Artificial Intelligence and Operational Art: The Element of Grip

A Monograph

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The United States lacks a deliberate theory of artificial intelligence (AI) warfare. This contributes to the lack of discussion of the implications of AI at the operational level of war. AI is typically defined using a technological lens devoid of implications for operational art. The proposed new element of operational art "grip," explains the fundamental relationship between AI and humans across two spectrums: autonomy and role-exchange. Grip sets the foundation for a theory of AI warfare that proposes a hypothesis for actions, in addition to revealing the necessity for altering mission command theory. The development of AirLand Battle and the resulting formal emergence of the operational level of war (and operational art) is a historically similar case of how key assumptions influence battlefield visualization. Removing the assumption of "human in the loop" AI warfare reveals a new element of operational art is required to arrange forces in time, space, purpose, in addition the Army mission command theory needs to adjust to enable a commander to move between forms of grip.

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Abstract

Artificial Intelligence and Operational Art: the Element of Grip, by MAJ Michael D. Pritchard, US Army, 57 pages.

The United States lacks a deliberate theory of artificial intelligence (AI) warfare. This contributes to the lack of discussion of the implications of AI at the operational level of war. AI is typically defined using a technological lens devoid of implications for operational art. The proposed new element of operational art "grip," explains the fundamental relationship between AI and humans across two spectrums: autonomy and role-exchange. Grip sets the foundation for a theory of AI warfare that proposes a hypothesis for actions, in addition to revealing the necessity for altering mission command theory. The development of AirLand Battle and the resulting formal emergence of the operational level of war (and operational art) is a historically similar case of how key assumptions influence battlefield visualization. Removing the assumption of "human in the loop" AI warfare reveals a new element of operational art is required to arrange forces in time, space, purpose, in addition the Army mission command theory needs to adjust to enable a commander to move between forms of grip.

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Acronyms

AI	Artificial Intelligence
ALB	AirLand Battle
AWS	Autonomous Weapon System
C4I	Command, Control, Communications, Computer, and Intelligence
DOD	Department of Defense
EB	Extended Battlefield
EMS	Electromagnetic Spectrum
HITL	Human in the Loop
HOOL	Human Off of Loop
HOTL	Human On the Loop
IB	Integrated Battlefield
MDO	Multi-Domain Operations
ML	Machine Learning
OODA	Observe, Orient, Decide, Act
OPCON	Operational Control
TACON	Tactical Control
US	United States
TDY	Temporary Duty
WIC	Weapons Instructor Course

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Introduction

> Robotics and Artificial Intelligence can fundamentally change the nature of warfare . . . whomever gets there first will dominate the battlefield.
>
> — Secretary of the Army Dr. Mark Esper, 2018

> AI has become a new focus of international competition. AI is a strategic technology that will lead in the future; the world's major developed countries are taking the development of AI as a major strategy to enhance national competitiveness and protect national security.
>
> — China's Artificial Intelligence Development Plan, 2018

Artificial Intelligence (AI) is anticipated to dramatically change the character of war in the 21st century. The potential applications of AI are only limited by the imagination and public policy. AI possesses the potential to reduce decision cycle time beyond the theoretical human limit. AI is also anticipated to perform *command and control* functions of human, machine, and hybrid formations.[1] The potential of AI within Autonomous Weapons Systems (AWS) is equally boundless: distributed manufacturing, swarming, and miniaturized advanced sensors create a multitude of configuration permutations for future commanders. The myriad problems associated with the technical, ethical, and conceptual questions surrounding AI have clouded how this technology may be integrated above the tactical level of war. Modern militaries have struggled for centuries to properly integrate evolutionary (and revolutionary) technological advancements. Railroad technology during the US Civil War contributed to both "railhead" armies and General Grant's victories in the Vicksburg Campaign. Twenty-five years later, the French ignored Prussia's railway experimentation to the Third Empire's peril, while failing to grasp the

[1] The definition of *command and control* is currently under revision within the draft version of *Army Doctrinal Publication (ADP)* 6-0, *Mission Command: Command and Control of Army Forces (Draft)*. Dr. Greg L. Zacharias, *Autonomous Horizons: The Way Forward* (Maxwell AFB, AL: Air University Press, 2019), 46, is one of the few service roadmaps that specifically mentions AI *controlling* humans in combat. As AI capability evolves, we will more than likely encounter what Kuhn describes as an 'anomaly' regarding the definition of *command*. Thomas Kuhn, *The Structure of Scientific Revolutions.* (Chicago: University of Chicago Press, 1970), 52.

advantage of the chassepot rifle. Carl von Clausewitz stated in *On War*, that every age had its own kind of war and preconceptions.[2] This monograph will explore current preconceptions and the emergence of AI at the operational level of war.

