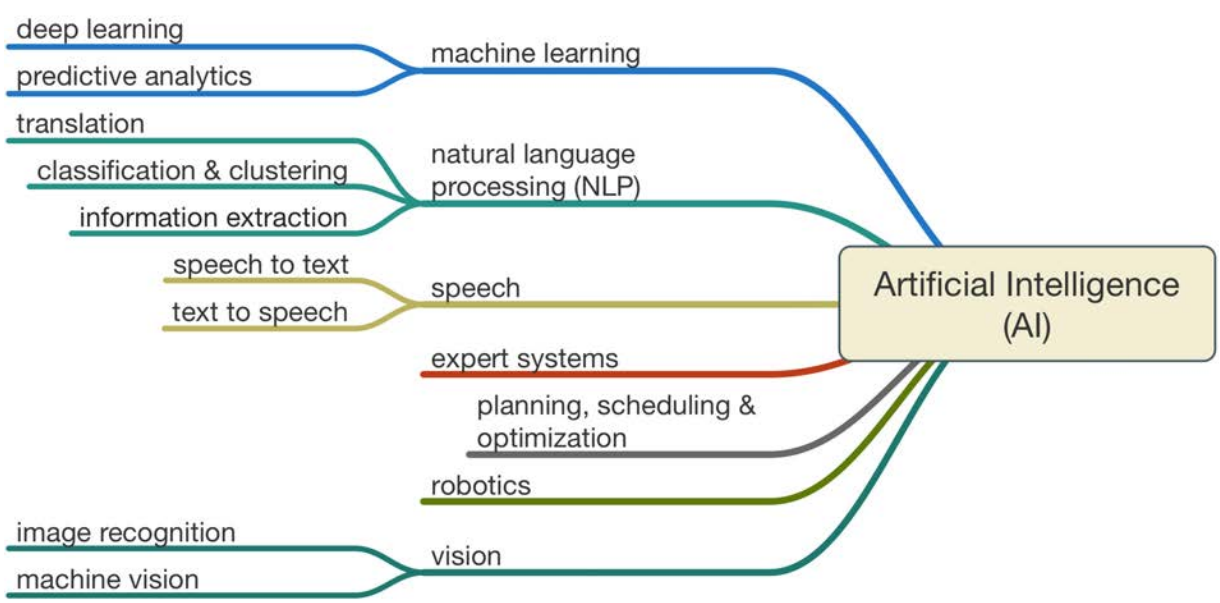


Figure 1. The sub-disciplines of Artificial Intelligence. Illustration by the author.

[5] George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving Sixth edition* (Boston: Pearson Education, 2009), 20-29.

Artificial Intelligence History

The concept of artificial intelligence began in 1947, when Allen Turing wrote the paper titled "Intelligent Machinery." Given his previous writings on mathematical computability and his experience decoding the German encryption device *Enigma* during WWII, Turing believed that "the path to creating an intelligent machine is to design a device that is analogous to the human brain in many ways." He conceived learning as one of the most important endeavors toward that end. As an early developer of theoretical computer science, Turing posed a fundamental question, "Can what the mind does be expressed as computation?"[6] With the progression of computing technology and theory, artificial intelligence developed as a distinct field of research in 1959 by Professor John McCarthy.

The theory of artificial intelligence is rooted in multiple disciplines, namely psychology, linguistics, biology, and philosophy.[7] Biologically, artificial intelligence is the continuance of evolution, as believed by some. In the book *Singularity is Near*, Ray Kurzweil discusses the evolution of biological species, asserting that the next evolutionary step is the creation of machines that can themselves create intelligent life, or general intelligence systems. This period, defined as singularity, is when the pace of technological change is so rapid that human life changes irreversibly.[8] The evolutionary clock ticks forward. However, achieving singularity requires overcoming a significant hurdle—reverse engineering and replicating the computational capacity of the human brain. This notion is significant because it implies the capacity of artificial intelligence and computer science remains largely untapped. For example, with the world's fastest supercomputers, their collective processing power is not equal in capability to the artificial intelligence employed by companies like Facebook, Google, and Amazon. In

---

[6] Harry Henderson, *Artificial Intelligence: Mirrors of the Mind* (New York: Chelsea House Publishing, 2007), 9.

[7] Coppin, *Artificial Intelligence Illuminated*, 3.

[8] Ray Kurzweil, *Singularity is Near: When Humans Transcend Biology* (London: Duckworth Overlook, 2005), 40-41.

the United States, the most powerful computing system, Titan, operated by Oak Ridge National Laboratory, is capable of nearly 18 quadrillion floating-point operations per second (petaflops).[9] While the Titan is only the fifth fastest supercomputer in the world, behind the top two Chinese record holders, these systems are capable of computational science, advanced modeling, and simulation of complex problems across various disciplines. Their massive processing power is useful for one complex problem at a time, providing and displaying the data generated by the complex problems, while failing to create linkages between the dataset.[10] Supercomputers help interpret highly complex problems, but unlike artificial intelligence, fails to perform the solution generated.

For artificial intelligence to have a credible future, it must have more capability and greater application. General artificial intelligence would operate as a subsystem of a larger system, performing systematic narrow AI tasks. These tasks, when interfaced with human-performed functions, accomplish the greater outputs of the systems than with humans alone. In the warehousing industry today, narrow artificial intelligence supports the human capacity to change the way the world distribute products. For example, Amazon uses machine learning to optimize logistics routes, natural language processing, and deep learning in its automated personal assistant, Alexa, and computer vision technology in its drone initiative.[11]

---

[9] William Gayde, "Summit supercomputer nears completion will be fastest in the world," *Techspot*, last modified 25 October 2017, accessed 1 November 2017, https://www.techspot.com/news/71583-summit-supercomputer-nears-completion-fastest-world.html.

[10] Ibid.

[11] Amazon Web Services, "Machine Learning on AWS," last modified 2018, accessed February 14, 2018, https://aws.amazon.com/machine-learning.

	THINK	ACT
HUMAN	**Machines that think like humans**	**Machines that act like humans**
RATIONAL	**Machines that think rationally**	**Machines that act rationally**

Figure 2. Philosophy of Artificial Intelligence. Ben Coppin, *Artificial Intelligence Illuminated* (Sudbury: Jones and Bartlett, 2004), 4.

Artificial Intelligence Defined

Artificial intelligence (AI), as a discipline, is the study of systems that act in a way that would appear to be intelligent.[12] There are many definitions for artificial intelligence, none of which have gained consensus, however, the following comprehensive definition contains as the most critical components to the concept of artificial intelligence and is foundational to this research. Artificial intelligence systems receive precepts from their environment and perform actions rationally to the same cognitive ability as humans. Additionally, these systems have the capacity to create and retain knowledge. This rationale combines two separate bodies of thought within the AI community—thinking and acting. The first body of thought fixates on the thought process and reasoning of artificial systems. The goal is to create systems that think like humans and/or think rationally. The second body of thought seeks to create systems that act like humans and/or act rationally, as depicted in Figure 2.[13]

This delineation is important as it drives direction of technological research and development in each body of thought relative to the foundations of artificial intelligence. This is no different from the philosophical debate of the nature of humans, debates that continue to present day. Artificial Intelligence

---

[12] Coppin, *Artificial Intelligence Illuminated*, 4.

[13] The author created Figure 2 based on Coppin's discussion of the difference in philosophy within artificial intelligence.

encompass this debate with the development of systems that appear real, but lack the ability to operate outside of strict, rule-based environments. For example, DeepBlue, an IBM supercomputer programmed to play chess, challenged the reigning World Chess Champion, Garry Kasparov to a televised chess match in May 1997. Within the context of the game, DeepBlue 'computationalized' its opponent's moves and determined the best response, by calculating thousands of chess-move scenarios per second. In the end, DeepBlue defeated the best human chess player on earth. However, DeepBlue was far from human. In fact, this system possessed only the ability perform highly specific task – to play chess. This form of artificial intelligence, capable of performing a single task, is Narrow AI. Conversely, Strong AI are machines capable of intelligent behavior across the broad range of cognitive tasks. A broad chasm still separates the Narrow AI, available today, from the much more difficult challenge of Strong AI. The consensus among experts is that Strong AI is still decades away.[14] As the subordinate technology encompassing artificial intelligence continues to evolve, there will continue to be both a general advancement of the field and a further splintering of sub-disciplines that develops, similar to the origins of political science rooted in history through Thucydides and Herodotus.

Major objections to Artificial Intelligence

As with any new technology, artificial intelligence has received its share of criticisms. For example, the mass proliferation of printed books in seventeen-century England brought both deep faculty and portability of knowledge, while also introducing tawdry novels, quack theories, and pornography; all of which critics vehemently opposed.[15] Officials speculated whether the invention of the typography brought more mischief than advantage. For artificial intelligence, the perceived capability of Strong

[14] Executive Office of the President National Science and Technology Council Committee on Technology, *Preparing for the Future of Artificial Intelligence*, October 2016, 7-8.

[15] Nicholas Carr, *The Shallows* (New York: W.W. Norton & Company, 2010), 71.

artificial intelligence receives the most scrutiny. Popular criticisms are classifiable as either fear-based or ability-based criticisms.

Fear-based criticism, though not formalized as a theory, asserts that if a machine can eventually develop the ability to speak and think, it can do evil as well.[16] Pop culture has continually popularized fear-based criticisms since the inception of the artificial intelligence discipline. Movies such as 2001: A Space Odyssey (1970), Terminator (1980/90), I-Robot (2000), and Transcendence (2010) continually reinforce the destructive faculty of Strong AI, directly countering the jubilation and euphoria from Ray Kurzweil and the theory of singularity. In fact, a chasm exists between many Silicon Valley

Figure 3. The spectrum of support for artificial intelligence. Maureen Dowd, "Elon Musk's Billion-Dollar Crusade to Stop the A.I. Apocalypse," *Vanity Fair*, April 2017, 17-21.

entrepreneurs, business owners, and scientists regarding the safety and regulation of artificial intelligence, to include Stephen Hawking, Elon Musk, and Mark Zuckerberg.[17] Depicted in the figure below is a spectrum of the protagonists and antagonists to the regulation and development of artificial intelligence. [18]

[16] Paul Ford, "Our Fear of Artificial Intelligence," *MIT Technology Review*, 11 February 2015, accessed 27 November 2017, https://www.technologyreview.com/s/534871/our-fear-of-artificial-intelligence/.