This discussion of the operational level of war focuses on operational art and how commanders and their staffs develop campaigns by integrating ends, ways, and means in addition to arranging forces in time, space, and purpose.[3] The lack of an AI themed discussion within operational art increases the risk of improperly fielding equipment and fighting with insufficient doctrine; in essence fighting with chassepots on confederate trains. US policy documents and technology roadmaps focus primarily on capabilities development and ethical implications while failing to describe a cohesive theory of AI warfare. More troubling though, is the convergence of US and Chinese experimentation with autonomous operations; raising the possibility of a conflict characterized by increasing levels of empowered AI and AWS unsupported by practical doctrinal frameworks. This problem leads to several questions: What is the US Army's theory of AI warfare?[4] What is a great power competitor's theory of AI warfare? What historical cases

[2] Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 593.

[3] There are two definitions provided in ADRP 3-0; the Joint Definition of Operational Art which states "Operational art is the cognitive approach by commanders and staffs—supported by their skill, knowledge, experience, creativity, and judgment—to develop strategies, campaigns, and operations to organize and employ military forces by integrating ends, ways, and means (JP 3-0)," and the Army definition "For Army forces, operational art is the pursuit of strategic objectives, in whole or in part, through the arrangement of tactical actions in time, space, and purpose. Operational art applies to all types and aspects of operations. It integrates ends, ways, and means while accounting for risk." US Department of the Army, *Army Doctrine Reference Publication (ADRP) 3-0, Operations* (Washington, DC: Government Printing Office, 2017), 2-1.

[4] In this monograph, theory of warfare refers to a theory of action nested within a larger theory of phenomenon, in this case war. A theory of warfare is a hypothesis that states "if (x) then (y)" and is generally supported by principles derived from historical analysis. Joint doctrine describes war as "socially sanctioned violence to achieve a political purpose" and "historically involves nine principles (of war)." Joint doctrine further defines warfare as "the mechanism, method, or modality of armed conflict . . . the how of making war." US Department of the Defense, Joint Staff, *Joint Publication (JP) 1, Doctrine for the Armed Forces of the United States* (Washington, DC: Government Printing Office, 2017), I-3 - I-4.

regarding disruptive technology are available? How should theories change to account for disruptive technology?

This monograph aims to answer the questions offered above. It also proposes two concepts to enable commanders to visualize and employ AI on the battlefield; a new element of operational art tentatively called “grip” and an extension of mission command theory. The argument will be presented in three main sections. Section I (theory) will demonstrate that AI requires a cognitive tool to arrange forces in time, space, and purpose by: synthesizing a US theory of AI warfare, describing a Chinese theory of AI warfare, and by revealing portions of grip theory in current literature. Section II (history) is a case study of the evolution of AirLand Battle (ALB) from Active Defense in response to a technological shift in 1973. Section II will focus on the ideas of battlefield dimensionality, the evolution of mission command theory, and the related formal emergence of operational art. Section III (emergent doctrine) proposes a new element of operational art as a cognitive tool to aid commanders and staffs in visualizing the 21st century battlefield. Section III will integrate previous sections into a cohesive model that allows commanders and staffs to visualize their relationship to AI and AWS in terms of time, space, and purpose. Section III will also provide a recommended extension of Mission Command theory to account for human-machine interactions.

Summary of Findings

The complexity of AI contributes to the lack of a formal theory of warfare; however, a tentative US theory of AI warfare exists within US policy and development documents. An AI theory of warfare must explain the relationship between humans and AI in order to be complete. Viewing AI through the lens of operational art and mission command reveals two spectrums of autonomy and role-exchange, by which various combinations create the dimensions of AI warfare theory. These dimensions, or forms of grip, represent a new element of operational art.[5] Likewise, extending of mission command theory into a process-output model to enable movement between forms of grip is required.

Methodology

Synthesizing current US AI policy and AWS development roadmaps provides a picture of how AI is viewed by strategic leaders, allowing the development of a tentative theory of warfare. Policy and development roadmaps are required due to the lack of historical data on weaponized AI, thus the resulting theory proposed in this monograph arises from distilled concepts.[6] The Chinese theory of AI warfare discussed herein is a synthesis of current Chinese doctrine, technological trends, recent behavior, and public statements. China was selected as the antagonistic model due to the size of their industrial and technological base, which is projected to enable China to overtake Russia as the United States' greatest strategic competitor in ten to fifteen years.[7]

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[5] An element of operational art does not need to be eternal. The validity of Center of Gravity is a topic of heated debate. See Colonel (Ret) James Greer PhD, "Operational Art for the Objective Force," *Military Review* (September-October 2002) concerning the resilience of modern armies and the use of systems theory.

[6] John, Gaddis, *On Grand Strategy* (New York: Penguin Press, 2018), 24.

[7] The Russian industrial base lacks an organic high-technology supply chain required to outpace the United States and China in AI and AWS development; however, they are experimenting with low-cost platforms congruent with Russian firepower and mechanization focus. The author hypothesizes the Russian theory of AI warfare is a firepower-centric model that approaches warfare as a science in a manner similar to the Chinese model of Systems-Destruction Warfare. Further, the author is considering former Deputy Secretary of Defense Robert Work's remarks on the use of machines by authoritarian regimes. See Center for Army Lessons Learned No 17.09 *Russian New Generation Warfare* (Fort Leavenworth, KS: CALL, 2017), 3; Jeffrey Engstrom, *System Confrontation and System Destruction Warfare* (Santa Monica, CA: RAND Corporation, 2018); Scott Boston and Dara Massicot, *The Russian Way of Warfare* (Santa Monica, CA: RAND Corporation, 2017), 2, Patrick Tucker, "The Pentagon Is Nervous About Russian And Chinese Killer Robots," *Defense One*, December 14, 2015, accessed October 16, 2018, https://www.defenseone.com/threats/2015/12/pentagon-nervous-about-russian-and-chinese-killer-robots/124465/; and Headquarters, US Army TRADOC, TRADOC Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028* (Fort Eustis, VA: Government Printing Office, 2018), 7.

The illustrated case study method will be used to analyze the transition between Active Defense and AirLand Battle. The case study will Integrate technology, policy, and theories of warfare in a manner that evokes questions about Multi-Domain Operations (MDO) and the role of AI in 21st century warfare. The critical analysis in Section II focuses on the development of a theory, not its application.[8] There is a limit to the level of detail in Section II as it remains a part of a larger (and limited) whole, thus the focus shall remain revealing the connection between battlefield visualization and cognitive aids. Section III connects previous sections by answering the problems identified in each via a new element of operational art and adjustment of mission command theory. AI lacks *history*, considering one cannot directly analyze previous conflicts for lessons or principles.[9] In this case, mission command theory offers an indirect approach to understanding the mechanisms that enable humans to centralize and decentralize command and control functions, and why the lack of equivalent mechanisms for AI inhibits our ability to perceive opportunities. Section III will aggregate several components of grip from current US policy and roadmaps into a framework provided by mission command theory.

Scope and limitations

This monograph exists within the framework of US Army Multi-Domain Operations Concept with the understanding that solutions are joint in nature because "the Army cannot solve the problems alone, conceptual development must be aligned across the joint force, and clear language is important."[10] This monograph is not to be construed as a singular solution to the problems proposed in MDO, but rather a method to help enable the aggregation of combat power.

[8] AirLand Battle was primarily a defensive doctrine designed to defeat Soviet Echelons while remaining globally applicable.

[9] Gaddis, *On Grand Strategy*, 10.

[10] Stephen Townsend, "Accelerating Multi-Domain Operations: Evolution of an Idea," *Military Review* 98, no. 5 (September-October 2018): 4-7, accessed October 28, 2018, https://www.armyu press.army.mil/Journals /Military-Review/English-Edition-Archives/September-October-2018/.