[17] Maureen Dowd, "Elon Musk's Billion-Dollar Crusade To Stop The A.I. Apocalypse," *Vanity Fair*, April 2017, accessed 15 February 2018, https://www.vanityfair.com/news/2017/03/elon-musk-billion-dollar-crusade-to-stop-ai-space-x.

[18] Dowd discusses a spectrum of critics and support for AI advancement. Figure 3 is an adaptation derived from the article.

Elon Musk, the most vocal proponent against artificial intelligence, is moderately protagonist, largely due to his urging for AI development under more government regulation.[19] Musk even founded a nonprofit research company, OpenAI, whose mission is to "build safe AGI [artificial general intelligence], and ensure AGI's benefits are as widely and evenly distributed as possible.[20] This is important because as the AI industry matures, governments will likely look to technological firm leaders to inform regulation. Despite Musk's efforts, artificial intelligence is still developing rapidly, with heavy investment by major companies across the country. However, in spite of a resource-injected industry, Strong AI has yet to bloom.[21] And while the claims of runaway Strong AI are somewhat sensationalized, fear-based criticisms serve as a stark warning of capabilities yet to be developed, abilities that some critics would contend are impossibilities.

Ability-based criticisms argue that, philosophically, artificial intelligence will never have the capacity for true intelligence, free will, or understanding. These criticisms bolster the idea that artificial intelligence operating beyond the control of humans is a myth. Thus, even if a machine has the capability to conduct intelligent activities, programming and human control still bound this machine. This is

---

[19] Ali Breland, "Elon Musk: We need to regulate AI before its too late," *The Hill*, July 17, 2017, accessed 30 January 2018, thehill.com/policy/technology/342345-elon-musk-we –need-to-regulate-ai-before-its-too-late.

[20] OpenAI, OpenAI Mission Statement, 2017, accessed 15 February 2018, https://openai.com/.

[21] Executive Office of the President National Science and Technology Council Committee on Technology, "Preparing for the Future of Artificial Intelligence," October 2016, accessed 6 December 2017, 7-8.

important because as companies innovate with artificial intelligence, their acceptance of ability-based criticisms diminishes their restraint to create more capable machine. The three major ability-based criticisms are the Turing Test, Lovelace Objection, and the Chinese Room Argument.[22] Each of these arguments are rooted in the philosophic origins are artificial intelligence, debating if a technical system can perform highly cognitive functions as well or better than humans.

The Turing test, developed by Allen Turing in 1950, is a test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human (acting humanly). During the assessment, a human subject would engage in a dialogue via computer to other entities. Unbeknownst to the human subject, the other entities would be either human or machine. The machine is deemed intelligent if, after a line questioning the human subject could not differentiate between human and machine on the other end of the computer dialogue.[23] While this test offers some relevancy to the present, critics such as Stuart Sheiber, argue that this test is insufficient in determining true intelligence. Similar to the DeepBlue dilemma mentioned earlier, a machine built specifically to master national language processing and automated reasoning functions found in the Turing test will likely not have the capability to accomplish other complex tasks. The Turing test also fails to provide a challenge to focus artificial intelligence technology to new breakthroughs.[24] In response to this criticism, developer's preference further study of the underlying principles of intelligence for societal integration rather than designing to a

---

[22] Larry Hauser, "Artificial Intelligence," *Internet Encyclopedia of Philosophy*, accessed 6 December 2017, http://www.iep.utm.edu/art-inte/#H4.

[23] Alan Turing, "Computing Machinery and Intelligence," *Mind 49*, 1950, accessed 7 December 2017, https://www.csee.umbc.edu/courses/471/papers/turing.pdf.

[24] Stuart Sheiber, "Principles for Designing an AI Competition, or Why the Turing Test Fails as an Inducement Prize," *AI Magazine 37*, Spring 2016, accessed 15 January 2018, https://search.proquest.com/docview/1786233981?accountid=28992.

test.[25] The integration of sub-disciplines of artificial intelligence into our personal computing devices is a testament to this effort.

Ada Lovelace created the Lady Lovelace Objection in the nineteenth century. As a programmer of the analytical engine, she asserted that computers are bound by their programming and thereby incapable of exercising free will. She also stated that these machines were incapable of pursuing originality or original thought, both issues constrained by computer programming. In other words, since computers cannot produce thoughts independent of human direction (e.g. programming or algorithmically) and are extremely deterministic, the system is unlikely to exceed the intellectual functionality of humans.[26] This objection still holds true. Alan Turing provided a response stating that, "if a program were sufficiently complex—and if the processor(s) on which it ran were sufficiently fast—then it is not easy to say whether the kinds of "constraints" that would remain would necessarily differ in kind from the kinds of constraints that are imposed by biology and genetic inheritance [on humans]." Turing was categorically saying that with technological advancements of the future, Lady Lovelace's objection would prove obsolete. However, the Lovelace objection still holds true at the time of this research.

American philosopher John Searle created the Chinese Room Argument as the third objection to artificial intelligence. Searle argues the impossibility of computers behaving intelligently, specifically related to consciousness, or mental states, in the same way as humans. His premise is that running a computer program that behaves in an intelligent way does not necessarily produce understanding, consciousness, or real intelligence based on the commonly shared understanding. The definition of intelligence must expand to include non-biological behavior and entities.[27]

---

25 Russell Norvig, *Artificial Intelligence: A Modern Approach* (Englewood Cliffs, NJ: Prentice Hall, 2012), 3.

26 Hauser, "Artificial Intelligence."

27 John Searle, *Rediscovery of the Mind* (Cambridge: MIT Press, 1992), 44.

Figure 4. An illustration of the Chinese Room thought experiment. John Searle, *Rediscovery of the Mind* (Cambridge: MIT Press, 1992), 44.

In his Chinese Room thought experiment, adapted above, Searle describes a room with the human subject and a set of cards printed with Chinese symbols.[28] The subject also has a set of instructions written in English. The human, who does not understand, speak, or read Chinese, can construct answers to the questions from the cards with instructions. Over time, the answers to the questions would satisfy the questioner, leading them to believe that the human subject inside the room truly understood the story, the questions, and the answers they gave. Searle's premise is that the person in the room does not understand Chinese yet the system, as a whole is able to exhibit properties that lead an observer to believe the contrary. This assertion directly contrasts the Turing test; a system that can function in a linguistic environment does not necessitate understanding by that system.[29]

---

[28] Figure 4 is an illustration inspired by the description of John Searle's Chinese Room thought experiment.

[29] Coppin, *Artificial Intelligence Illuminated,* 20-21.

Governance of Artificial Intelligence

The governance of artificial intelligence varies widely by country. Within the United States, there is an absence of legislation specifically regarding artificial intelligence. The US Department of Defense has policy guidance related specifically to autonomous weapons. While these systems integrate robotics and some artificial intelligence functionality, AI is not formally accepted or rejected within the document.[30] Abroad, the European Union Committee on Legal Affairs has a similar stance by issuing ethical principles of development, programming, and use of robots and artificial intelligence on the battlefield.[31] Several industry leaders, most famously Elon Musk, have called for more stringent and directive regulation on the development and application of artificial intelligence systems. He insists artificial intelligence represent an "existential threat to humanity," similar to the fear-based objections discussed previously.[32]

Contrarily Dr. Oren Etzioni, chief executive of the Allen Institute for Artificial Intelligence, believes industry norms established by artificial intelligence researchers will influence and keep artificial intelligence headed in a responsible direction. While he acknowledges the valid concerns of AI being an existent threat, he clearly states the risk of limiting the development of artificial intelligence in the United States. "The problem is that if we [regulate], then nations like China will overtake us."[33] Etzioni advocates for a progressive approach starting with *three rules of artificial intelligence systems* borrowed from Isaac Asimov's "three laws of robotics" as a starting point for the discussion (Figure 5). Until legislators and governments regulate artificial intelligence, companies will be at liberty to create

---

30 Department of Defense, *Autonomy in Weapons Systems*, 21 November 2012, 1-4.

31 Committee of Legal Affairs, European Parliament, 5 May 2016, 5.

32 Ali Breland, 'Elon Musk: We need to regulate AI before 'it's too late', 17 July 2017, accessed 21 January 2018, thehill.com/policy/technology/342345-elon-musk-we –need-to-regulate-ai-before-its-too-late.

33 Oren Etzioni, "How to Regulate Artificial Intelligence," *New York Times*, 1 September 2017, accessed 23 November 2017, https://www.nytimes.com/2017/09/01/opinion/artificial-intelligence-regulations-rules.html.

products in accordance with their organization's moral inclinations. Take for example Boston Dynamics, an American engineering and robotics company. Their development of humanoid robot, Atlas, recently made news headlines for its newly found gymnastic ability. This robotic system, with resident artificial

<u>Three Laws of Artificial Intelligence</u>

1. An A.I. system must be subject to the full gamut of laws that apply to its human operator.
2. An A.I. system must clearly disclose that is it not human.
3. An A.I. system cannot retain or disclose confidential information without explicit approval from the source of that information.

Figure 5. The three laws of Artificial Intelligence. Oren Etzioni, "How to Regulate Artificial Intelligence," *New York Times,* 1 September 2017, accessed 23 November 2017, 12.

intelligence technology, can negotiate various obstacles and can even execute a backflip. Boston Dynamics' technical team of engineers and scientists are only constrained by the company's ethics and guidelines on the technical abilities they create. For critics like Elon Musk, this is a terrifying discovery that requires government oversight.

Nicolas Petit, professor of law at the University of Liége, offers a framework in drafting legislation. He suggests two dominant routes to laws and regulations governing artificial intelligence—legalistic or technological. First, within the legalistic theoretical framework, lawmakers draw a list of legal fields or issues affected by AI and robots such as liability, privacy, and cyber security. Using the existing legal system, this process provides both a holistic and comprehensive methodology to developing legislation. However, this effort requires a significant investment of time and any dissent among lawmakers would stall further developments. The second approach is technological, which requires more creativity since it envisions legal issues from the bottom-up standpoint of each class of technological application such as driverless cars, social robots, and exoskeletons.[34] Nevertheless, lawmakers' lack of action will likely continue until an existential threat materializes or the technology violates the civil liberties of constituents.

This legislative leniency offers positive and negative effects. On the positive side, it enables private industries to invest, research, and innovate, thus furthering the depths of each disciplines of artificial intelligence. Large technological firms such as Google, Amazon, Apple, and Microsoft are some of the best-known beneficiaries of this political environment. Nevertheless, this general disregard by government has an adverse effect on holistic government investment and threatens to loosen the United States' grip as the artificial intelligence leader.[35] For example, the Chinese government is investing tens of billions of dollars in financial and physical capital into the artificial intelligence industry. With this level of government investment, working in concert with the state-owned companies, the environment is particularly conducive to the growth of a Chinese-based artificial intelligence technology in the future. The Chinese government is unconcerned with data protection of its residents and thus stands to benefit from the data generated by its 700-million smartphone users.[36] Nevertheless, while private industry continues to pursue and push the limits of artificial intelligence, globally, this dynamic provides the unintended opportunity for the military to maximize its planning capacity using artificial intelligence.

---

[34] Nicoas Petit, *Law and Regulation of Artificial Intelligence and Robots: Conceptual Framework and Normative Implications*, 9 March 2017, accessed 29 November 2017, http://dx.doi.org/10.2139/ssrn.2931339.

[35] "Why China's AI push is worrying," *The Economist*, 27 July 2017, accessed 5 December 2017, https://www.economist.com/news/leaders/21725561-state-controlled-corporations-are-developing-powerful-artificial-intelligence-why-chinas-ai-push.

[36] Will Ford, "China's AI awakening," *MIT Tech Review*, 10 October 2017, accessed 5 December 2017, https://www.technologyreview.com/s/609038/chinas-ai-awakening/.

Operational-level Planning

Military planning is the result of dictated action. The National Command Authority directs options to resolve conflict, and the military seeks to accomplish the desired state of affairs.[37] In essence, military planning is a means to identify and prosecute a solution. In the introductory example, the operational planning team needed to provide options that were relevant to the current operational environment, relative to the research and planning work that completed in the contingency plan. The technological revolution has fundamentally increased the interactive complexity of the global environment, influencing regional actors within the operational environments. US Army doctrine, specifically Army Doctrine Reference Publication (ADRP) 5.0 *Operations Process*, defines planning as "the art and science of understanding, envisioning a desired future, and laying out effective ways of creating that desired future.[38] For the operational level of warfare, this is termed as operational planning for the remainder of this monograph.

No specific definition for operational-level planning exists in Joint publications or US Army doctrine. However, the operational level of warfare is the link between the national-military strategic objectives and tactical employment of forces focuses on designing, planning, and execution of operations using operational art.[39] Further, United Kingdom Allied Joint Publication 5 (AJP-5) provides a specific definition that completely captures the essence of operational-level planning. AJP-5 defines operational-

---

[37] US Department of the Army, Pamphlet 525-5-500, *Commander's Appreciation and Campaign Design* (Fort Monroe: Training and Doctrine Command (TRADOC) Printing Office, 2008), 8.

[38] US Department of the Army, Army Doctrine Publication (ADP) 5-0, *The Operations Process* (Washington DC: Government Printing Office, 2015), 2-1.

[39] US Department of the Army, Field Manual (FM) 3-0, *Operations* (Washington DC: Government Printing Office, 2015), 1-5.

level planning as "military planning at the operational level to design, conduct, and sustain campaigns and major operations in order to accomplish strategic objective within given theaters or areas of operation."[40]

At this level of warfare, planning translates strategy into actions. Operational-level planning is also where conceptual planning and the art of command, interfaces with detailed planning and the science of control. This level of planning also most exclusively focused on a military solution, largely escaping the ambiguity associated with politics of warfare. Major operations after the Yom Kippur War were more concerned with achieving the military objectives than engaging in the politics of warfare. Moreover, the focus of operations was to seize, retain, or exploit the initiative. For example, in the planning phases of Operation Desert Storm, the operational-level planners, trained by the School of Advanced Military Studies were less concerned with the political ramifications of their plan than on the using operational art to achieve the military endstate.[41]

Operational art is a tool to produce understanding.[42] Therefore, campaign planning relies heavily on the commander's ability to properly frame the problem and visualize a range of possible solutions. Army doctrine states that operational art is the cognitive approach by commanders and staffs to develop strategies, campaigns, and operations to organize and employ military forces by integrating ends, ways, and means. By sequencing of tactical actions over time and space, commanders and staffs can organize the systemic defeat of an opposing force, or those strategic aims determined at the outset of operational-level planning.[43] As with any level of planning, the experience of the staff is especially critical in creating

---

[40] UK Ministry of Defence, Allied Joint Publication (AJP) 5-0, *Allied Joint Doctrine for Operational-Level Planning* (London: Government Printing Office, 2013), 1.18-1.19.

[41] Rick Adkins, *Crusade: The Untold Story of the Persian Gulf War* (New York: Houghton Mifflin Company, 1993), 109.

[42] Department of Defense, Joint Publication (JP) 5-0, *Joint Operation Planning* (Suffolk, VA, Government Printing Office, 2011),.IV-1

[43] US Army, FM 3-0, 1-20.

shared understanding, and the value of the staff will continue to increase as operations within the domains of warfare continue to expand over time.

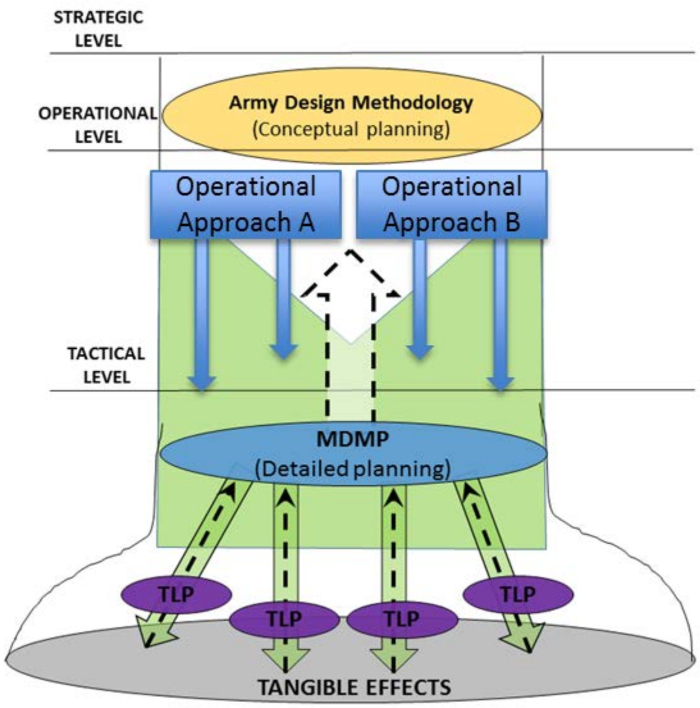
The staff is important because they provide the necessary insights that allow the commander to make an informed decision. Through critical thinking, informed analysis, and experience, the staff assists the commander with understanding situations, making and implementing decisions, controlling operations, and assessing progress.[44] These functions drive the operations process, which is the foundational framework for US Army operational-level planning.

The Army has three planning methodologies that enable planning for the employment of forces. The Army Design Methodology (ADM) and the Military Decision-Making Process (MDMP), serve as the conduit for the strategic and operational levels of war respectively, while the troop leading procedures (TLPs) enables operations solely at the tactical level. Commanders and staffs determine and use the appropriate mix of these methodologies based on the complexity of the problem, time available, and availability of the staff. Along the planning continuum, ADM is mostly conceptual in nature. The abstract nature of ADM is largely due to the complexity of the operational problems it intends to solve. MDMP easily solves well-structured problems by means of technical reduction and a systematic method-based solution. However, as the problem becomes more ambiguous and unpredictable, or ill structured, the Army Design Methodology provides the tools to think critically and creatively to understand, visualize, and describe unfamiliar problems and solutions to solve them.[45] ADM helps commanders and staffs aggregate the most relevant facts and provide an operational approach to help transition to the more

[44] US Army, ADRP 5-0, 1-2.

[45] US Army, TRADOC Pamphlet 525-5-500, 8-9.

detailed planning methodology, MDMP.[46] While conceptual planning requires some data to establish the flow of force into theater, MDMP creates much of the detailed actions within the plan (Figure 6).



The military decision-making process is the starting point for detailed planning. MDMP is the planning methodology that is iterative and more defined, establishing the framework to operationalize the

Figure 6. The US Army's planning methodologies. US Army, FM 3-0, 1-20.

concept expressed in the solution frame of ADM. MDMP is collaborative, enabling the commander and staff to understand, visualize, and describe the operational environment, advancing the process to develop a course of action for execution. It consists of a series of steps with discreet inputs and outputs. The outputs lead to an increased understanding of the operational environment and facilitate the next step of

46 US Army, ADRP 5-0, 7.

the MDMP. MDMP is largely sequential, a testament to the rigidity of the process. MDMP can be very time-consuming, and is highly subjected on the level of knowledge, proficiency, and objectivity of the staff.[47]

Human Element of MDMP

As with any organization, the division staff will carry unconscious biases, ulterior motivations, and judgments informed by each individual's experience. These internal dynamics are as much a human attribute as warfare itself. Human cognitive biases are unavoidable in planning and decision-making, unless the staff develops deliberate, objective strategies to confirm assumptions and adjust paradigms. Biases are largely due to intuitive judgment, termed *System 1* thinking, by author Daniel Kahneman.[48] Using naturally developed heuristics, or rules of thumb, military planners establish hasty cognitive 'frames' in which information is sort and processed, enabling cognitive efficiency.[49] While not all biases are bad, failure to have awareness of one's mental tendencies could be negative when planning military operations around the world.