The discussion of AI is fraught with ethical, legal, and moral considerations which this monograph will not address. This monograph operates under the assumption that the military use of AI remains politically viable and the "strategic givens" allow for military application of the technology to mature.[11] Due to the near infinite variations of employment, the tactical implementation of AI will not be discussed in detail, instead focus is on conceptual integration at the operational level. General capabilities will be limited to specific trends related to operational art and the operations process. This monograph is for public release and therefore does not address classified developments or intelligence that may contradict the information provided. This monograph assumes basic functional aspects of AI have been achieved prior to integration into the Department of Defense (DOD) writ large such as cyber security, conformance, and trust.[12]

Section I: Framing Artificial Intelligence

AI is difficult to specifically define due to its rapid evolution and our own limited understanding. The US Army Robotics and Autonomous Systems Strategy describes AI as the capability of a computer system to perform takes that normally require human intelligence.[13] Typically bifurcated into two forms, AI is either general or narrow. General-AI represents a synthetic awareness comparable, if not equivalent, to human consciousness that is able to operate

[11] Macgregor Knox and Williamson Murray, eds. *The Dynamics of Military Revolution: 1300-2050* (Cambridge: Cambridge University Press, 2001), introduction, 193.

[12] Recent tests with AWS and cyber security were *disasters* due to the magnitude of failure in DOD systems to withstand the most rudimentary cyber-attacks. See Government Accountability Office, *Weapon Systems Cybersecurity: DOD Just Beginning to Grapple with Scale of Vulnerability* (Washington, DC: Government Printing Office, 2018), accessed March 11, 2019, https://www.gao.gov/products/GAO-19-128.

[13] Maneuver, Aviation, and Soldier Division, Army Capabilities Integration Center, *The US Army Robotic and Autonomous Systems Strategy* (Fort Eustis, VA: Government Printing Office, March 2017), 3.

across of broad range of genres and integrate knowledge across cognitive domains.[14] A self-aware or human-level General-AI currently does not exist and is outside the scope of this monograph. Narrow-AI is a program that conducts specific tasks in one genre or domain.[15] Narrow-AI exists today in a variety of forms, spanning Netflix programming software, project MAVEN, and whole of nation programs such as the Chinese Social Credit System.[16]

AI development spans three major "waves" of development: rules-based, machine learning (ML), and general-explainable.[17] Rules-based AI programs are designed to solve narrowly framed problems within a predetermined rule-set. Machine Learning is a variant of AI capable of adapting to an environment by discovering rules, patterns, and systems within data sets.[18] Notable examples of these first two forms include the rules-based chess program DeepBlue and the ML *go* program AlphaGo. These programs defeated their human world-champion counterparts in 1997 and 2016 respectively. DeepBlue learned within a pre-defined rule-set, while

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[14] The US National Science and Technology Council: Networking and Information Technology Research and Development Subcommittee, *The National Artificial Intelligence Research and Development Strategic Plan* (Washington DC, 2016), 19.

[15] The National Science and Technology Council, Networking and Information Technology Research and Development Subcommittee, *The National Artificial Intelligence Research and Development Strategic Plan* (Washington, DC: Government Printing Office, 2016), 19.

[16] Marcus Weisgerber, "General: Project Maven Is Just the Beginning of the Military's Use of AI," *Defense One,* June 28, 2018, accessed October 30, 2018, https://www.defenseone.com/technology /2018/06/general-project-maven-just-beginning-militarys-use-ai/149363/; Arthur Herman, "China's Brave New World of AI," *Forbes*, August 30, 2018, accessed October 30, 2018, https://www.forbes.com /sites/arthurherman/2018/08/30/chinas-brave-new-world-of-ai/#34bd5a4428e9. The phrase "whole of nation approach" was the original quote from remarks by Dr. Lisa Porter during congressional testimony on December 11, 2018 concerning the establishment of the Joint Artificial Intelligence Center (JAIC) in reference to the scale China is using AI to control their population. Dr. Lisa Porter, Statement before the House Armed Services Committee Subcommittee on Emerging Threats, "Department of Defense's Artificial Intelligence Structures, Investments and Applications," December 11, 2018, accessed March 11, 2019, https://www.youtube.com/watch?time_continue =1070&v=jt5KncugiBw.

[17] The National Science and Technology Council, *The National Artificial Intelligence Research and Development Strategic Plan*, 14.