Commanders and staffs need to understand the operational environment in order to achieve shared understanding, not only for the conduct of military operations, but also for the narrative, those military operations will communicate to the larger audience. Artificial intelligence may support more informed decisions, while minimize some obvious cognitive bias in humans. The recent employment of AI in Afghanistan, Project Maven, is proving promising at minimizing human bias. The Algorithm Cross Functional Teams provides a glimpse of the potential of human machine teaming. [50]

---

47 US Army, ADP 5-0, 8.

48 Daniel Kahneman, *Thinking Fast and Slow* (New York: Farrar, Straus and Giroux, 2011), 19

49 Ibid, 21.

50 Marcus Weisgerber, "The Pentagon's New Artificial Intelligence is already hunting terrorists," *Defense One*, 21 December 2017, accessed 29 January 2018,

Artificial Intelligence for ‘Operational-Level Planning’

The integration of emerging technology and warfare is a historically occurring phenomenon. Since the transition from lances and swords to arrows and hand cannons, advanced technology continues to heighten the lethality and destructive capacity of war. However, not all technological innovations are associated with ‘frontline fighting’. For example, when Prussian Chief of Army, Helmuth Moltke, integrated a complex system of railroads into the Prussian mobilization schema, this technology primarily supported his logistics and personnel replenishment, positively affecting his operational reach.[51] This ‘behind-the-frontline’ technology is unlike the development and employment of machine guns, which directly contributed to the increased lethality of trench warfare during World War I. The future of warfare echoes the same sentiments.

Transitioning to a multi-dimensional battlefield, conceptually, artificial intelligence technologies can be utilized as ‘sensors,’ ‘fighters,’ and ‘planners,’ or a combination therein. Each role offers a contributory effect to the conduct and application of military means—forward, at, or behind the ‘frontline.’ An Unmanned Aerial Vehicle (UAV) offers an example of forward sensor and fighting capabilities, depending on its variant and payload. Lethal Autonomous Weapons (LAW) are another example of fighting with artificial intelligence technology.

Until recently, artificial intelligence technologies for sensing and fighting are the most common suggestions for employment. Nevertheless, artificial intelligence in planning is beginning to resurface as an element of The Third Offset Strategy, leveraging emerging technologies to enhance technological superiority. Beginning with the Defense Advanced Research Projects Agency (DARPA) Strategic

---

http://www.defenseone.com/pentagons-new-artificial-intelligence-already-hunting-terrorists/144742/.

[51] Daniel J. Hughes, *Moltke on the Art of War: Selected Writings* (New York: Ballantine, 1993), 109-111.

Computing Initiative, into the contemporary Robotics and Autonomous Systems Strategy, the US Department of Defense is continuing its efforts to incorporate technology into military operations.

DARPA Strategic Computing Initiative

The Defense Advanced Research Projects Agency (DARPA) developed the Strategic Computing Initiative in 1983 as a means to fund and develop increasingly effective artificial intelligence software. This initiative approached intelligent machines as a single problem composed of interrelated subsystems. By developing subsystems cooperatively through university and industrial partnerships, Strategic Computing could map out how the systems connect and interface with the existing technologies.[52] Since its inception, the Strategic Computing Initiative held high ambitions; predicting fully automated machine intelligence at the program's end, which was scheduled ten years later. The program sought to analyze and answer critical questions regarding the support or automation of planning tasks. The research later found that the development of fully automated planning software neither possible nor deemed desirable by military, but a system supporting human capability was feasible.[53]

Two proposed military applications of the era centered on *expert systems* and *natural language understanding*. By creating an expert system with the ability to solve problems, to give advice, to predict, and to provide a rationale in a narrow area of consideration, developers sought to create a body of knowledge for military planners. This capability would operate in concert with natural language understanding giving the machine the ability to understand natural language as a communicative interface. However, computer technology of the 1980's could not interpret the native language and be able to act on that information reliably. Instead, users would have to use a stylized, formal computer

---

[52] Alex Roland, Philip Shiman, *Strategic Computing: DARPA and the Quest for Machine Intelligence* (Cambridge: MIT Press, 2002), 1.

[53] Stephen J. Andriole, "TACPLAN—An Intelligent Aid for Army Tactical Planning," in *Artificial Intelligence and National Defense: Application to C3I and Beyond* (Washington DC: AFCEA International Press, 1987), 143.

language and very limited key words to give commands to the computer.[54] While the technology of the time did not support this concept, the dialogue generated by this effort would materialize into other programs with meaningful results.

DARPA later developed the Dynamic Analysis and Replanning Tool (DART) in partnership with MITRE Corporation and Carnegie Mellon University to analyze the feasibility of an intelligent planning system. As an AI-based decision-support system, it was utilized during the Persian Gulf War to identify the logistics requirements of moving military materials across the world.[55] US Transportation Command and European Command reported this program's success because it offset the funds used by DARPA for the previous 30 years. Over the next 20 years, this program would evolve to be Joint Assistant for Development and Execution (JADE), a planning tool that supports the development of large-scale, complex deployment plans in minimal time (one hour).[56] JADE interfaces with Joint Operation Planning and Execution System (JOPES) to produces the Time Phased Force Deployment Data (TPFDD) still utilized today. DART and JADE are highly functional programs because they enabled military planners to identify and forecast problems before occurred. These systems offload the cognitive tasks of their human operations, 'cueing' these planners to points of friction in the plans. Unfortunately, these systems employ artificial intelligence at a level above the operational level, denying their employment to tactical planners.

---

[54] Randall Shumaker, Jude Franklin, "Artificial Intelligence in Military Applications," in *Artificial Intelligence and National Defense: Application to C3I and Beyon* (Washington DC: AFCEA International Press, 1987), 14-18.

[55] Antonio M. Lopez, Jerome Comello, William Cleckner, 'Machines, the Military, and Strategic Thought,' *Military Review*, September-October 2004, 15-18.

[56] Alice M. Mulvehill, Clinton Hyde, David Rager, *Joint Assistant for Deployment and Execution (JADE)* (Washington DC: Defense Advanced Research Projects Agency, 2001), 1-2.

Project ARES

US Army Communications-Electronics Command (CECOM) conducted parallel efforts with the creation of Project ARES, a decision assistant system to enable Corps level planners. Project ARES was a basic research and exploratory development investigating the application of AI methods and tools for Army corps level organizations in 1986. The goal of ARES was to demonstrate an AI based aid-performing planning for future operations and in controlling ongoing operations. Using terrain analysis, situational analysis, and course-of-action generation tools, the system was oriented to maximizing human-machine interface. These capabilities support the planning staff, diminishing the cognitive strain on a stressful environment.[57]

However, operational research found a major issue with AI planning theories being too complicated when the planner must consider the simultaneous actions of a number of executive agents with varying capabilities. The complex character modern of warfare proved too demanding for computer systems of the era to model and provide useful information.[58] Although Project ARES failed to accomplish its initial objectives, its focus on terrain analysis and Soldier –Machine interaction shifted the focus of future research to intelligent systems, spurring the creation of Force XXI systems. While these systems are useful, they merely provide situational awareness and not the task automation intended for artificial intelligence system. Additionally, these systems produce a targetable signature for advanced electronic warfare, a disadvantage of the complex battlefield.

---

[57] Gerald Powell, Gary Loberg, Harlan Black, and Martin, Gronberg, "ARES: Artificial Intelligence Research Project," in *Artificial Intelligence and National Defense: Applications to C3I and Beyond* (Washington DC: AFCEA International Press, 1987), 122-131.

[58] US Army Communications-Electronics Command (CECOM), *Acquiring Expertise in Operational Planning: A Beginnin,* (Washington DC: Governmental Printing Officer, 1986), 4-5.

Third Offset Strategy

The Third Offset Strategy is a plan to overcome adversary parity, reduced military force structure, and declining technological superiority. This multi-year effort provides direction and funding to a host of focus areas. These include anti-access and area denial (A2AD), guided munitions, undersea warfare, cyber and electronic warfare, human-machine teaming, and wargaming and concepts development.[59] One of the primary concerns addressed by the Third Offset Strategy is the risk of the United States falling dangerously behind potential adversaries who are investing heavily in advance technology, and without self-imposed restraints.[60] As the strategy continues to align ends, ways, and means under a concept, subordinate initiatives such as the Robotics and Autonomous Systems Strategy have very focused efforts that support the strategy.

Robotics and Autonomous Systems Strategy

In response to the global force modernization efforts by near-peer competitors, the US Army developed the Robotics and Autonomous Systems Strategy (RAS) in 2017, prioritizing investments and capability focus over time. The RAS has five capability objectives: increasing situational awareness, lightening Soldier load, sustaining the force, facilitating movement and maneuver, and protecting the force. The strategy focuses on human-machine teaming, also referred to as manned-unmanned teaming (MUM-T). This concept integrates people with autonomous systems or artificial intelligence to enhance decision-making speed—a much needed attribute on the contemporary battlefield. This strategy combats

---

[59] Samuel R. White Jr., *Closer Than You Think: The Implication of the Third Offset Strategy for the US Army* (Carlisle Barracks, PA: US Army War College Press, 2017), iii.

[60] White. *Closer Than You Think: The Implication of the Third Offset Strategy for the US Army*, xiv.

the challenges in the future OE: accelerated speed of action on the battlefield, increased use of RAS by adversaries, and amplified complexity of contested environments.[61]

While these objectives are a subset of the Third Offset Strategy, they provide a renewed focus of the tactical level. Nevertheless, this strategy necessitates complementary technologies at higher echelons. For example, the RAS recommends increasing the number of unmanned aircraft and ground systems at the battalion and below levels.[62] However, the substantial increase in systems for the squads, platoons, and companies of a battalion staff likely means an exponential increase in amount of data collected and processed. Without artificial intelligence systems at the higher echelons, the Division staff will be unable to keep pace with synchronizing operations. Worse, these staff could become cognitively overwhelmed with the volumes of data being transmitted, preventing them from effectively managing the holistic operating environment. Just as General Moltke introduced the intricacies of rail movements to warfare with the complementary railroad operations officer, an early form of human-machine teaming, this strategy needs a parallel effort at higher echelons.

Human Machine Team

Human machine teaming is the pairing of systems and human to offset the weaknesses of both.[63] The US Army's UAS and AH-64 Apache helicopters employ this concept, called Manned-Unmanned Teaming (MUM-T). Through this process, airborne Army AH-64 Apache pilots are able to employ and

---

[61] US Department of the Army, *Robotic and Autonomous Systems Strategy* (Fort Eustis, VA: US Army Training and Doctrine Command (TRADOC), 2017, 1-6.

[62] Institute of Land Warfare, "Integrating Army Robotics and Autonomous Systems to Fight and Win," *ILW Spotlight*, July 2017, 2.

[63] White. *Closer Than You Think: The Implication of the Third Offset Strategy for the US Army*, 33.

control unmanned systems in environments deemed too hazardous for manned aviation.[64] MUM-T enables the UAS to utilize its strengths, standoff distance, and target acquisition, to maximize the strengths of the pilot, lethality, and responsiveness. This concept serves as the basis for artificial intelligence human-machine teaming.

Within the context of artificial intelligence, the pairing of an artificial mind and human mind is the concept. The human provides objectives, creativity, and ethical thinking, while the AI mind provides self-taught experience, intuition, and forecasting ability. This capability exists within current artificial intelligence technology. For example, through algorithms, the AlphaGo system to beat the world's best player in Go, a game estimated to be 300 times more complicated than Chess.[65] The techniques used by Deep Blue, mentioned earlier, are impractical for a computer playing Go. [66] Thus, partnering machine and human, the military could maintain the 'human-in-the loop' while reaping the benefits of cued response and enhanced situational understanding, similar to the Apache helicopters pilots mentioned previously.

Summary

In summary, the convergence of artificial intelligence and military application is not a novel concept. Unfortunately, when initially conceived, the aspirations of this AI system and human planners far exceeded the technological capability of the era. Computing speed and computer science techniques have progressed exponentially within the last three decades. Given the advancements by private industry,

---

[64] Mariana Iriarte, "MUM-T operations on the U.S. Army's UAS roadmap," *Military Embedded Systems,* 19 April 2016, accessed 29 January 2018, http://mil-embedded.com/articles /mum-t-armys-uas-roadmap/.

[65] Danielle Muoio, "Why Go is so much harder for AI to beat than chess," *Business Insider,* 10 March 2016, accessed 31 January 2018, http://www.businessinsider.com/why-google-ai-game-is-harder-than-chess-2016-3.

[66] Muoio, "Why Go is so much harder for AI to beat than chess."

the use of artificial intelligence as a societal norm, and its proliferation into all other aspects of daily life, the aspirations once thought implausible in previous decades may now be on the verge of realization.

Methodology

This research determines where MDMP benefits from automation, while accounting for tradeoffs associated with such action. Additionally, The military decision making process is used at all levels of warfare in Army Headquarters, but the underlying analysis will use the Army division as the frame of reference. At the division level, the staff would be sufficient to manage multiple planning efforts through the various planning horizons. This research will first conduct an analysis of the Military Decision-Making Process, examining the specific inputs and outputs of some steps. Then, the research analyzes most relevant outputs to determine if artificial intelligence can provide the output or augment the human staff member, while also identifying whether the technology currently exists. The research will also discuss the basic technological requirements to achieve success in these subordinate processes. This section will also explore similar existing technologies within military and business applications. Lastly, the research will discuss the tradeoffs of using AI within the process, providing parallels to some analog processes that atrophy with humans' increased reliance on technological processes.

Analysis

The Military Decision Making Process consists of seven steps that integrate the functional areas of expertise called warfighting functions. MDMP has discreet inputs and outputs that enable increased understanding of the situation. MDMP is the foundation for the 'Plan' step within the Army Operations Process, followed by the Preparation, Execution, and Assessment of military operations. As outlined below, each steps has sub-processes that may or may not be more effective and timely when supported by artificial intelligence technologies. Those sub processes best supported by artificial intelligence are as follows:

Receipt of Mission

Receipt of Mission is the first step of MDMP. This step involves dissecting the higher headquarters operations order while enabling the initiation of planning.[67] It requires alerting the staff and other key participants, gathering the necessary tools, and conducting the initial assessment of the time available to plan. Receipt of mission also involves establishing the plan for planning—part of the larger Army Operations Process. Typically, the Division staff conducts parallel planning as higher echelons establish the area of operations and transitions output products for use in MDMP. MDMP incorporates elements of the Army Design Methodology (e.g. the operational approach), the conceptual nature of the ADM process requires human creativity and critical thinking. The operational approach sets the pace and trajectory of the process by establishing the timeline between the higher headquarters, the operations, the planning gateways, and enemy timelines.[68] The outputs of step one are the commander's initial guidance to the planning methodology and the issuance of the first warning order.[69]

---

[67] Department of the Army, Field Manual 6-0 *Commander and Staff Organization and Operations* (Washington DC: Government Printing Office, 2014), 9-4.

[68] E. Jerome Hillard, Steven Krippel, Adam Moore, "Strategies for Effective Time Management During the Planning Process," *Decisive Action Training Environment at the National Training Center*, September 2016, 27.

[69] Hillard. *Decisive Action Training Environment at the National Training Center*. 9-2.

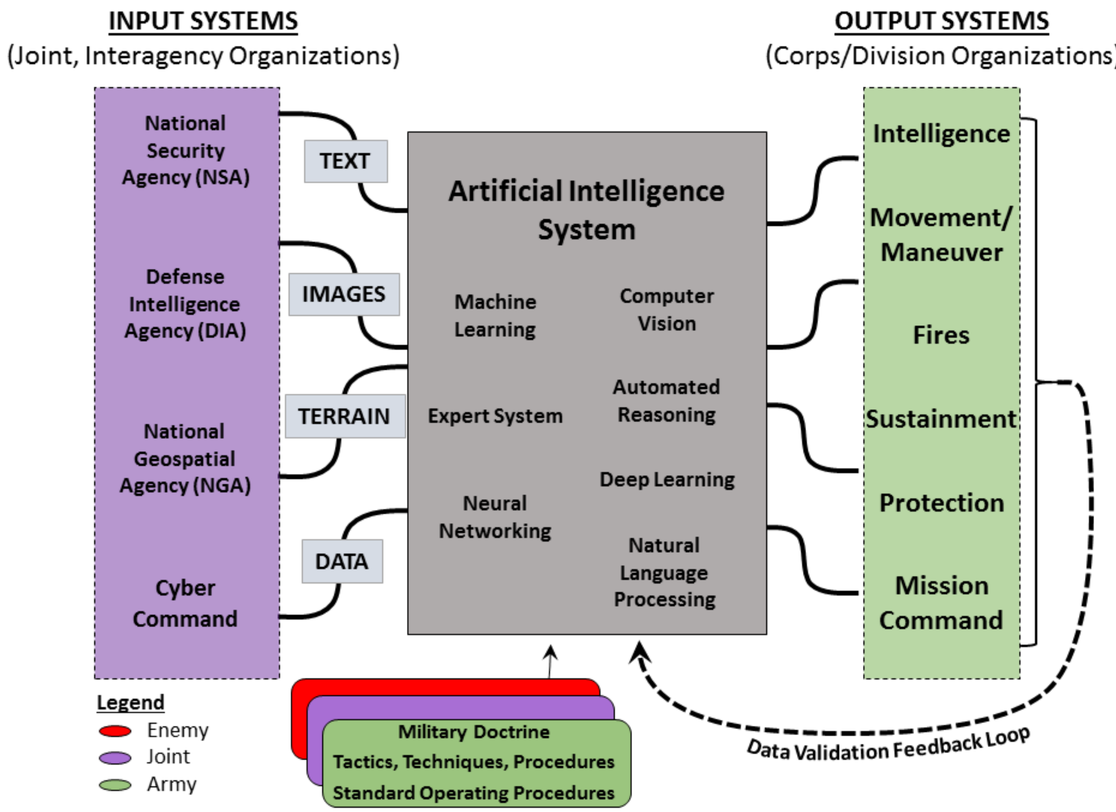


Figure 7. A graphical depiction of Mission Assistance Computing (MAC) system.

Within MDMP, artificial intelligence would provide supplemental support to the process using *cognitive computing* methods to achieve *deep learning*. Just as mission command systems are prepared and assimilated during the ‘Gather the Tools’ sub-step of step one of MDMP, the artificial intelligence system, **M**ission **A**ssistance **C**omputing or MAC, would be provided a *curated data set* consisting of higher headquarters operations order/annexes.[70] This would enable the system to make new connections within its *corpus of knowledge*, consisting of Army Doctrine, Lessons Learned, Standard Operating Procedures, but at an incredible speed and scale. This *ingestion* process would support cross-analysis of the updated staff estimates generated during step one, while allowing interaction with users to build

[70] Mission Assistance Computing is an acronym, created by the researcher, to differentiate from Mission Command-type systems such as Command Post of the Future (CPOF) and Blue Force Tracker (BFT).

better connections within the neural network of the system. Using a preformatted warning order template generated by FM 6-0 and the staff, the system would automatically populate a warning order with the information from higher headquarters. Based on the incremental access to a redundant network of joint and interagency systems, the system would correlate information, for analysis and discourse with the staff in step two of MDMP. (See Figure 7)[71]

Mission Analysis

The second step of MDMP is mission analysis. This is the most important step of MDMP because it defines the environmental context containing the problem. By continuing the assessment of the situation, mission analysis frames the operational environment to generate both the problem and mission statement, and the commander's intent that will drive operations.[72] Using the collective staffs' effort, higher, organic, adjacent, and subordinate staffs with the commander gather, analyze, and synthesize information to orient the organization to the current conditions of the operational environment.[73] The output products of step two affect the remainder of the operations process, enabling the commander and staff to continue to plan, prepare, and execute operations. If problem statement, mission statement, or commander's intent are insufficiently understood from the beginning, the likelihood of mission success diminishes greatly. Thus, every sub-step is important and relevant in planning. The illustration below discusses the sub-steps.