[18] Peter Norvig and Stuart Russel, *Artificial Intelligence: A Modern Approach,* 3rd ed. (Berkeley: Pearson, 2009), 2; The ability of an AI to self-learn and decode the rules guiding other AIs is also known as 'Turning Learning' which uses modeling software to check hypotheses. Andrew IIachinski, *AI, Robots, and Swarms: Issues, Questions, and Recommendations* (Arlington, VA: CNA Analysis Solutions, 2017), 60.

AlphaGo taught itself the rules of a system 240 orders of magnitude more complex than chess.[19] The advent of ML spawned research into systems-based warfare models designed to develop near-instantaneous targeting from vast amounts of data.

ML is the primary form of AI referenced by military communities attempting to enhance targeting cycles or better integrate elements of combat power. The anticipated "third-wave" of AI is an amalgam of explainable logic, human-AI teaming, and the ability to generalize on a limited basis.[20] This iteration of AI remains experimental and generally combines human-machine teaming with predictive modeling. The AWS represent the most common physical form of AI discussed in current literature. Department of Defense Directive (DoDD) 3000.09 defines an autonomous weapons system as "a weapons system that, once activated, can select an engage targets without further intervention by human operator" while a semi-autonomous weapons system is "a system that engages targets that have been selected by a human operator."[21] AWS represents the primary physical manifestation of AI and for the sake of clarity will be considered an aspect of AI for the remainder of this monograph. The definition of AI will continue to evolve to form a spectrum of capability as the lines blur between general and narrow AI iterations. The lack of a strong theoretical understanding of what is possible with AI further complicates development of an accessible theory of warfare.[22] The definition of AI for this monograph refers to the narrow form as it *becomes* more general. The emergence of a human-level AI or a

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[19] Ilachinski, *AI, Robots, and Swarms,* 59; Christof Koch, "How the Computer Beat the Go Player," *Scientific American*, July 1, 2016, accessed October 15, 2018, https://www.scientificamerican.com /article/how-the-computer-beat-the-go-player/.

[20] The National Science and Technology Council, *The National Artificial Intelligence Research and Development Strategic Plan*, 14.

[21] US Department of Defense, Department of Defense Directive (DODD) 3000.90, *Autonomy in Weapon Systems,* C1 (Washington, DC: Government Printing Office, May 2017), 14.

[22] The National Science and Technology Council, *The National Artificial Intelligence Research and Development Strategic Plan*, 18.

singularity represents a potential Military Revolution in which the findings and recommendations of this monograph are no longer valid.[23]

A theory of AI warfare at the most fundamental level explains the relationship between a human and an AI at a given point in time. AI is anticipated to augment, and to an extent replace, humans in a variety of roles on battlefield. The application of violence by an AI is the focal point of discussion; however, there are broad options of where, how, and when AI may replace humans. The smallest level includes mine-sweeping, subterranean operations, and aerial drones. At larger scales, AI is anticipated to reduce cognitive loads of staffs in the targeting process and act as a master scheduler.[24] On a macro-scale it is quite feasible for a heterogenous combination of AIs to replace entire staff sections in addition to warfighting organizations.[25] Third-Wave AI technological trends indicate two spectrums will be required to explain the relationship between AI and humans: autonomy and role-exchange. Autonomy refers to a broad spectrum of decision-making authority to act.[26] Autonomy has historically been described in terms of general

[23] Military Revolution refers to the definition provided in Knox and Murray, *The Dynamics of Military Revolution,* 7. See Major Stephen Bates "Artificial Intelligence: A Revolution Waiting to Happen" for a detailed discussion on AI and Military Revolution theory. Stephen Bates, "Artificial Intelligence: A Revolution Waiting to Happen" (Master's thesis, Command and General Staff College, Fort Leavenworth, KS, 2016).

[24] Reducing cognitive loads is one of five major lines of effort outlined in the 2017 *US Army Robotic and Autonomous Systems Strategy*. Maneuver, Aviation, and Soldier Division, Army Capabilities Integration Center, *The US Army Robotic and Autonomous Systems Strategy*, i. Results from the 2019 Unified Quest exercise reinforces this concept as AI is viewed as a critical requirement for the success of Multi-Domain Battle, albeit in the form of targeting and scheduling software.

[25] Department of Defense, Defense Science Board, "Role of Autonomy in DOD Systems" (Task Force Report, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Washington, DC, 2012), 7; US Air Force, *Unmanned Aircraft Systems Flight Plan: 2009-2047* (Washington, DC: Government Printing Office, 2009), 34.