Within a division planning staff 'integrating cells', either the plans, future operations, or current operations cell, will have members from each warfighting functional teams responsible for a mission analysis sub-steps. With some sub-steps, every functional team is required to review, analyze, and

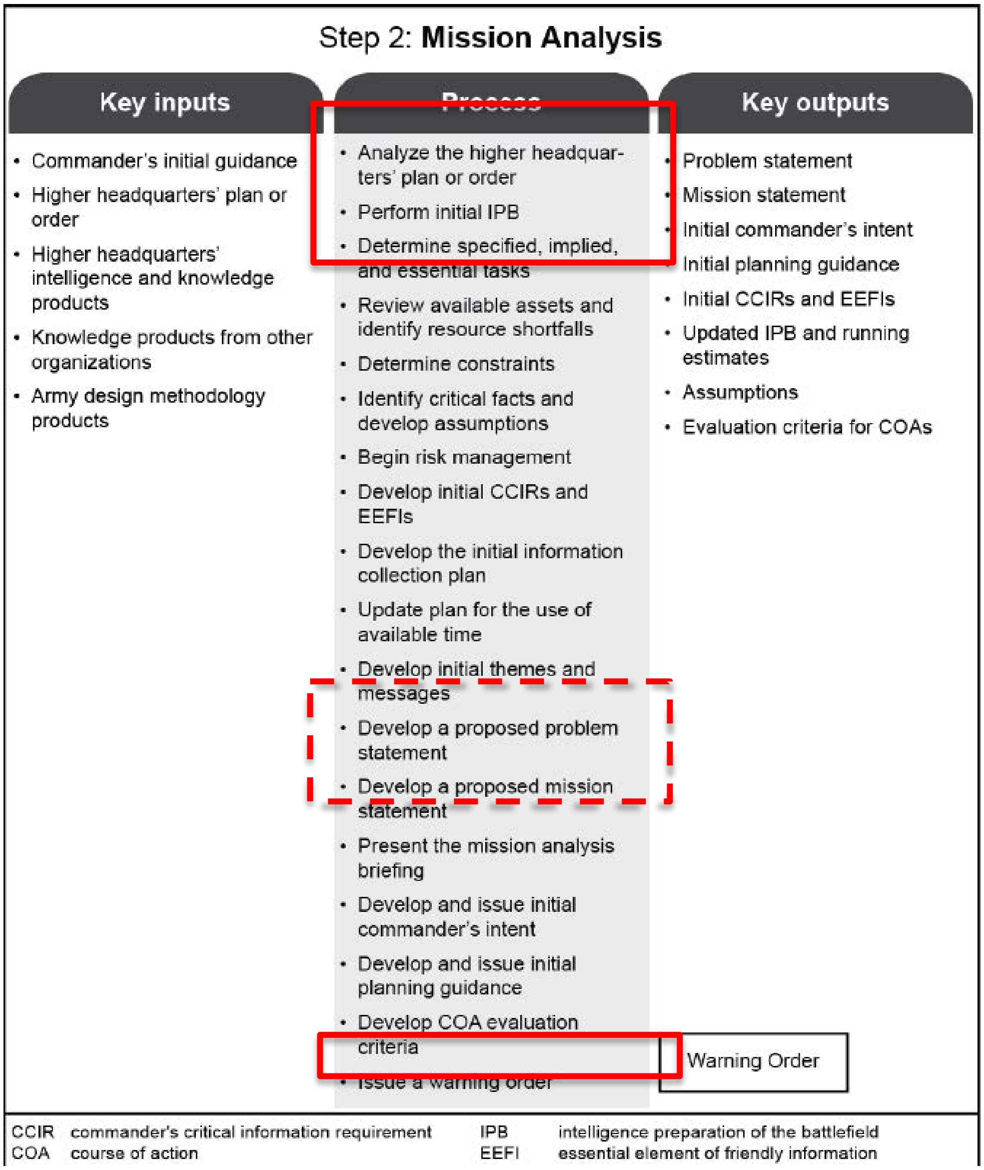
---

[71] IBM Watson: "*IBM Watson: How it Works," 2015,* accessed 23 January 2018 https://youtu.be/_Xcmh1LQB9I.

[72] US Army, FM 6-0, 9-7.

[73] Department of the Army, Army Tactics, Techniques, and Procedures (ATTP) 5-0.1 *Commanders and Staff Guide* (Washington DC: Government Printing Office, 2014), 4-6.

present relevant information to the group. For example, every warfighting function must identify, analyze, and evaluate the specified, implied, and essential tasks passed down by the higher command. With other sub-steps such as Intelligence Preparation of the Battlefield (IPB), each warfighting function provides an analysis of their respective adversarial function (e.g. friendly fires assets vs. enemy fires assets), but the Intelligence Warfighting Function manages the process. As the functional teams work through each of the sub-steps, the collective product communicates the findings to the commander in a mission analysis briefing (sub-step 14). The researcher chose sub-steps 1-3, 4, & 6 of Mission Analysis for the integrating artificial intelligence. These steps are data-driven and provide the best use for artificial intelligence.



US Army, ATTP 5-0.1, 4-6.

Analyze the higher headquarters plan or order

Upon receipt of the higher headquarters operations order and annexes, MAC would be loaded with the data. This action enabled the system to make linkages between the operations order data, preparing it for *partnered understanding* with the users. As the Army planners require information, MAC is prepared to provide answers, as well as the reasoning behind its response. For example, MAC would provide the higher command's concept of the operation at the user's request, as well as any other text information found within the order. As users become more familiar with the order and need to reference specific verbiage found throughout the annexes, MAC would be able to provide the page and other contextual information as requested, thus enabling better synchronization between echelon staffs. As information changes, MAC could be updated and alert the subordinate staff sections of the change, while also keeping a log of the changes for reference later. With the continuation of Mission Analysis into Intelligence Preparation of the Battlefield (IPB), MAC would be essential in aggregating data about the environment to help enhance the situational understanding for the staff.

Perform Initial Intelligence Preparation of the Battlefield

Intelligence Preparation of the Battlefield (IPB) is the systematic process of analyzing the mission variables of enemy, terrain, weather, and civil considerations to determine their effect on operations for both enemy and friendly forces.[74] IPB offers insight into the interaction of the friendly and threat forces through facts and assumptions. By identifying critical gaps in planning, IPB also drives the commander's intelligence collection efforts.[75] These efforts generate intelligence knowledge and further refine the operational picture, providing the commander a stronger foundation of understanding to make decisions. IPB consists of four steps: Define the operational environment, Describe the Environmental Effects on Operations, Evaluate the Threat, and Determine Threat Courses of Action. The data used to

---

[74] ATTP 5-0.1, 9-8.

[75] US Department of the Army, Army Training Publication (ATP) 2-01.3, *Intelligence Preparation of the Battlefield* (Washington DC: Government Printing Office, 2014), 1-8.

carry out the steps gathered from a wide array of sources. Once curated geospatial data, enemy model data, infrastructure data, and climatological data are uploaded, this allows MAC to compile the data and offer some correlation not immediately apparent to the planners. This human-machine teaming, or tethered autonomy, supports the staff in gaining a deeper understanding of the environment through iterative dialogue and partnered learning.

Similar to the Amazon Echo, Alexa, or Google Home technology, MAC would answer questions regarding any of the content within its database. For instance, "MAC, tell me about the population centers of Atropia." The system would provide information regarding cultural and demographic attributes of the population, as well as the condition of the infrastructure therein. Querying near real-time social media data, the system could provide atmospheric that later informs course-of-action planning (e.g. hostile vs. neutral human terrain). With natural language processing (NLP) and question-answering technology (QA), the system could engage in a dialogue with the user to facilitate better understanding.[76] During these interactions, the user would be in total control of the engagement, shifting the dialogue to ascend the cognitive hierarchy from data, to information, to understanding. This level of dialogue between humans and machines exists in the commercial industry at the time of this research.

Many homes within the United States already deploy Natural Language Processing technology. The next evolution of this technology is enabling the system to ask probing questions to provide better responses to the user's query. QA technology is also in existence, the latest example being IBM's Watson, which used this tech to win the show Jeopardy.[77] As with any system, its improvement is strongly dependent on feedback, and MAC would be no different. The system would solicit feedback for

---

[76] David Ferrucci, Eric Brown, Jennifer Chu-Carroll, "Building Watson: An Overview of the DeepQA Project," *AI Magazine*, Fall 2010, 1/24.

[77] Ibid, 21/24.

the answers provided to users as a quality assurance mechanism to the interaction. The feedback would allow the data curator to adjust the data within the set while also fine-tuning the algorithms as necessary.

At the completion of IPB, MAC would provide mobility data to inform the friendly and adversarial COAs. This would include real-time movement conditions via satellite imagery analysis and other data feeds from interagency sources, attributes demonstrated with artificial intelligence conducted in years past.[78] As planning continues, MAC would prompt the planners of assumptions validated or proven invalid in addition to any other formally requested alerts to the user(s). This capacity expands upon existing technology employed by Project Maven, an artificial intelligence technology deployed in Afghanistan in 2018 to support intelligence analyst with image intelligence (IMINT).[79]

Together, the user and MAC would generate the IPB outputs most heavily utilized throughout MDMP, the event template, initial information requirements, decision support matrix, and decision support template. In assisting the user, MAC would provide suggested entries for either editing or complete change. With time and observation of approved products, MAC would improve its suggestions to user, particularly with Problem Statements and Mission Statements.

Determine specified, implied, and essential tasks

A task is a clearly defined and measurable activity accomplished by Soldiers, units, organizations, that may support tasks. Specified tasks are explicitly stated in the higher headquarters' order or guidance. Implied tasks must be performed to accomplish a specified task, though these tasks may not be explicitly stated. Lastly, essential tasks must be completed to accomplish the mission. Essential tasks are either

---

[78] James Donlon and Kenneth Forbus, "Improving Digital Terrain with Artificial Intelligence," *Army AL&T*, November-December 2001, 32-33.

[79] Gregory C. Allen, "Project Maven brings AI to the fight against ISIS," *Bulletin of the Atomic Scientists*, 21 December 2017, accessed 5 January 2018, https://thebulletin.org/project-maven-brings-ai-fight-against-isis11374.

specified or implied tasks, but will always be part of the mission statement during operations. The staff must find, understand, and account for every required task to better plan and execute operations.[80]

Typically, staff planners scour the higher headquarters operations order and annexes, sometimes in excess of 50 pages of text, attempting to identify any tasks related to or involving a particular warfighting function. While this method is tedious, it extracts any specified and implied tasks that may be critical to conducting operations. This method also enhances the understanding of the staff by generating clarifications between the echelons of command. However, at higher echelons, where the operations orders can be hundreds of pages with numerous annexes, the ability to process all the tasks can be overwhelming. Even worse, this process takes time and few staff members actually read all the orders for comprehension, leading to lapses in planning.

Using text-scanning software, MAC would scan orders, annexes, and written guidance to provide a composite of tasks relevant to the queried unit and warfighting function. For example, a sustainment planner would ask, "MAC, please pull all the tasks from XVIII Corps order number 12-345 relevant to 1st Armored Division and the Sustainment warfighting function." MAC would then display the results while verbally providing a holistic description of the number of tasks. Upon confirmation from the sustainment planning, which references the provided source pages, the relevant tasks populate the sustainment-running estimate. This process occurs iteratively among each warfighting function simultaneously, diverting the staff's efforts from countless hours of reading and searching to analyzing and synthesizing knowledge for the next stages of planning.

Propose Problem/Mission Statement

The problem statement provides the issue or obstacle that prevents the achievement of a desired goal or objective. Though ADM informs the problem formulation, the sub steps of Mission Analysis

80 US Army, FM 6-0, 9-8.

provide the proper context to frame the operational environment and the operational problem. The problem statement helps the commander and staff develop solutions to achieve the desired objective.[81]

The mission statement is the short sentence or paragraph that describes the organization's essential task, purpose, and action. Derived from the unit's essential tasks, the staff proposes a mission statement for the commander's approval. Higher headquarters' operations orders and commander's guidance inform a unit's mission, making the mission statement formulaic and thus calculable by an artificial intelligence program.[82]

While, artificial intelligence has the capability to aggregate, identify, and recall data, it still lacks the capability of abstract thought necessary to create a problem statement independently. Nevertheless, since the mission statement is formulaic, using specific inputs from the unit's specified and implied tasks, MAC could suggest a mission statement. Using the same methodology that military planners use, the system would provide suggestions and continually receive user feedback that would enable improvement over time through deep learning techniques. MAC would also have the capability to examine, analyze, and classify the causal links between the user-produced products, allowing its deep reinforcement-learning store and generate recommendations for future application.

Issue Warning Order

The system would be capable of producing an updated warning order, based off the approved data from the mission analysis briefing and the previous warning order drafts. Users would approve data fields of the draft warning orders, editing any information as necessary for subordinate units. Additionally, the system would provide updated input data for the future operations order (step 7), updating the data fields as the plan is developed and refined. The system would also prompt users to new information from fragmentation orders processed from higher headquarters. For example, if the higher command approved

81 US Army, FM 6-0, 9-10.

82 US Army, FM 6-0, 9-12.

a unit boundaries change to reconcile the battlespace, MAC would update COA development team and suggest an update to the operations order template, alerting the planning staff to the information and the portion of the planning affected.

Course of Action Development

Course of Action Development is the method to generate options for the commander. Using tactical actions synchronized between subordinate units, the COA is a broad potential solution to the identified problem. COA Development consists seven subordinate steps; Assess Relative Combat Power, Generate Options, Array Forces, Develop a Broad concept, Assign Headquarters, Develop Course of Action Statements and Sketches, and Conduct a Course of Action Briefing. Human planners would still be the primary agents in completing these steps. The artificial intelligence technologies of today have not demonstrated the ability to orchestrate courses of action, taking into account the level of detail required to plan fires, synchronize intelligence assets, and arrange movement formations. MAC would support each sub-steps by providing an analysis of movement over time, using terrain data, climate data, and vehicle-specific mobility data. This technology is similar to Google Maps, but incorporates a more robust algorithm to account for cross-country mobility, formation size, movement corridors, and vehicle types. Analysis from MAC would sharpen the accuracy of the timeline and provide better synchronization for the entirety of the plan. As planners develop the synchronization matrix for each course of action, MAC would populate the COA statement with inputs from the COA team by warfighting function, enabling collaboration. Once the selected COA(s) advances to the next step, War Gaming, MAC assists in determining attrition and relative combat power over time.

Course of Action Analysis (War Game)

The War game enables commanders and staffs to identify difficulties and coordination problems associated with considered COAs. By reality testing the assumptions and actions within the plans, organizations can anticipate potential risks, friction points, and actions (friendly and enemy) that would prevent mission accomplishment. This step also influences the commander's appreciation of the operational problem by determining if the proposed solution will bring about the proposed endstate. In the event the proposed COA's are not feasible, acceptable, suitable, complete, or distinguishable, the COA returns to the development process for refinement.[83]

With this step, MAC would provide two functions. The most involved effort would be the creation of a computer-aided modeling and simulation for each COA. This option is very time-consuming considering the COA data requires updating. The user would have to verify the data gathered from system inputs (e.g. headquarters, task force composition, etc.) in order to properly array forces and fight the plan. The second function is less intensive and involves calculating the outcomes of each engagement. This function is important because it provides an analysis of the combat power over time. It also provides an assessment of the effectiveness of tactical actions, preserving enough combat power to achieve the mission and desired endstate. MAC would take into account technical weapons data; kill probability, and vehicle armament data to provide results. The human planner would still be responsible for the war-gaming method and conducting the wargame briefing. The outputs of this step would not involve artificial intelligence.

Orders Production, Dissemination, and Transition

The final step of the MDMP is Orders Production, Dissemination, and Transition. In this step, planning transitions into execution phase of the Operations Process. Step 7 consists of producing and disseminating the operations order, annexes, and appendices. During this process, the staff is responsible for reconciling any discrepancies of gaps in planning due to oversight, or changes in the base plan. Additionally, the staff is liaising with their higher command, appropriately reflecting critical changes in the operating environment and military plans. Each warfighting function has a designated section of the operations order to complete and all sections must ensure the collective product is coherent,

[83] US Army, FM 6-0, 9-26.

comprehensive, and complete. In an Army division, the cell has a designated person responsible for writing the input to the operations order, along with a designee who compiles all the section into the final order.[84]

MAC, using the data inputs throughout process, would be the primary agent executing within this task. For example, the system would read the COA statement from the approved COA sketch and use this text as the basis for the concept of the operations section. Since the system ingested the higher headquarters' situation and concept of the operations paragraphs, it would provide these as a recommendation for the division's order accounting the revisions within the data set.

This same activity would occur for the respective annexes and appendices for each warfighting function. Additionally, the system would review the newly entered data against supporting document already submitted within the system, cueing the user to discrepancies or gaps in planning between the documents, similar to a more robust spell and grammar check, aide like the Grammarly program.[85] For example, if the Sustainment Annex has a directive fundamentally inconsistent with the Scheme of Maneuver narrative, the system would make this correlation and prompt the user to the issue. Once reconciled, the user would submit the section allowing the designated compiler to complete the project. The designee compiling the order would be the system user approving, editing, and reviewing the data as transposed on a computer. This technology is an adaptation of the Smart Reply technology currently utilized by Google's application. Using deep neural network capable of writing email, this form of artificial intelligence analyzes the content of an email and applies a complex set of programmed rules to

[84] US Army, FM 6-0, 9-28.

[85] Martin Welker, "The Future of Productivity: AI and Machine Learning," *Entrepreneur*, July 2017, accessed 31 January 2018, https://www.entrepreneur.com/article/295264.

construct a response.[86] Humans are not involved in the process; the algorithm is continuing to process natural language through machine learning and exposure to content.

With MDMP complete and the order packaged for distributed, MAC would continue to support the staff by recommended text entries within the annexes and appendices. As changes continue throughout the operations process, MAC would continue to provide cues to the collective staff for changes from the higher order. Additionally, as subsequent MDMP occurs, MAC would recommend changes to the evolution of the operating environment. This iterative process would continue until the Division deployment is complete, in which case, the data set is analyzed and adapted for future systems. The curated data set is would be classified appropriately refined to account for the feedback of the previous users, creating a better system over time.

Technological Tradeoffs

With the use of any technology, humans fundamentally adapt to better its utility. The human interaction and dependency on present-day mobile devices best demonstrates this cognitive adaptation. In Nicholas Carr's writing, *The Shallows*, he discusses how humans have shorter attention spans, stymied focus skills due to our interaction with personal computing devices.[87] With the convergence of artificial intelligence and operational-level planning, military planners risk becoming dependent on the speed and ease of use the technology provides. This possibility is similar to the correlation between world's dependence of Google to find information (speed and ease of use) and the atrophy of the skills to think deeply and remember information.[88] In either case, the US Army risks planners with less adaptability in

---

[86] J.D. Biersdorfer, "How to Use Smart Reply in Gmail Inbox," *New York Times*, Dec 2015, accessed 27 January 2018, https://nyti.ms/2Br75UI.

[87] Nicholas Carr, *The Shallows* (New York: W.W. Norton & Company, 2010), 71.

[88] Ibid, 90-94.

highly contested and austere environments at the division level.[89] However, training with degraded systems mitigates this risk. In addition, planners would still use MDMP without artificial intelligence at lower echelons, thus retaining the skill to plan analog. Another risk is a potential decrease in face-to-face collaboration between the echelons of planning staff, since the systems pulls and archives OPORD information electronically. This effect is similar to the correlation between increased email communications and decrease physical communication. Each of these effects is unavoidable, but do not significantly hinder the conduct of military planning. In fact, these risks are worth the promise of efficiency, speed, and accuracy with integrating artificial intelligence into operational-level planning.

Conclusion

Artificial intelligence is more wedded to societal norms than ever before. This technology accompanies humans in nearly every aspect of their lives. The advancements in the deep reinforcement learning and expert systems technology are proliferating private enterprise. However, the US military is only witnessing a small fraction of the power of artificial intelligence. As other developed nations invest exponentially in AI technology, the US is falling behind the innovative curve. Without increased, incremental integration of AI into military planning cells and operational planning teams, the operations process will not be advantageous for the future. Moreover, the US Army stands to witness a battlefield that eludes our cognitive ability to plan, prepare, and execute, adapt to operations using MDMP.

By analyzing MDMP through the capabilities of artificial intelligence, this research identified potential efficiencies and positive performance gained through a partial convergence. Artificial intelligence technologies should be incrementally integrated into Army Division-level MDMP to be

---

[89] Nicholas Carr discusses the correlation between people's exposure to digital media and the shortening of their attention span over time. Army planner's loss of adaptability compare cognitive performance between planning with AI and planning without AI.

leverage its capability. Current artificial intelligence technologies can support some aspects MDMP, but only after being specific adaptation for military use. Future research should investigate the expansion of an Army Cross Functional Team, which currently uses AI technology in a combat environment, to incorporate the planning process into their scope. Lastly, research should investigate the benefits of AI across all warfighting functions.

Bibliography

Adkins, Rick. *Crusade: The Untold Story of the Persian Gulf War*. New York: Houghton Mifflin Company, 1993.

Allen, Gregory C. "Project Maven brings AI to the fight against ISIS," *Bulletin of the Atomic Scientists*, December 21, 2017. Accessed January 5, 2018. https://thebulletin.org/project-maven-brings-ai-fight-against-isis11374.

Amazon Web Services. "Machine Learning on AWS," last modified 2018. Accessed February 14, 2018. https://aws.amazon.com/machine-learning.

Andriole, Stephen J. "TACPLAN—An Intelligent Aid for Army Tactical Planning," in *Artificial Intelligence and National Defense: Application to C3I and Beyond.* Washington DC: AFCEA International Press, 1987.

Antonio M. Lopez, Jerome Comello, William Cleckner. "Machines, the Military, and Strategic Thought." *Military Review,* September-October 2004. Accessed January 29, 2018. http://www.au.af.mil/au/awc/awcgate/milreview/lopez.pdf.

Biersdorfer, J.D. "How to Use Smart Reply in Gmail Inbox." New York Times, Dec 2015. Accessed January 27, 2018. https://nyti.ms/2Br75UI.

Breland, Ali. "Elon Musk: We need to regulate AI before its too late." *The Hill*, 17 July 2017. Accessed January 30, 2018. http://thehill.com/policy/technology/342345-elon-musk-we –need-to-regulate-ai-before-its-too-late.

Carr, Nicholas. *The Shallows*. New York: W.W. Norton & Company, 2010.

Committee of Legal Affairs. *Recommendations to the Commission on Civil Law Rules on Robotics.* European Parliament, 2016.

Coppin, Ben. *Artificial Intelligence Illuminated*. Sudbury: Jones and Bartlett, 2004.

Department of Defense. *Autonomy in Weapons Systems*. Washington DC: Government Printing Office November 21, 2012.

Department of Defense. Joint Publication (JP) 5-0, *Joint Operation Planning*, Suffolk, VA, Government Printing Office, 2011.

Donlon, James and Kenneth Forbus. "Improving Digital Terrain with Artificial Intelligence." *Army AL&T,* November-December 2001.

Dowd, Maureen. "Elon Musk's Billion-Dollar Crusade To Stop The A.I. Apocalypse." *Vanity Fair*, April 2017. Accessed 15 February 2018. https://www.vanityfair.com/news/2017/03/elon-musk-billion-dollar-crusade-to-stop-ai-space-x.

Executive Office of the President National Science and Technology Council Committee on Technology. *Preparing for the Future of Artificial Intelligence*, October 2016.

Etzioni, Oren. “How to Regulate Artificial Intelligence,” September 1, 2017. Accessed November 23, 2017. https://www.nytimes.com/2017/09/01/opinion/artificial-intelligence-regulations-rules.html.

Ferrucci, David, Eric Brown, Jennifer Chu-Carroll. “Building Watson: An Overview of the DeepQA Project,” *AI Magazine*, Fall 2010.

Ford, Paul. “Our Fear of Artificial Intelligence.” *MIT Technology Review*, February 11, 2015. Accessed November 27, 2017. https://www.technologyreview.com/s/534871/our-fear-of-artificial-intelligence/.

Ford, Will. “China’s AI awakening.” *MIT Tech Review*, October 10, 2017. Accessed December 5, 2017. https://www.technologyreview.com/s/609038/chinas-ai-awakening/.

Gayde, William. "Summit supercomputer nears completion will be fastest in the world," *Techspot*, last modified October 25, 2017. Accessed Nov 1, 2017. https://www.techspot.com/news/71583-summit-supercomputer-nears-completion-fastest-world.html.

Henderson, Harry. *Artificial Intelligence: Mirrors of the Mind.* New York: Chelsea House Publishing, 2007.

Hauser, Larry. “Artificial Intelligence,” Internet Encyclopedia of Philosophy. Accessed December 6, 2017. http://www.iep.utm.edu/art-inte/#H4.

Hillard, E. Jerome, Steven Krippel, and Adam Moore, “Strategies for Effective Time Management During the Planning Process,” *Decisive Action Training Environment at the National Training Center*, September 2016.

Hughes, Daniel J. *Moltke on the Art of War: Selected Writings*. New York: Ballantine, 1993.

IBM Watson. “*IBM Watson: How it Works.*” Accessed January 29, 2018. https://youtu.be/_Xcmh1LQB9I.

Institute of Land Warfare at Association for the United States Army (AUSA). “Integrating Army Robotics and Autonomous Systems to Fight and Win.” *ILW Spotlight*, July 2017, 2.

Iriarte, Mariana. “MUM-T operations on the U.S. Army’s UAS roadmap.” *Military Embedded Systems.* April 19, 2016. Accessed January 29, 2018. http://mil-embedded.com/articles /mum-t-armys-uas-roadmap/.

Kahneman, Daniel. *Thinking Fast and Slow*. New York: Farrar, Straus and Giroux, 2011.

Kelly, John E. *Computing, Cognition and the Future of Knowing*. Somers: IBM Global Services, 2015.

Kurzweil, Ray. *Singularity is Near: When Humans Transcend Biology*. London: Duckworth Overlook, 2005.

Luger, George F. *Artificial Intelligence: Structures and Strategies for Complex Problem Solving Sixth edition*. Boston: Pearson Education, 2009.

Mcleary, Paul. "Army Looks to Replace $6 Billion Battlefield Network After Finding It Vulnerable." *Foreign Policy*, November 21, 2017. Accessed December 26, 2017. http://foreignpolicy.com/ 2017/11/21/ army-looks-to-replace-6-billion-battlefield-network-after-finding-it-vulnerable/.

Mulvehill, Alice, Clinton Hyde, David Rager. *Joint Assistant for Deployment and Execution (JADE)*. Washington DC: Defense Advanced Research Projects Agency, 2001, 1-2. Accessed November 22, 2018. http://www.dtic.mil/get-tr-doc/pdf?AD=ADA398021.

Muoio, Danielle. "Why Go is so much harder for AI to beat than chess," *Business Insider*, March 10, 2016. Accessed 31 January 2018. http://www.businessinsider.com/why-google-ai-game-is-harder-than-chess-2016-3.

Norvig, Russell. *Artificial Intelligence: A Modern Approach*. Englewood Cliffs, NJ: Prentice Hall, 2012.

OpenAI. OpenAI Mission Statement, 2017. Accessed February 15, 2018. https://openai.com/about/.

Petit, Nicoas. *Law and Regulation of Artificial Intelligence and Robots: Conceptual Framework and Normative Implications*, March 9, 2017. Accessed November 29, 2017. http://dx.doi.org/10.2139/ssrn.2931339.

Powell Gerald, Gary Loberg, Harlan Black, and Martin, Gronberg. "ARES: Artificial Intelligence Research Project," in *Artificial Intelligence and National Defense: Applications to C3I and Beyond*. Washington DC: AFCEA International Press, 1987.

Roland, Alex, Philip Shiman. *Strategic Computing: DARPA and the Quest for Machine Intelligence*. Cambridge, MA: MIT Press, 2002.

Searle, John. *Rediscovery of the Mind*. Cambridge, MA: MIT Press, 1992.

Sheiber, Stuart. "Principles for Designing an AI Competition, or Why the Turing Test Fails as an Inducement Prize," *AI Magazine* 37, Spring 2016. Accessed January 15, 2018. https://search.proquest.com/docview/1786233981?accountid=28992.

Shumaker, Randall, Jude Franklin. "Artificial Intelligence in Military Applications," in *Artificial Intelligence and National Defense: Application to C3I and Beyond*. Washington DC: AFCEA International Press, 1987.

Turing, Alan. "Computing Machinery and Intelligence," *Mind 49*, 1950. Accessed December 7, 2017, https://www.csee.umbc.edu/courses/471/papers/turing.pdf.

"Why China's AI push is worrying." *The Economist*, July 27, 2017. Accessed December 5, 2017. https://www.economist.com/news/leaders/21725561-state-controlled-corporations-are-developing-powerful-artificial-intelligence-why-chinas-ai-push.

UK Ministry of Defence. Allied Joint Publication (AJP) 5-0, *Allied Joint Doctrine for Operational-Level Planning*. London: Government Printing Office, 2013.

U.S. Army Communications-Electronics Command (CECOM). *Acquiring Expertise in Operational Planning: A Beginning.* Washington DC: Governmental Printing Officer, 1986, 4-5.

US Department of the Army. Army Doctrine Publication (ADP) 5-0, *The Operations Process*. Washington DC: Government Printing Office, 2015.

———. Army Training Publication (ATP) 2-01.3. *Intelligence Preparation of the Battlefield*, Washington DC: Government Printing Office, 2014.

———. Field Manual (FM) 3-0, *Operations*. Washington DC: Government Printing Office, 2015.

———. Field Manual (FM) 6-0 *Commander and Staff Organization and Operations*. Washington DC: Government Printing Office, 2014.

———.Field Manual (FM) 101-5, Staff Officers' Field Manual: Staff Organization and Procedures. Washington, DC: Government Printing Office, 1972.

———. Pamphlet 525-5-500, *Commander's Appreciation and Campaign Design*, Fort Monroe: Training and Doctrine Command (TRADOC) Printing Office, 2008.

———. *Robotic and Autonomous Systems Strategy*. Fort Eustis, VA: US Army Training and Doctrine Command TRADOC, 2017.

Weisgerber, Marcus. "The Pentagon's New Artificial Intelligence is already hunting terrorists." *Defense One*, December 21, 2017. Accessed January 29, 2018. http://www.defenseone.com/pentagons-new-artificial-intelligence-already-hunting-terrorists/144742/.

Welker, Martin. "The Future of Productivity: AI and Machine Learning." *Entrepreneur*, July 2017. Accessed January 31, 2018. https://www.entrepreneur.com/article/295264.

White Jr., Samuel R. *Closer Than You Think: The Implication of the Third Offset Strategy for the US Army*, Carlisle Barracks, PA: United States Army War College Press, 2017.