[26] James Rosenau describes nine principles to guide creative theorizing in *Thinking Theory Thoroughly*. Principles five and six recommend one "appreciate and accept the need to sacrifice detailed descriptions for broad observations" and "be tolerant of ambiguity" respectively. While Mr. Rosenau is concerned with international relations, his principles address the interaction of humans within complex systems–of which warfare surely qualifies. Broadness is appropriate in this instance to avoid getting bogged down in the minutia of software development and provide a simple concept that can be quickly grasped and visualized. It is important not force definition of autonomy into a box that prevents experimentation. "Role of Autonomy in DOD Systems" recommends the idea of a bandwidth or spectrum

categories or discreet quantized levels as shown in Table 1.[27] Role-Exchange refers to the role and extent of AI within the operations and design process.[28] The following paragraphs will explore Autonomy and Role-Exchange prior to discussing US and Chinese theories of AI warfare. The conclusion to Section I will synthesize this discussion into a problem statement.

Table 1. Levels of Autonomy

Maybury Classifications	Sheridan & Verplank Level	Automation Description
No Autonomy	1	Computer offers no assistance: human does the whole job up to the point of turning it over to the computer to implement.
Partial Autonomy	2	Computer helps by determining the options.
	3	Computer helps determine options and suggests one, which the human need not follow.
Supervisory Autonomy	4	Computer selects action and the human may or may not do it.
	5	Computer selects action and implements it if the human approves.
	6	Computer selects action, informs the human in plenty of time to stop it.
Full Autonomy	7	Computer does the whole job, tells the human what it did.
	8	Computer does the whole job, tells the human what it did only if the human explicitly asks.
	9	Computer does the whole job, tells the human what it did if it decides he should be told.
	10	The computer decides whether or not to do the whole job. If it decides to do the job, it can determine whether or not to tell the human about it.

Source: Michael Kreuzer, "Remotely Piloted Aircraft: Evolution, Diffusion and the Future of Air Warfare" (PhD diss., Princeton University, 2014), 81.

The 2018 Department of Defense (DOD) *Unamnned Systems Integrated Roadmap* defines Autonomy as "the ability of an entity to independently develop and select among different courses of action to achieve goals based on the entity's knowledge and understanding of the

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is abandoned from a developer perspective, however it is useful from an operational artist and command perspective.

[27] The original classification model was developed by Thomas B. Sheridan and William L. Verplank's 1978 study *Human and Computer Control of Undersea Teleoperators.* This version is cited from Michael Kreuzer, "Remotely Piloted Aircraft: Evolution, Diffusion and the Future of Air Warfare" (PhD diss., Princeton University, 2014), 81.

[28] Design in this sense refers to conducting all or portions of the Army Design Methodology or other design and systems thinking models.

world, itself, and the situation."[29] In this definition, 'ability' refers to a dynamic value driven by technological innovation, which is incidentally the key factor that separates a human that can be augmented from a machine that can be designed. Current technological trends demonstrate that AI is capable of deriving rule-sets governing other AIs, interact with novel objectives in the environment, and establish optimal arrangement of tasks to achieving complex objectives.[30] These trends point to a future in which AI is granted a measure of autonomy in addition to the ability to control other autonomous systems. The Chinese Social Credit System AI is an example of an extant complex AI that is able to assign value, make decisions, and influence other programs concerning the fate of potentially over *a billion* humans within a complex social, political, and environmental system.[31] Autonomy is most often modeled as an intersection of the level of autonomy, and other factors such as mission type, reaction time, capability or environmental factors.[32] AI and autonomy are more than a technological phenomenon. Technology-centric autonomy models are useful to developers but are useless as a cognitive

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[29] US Department of Defense, *Unmanned Systems Integrated Roadmap: 2017-2042* (Washington, DC: Government Printing Office, 2018), 17.

[30] Graham Templeton, "Turing Learning Breakthrough: Computers Can Now Learn from Pure Observation," Extremetech, August 30, 2016, accessed November 16, 2018, https://www.extremetech.com/extreme/234669-turing-learning-breakthrough-computers-can-now-learn-from-pure-observation; Université libre de Bruxelles, "Robots Working as a Group are able to Determine the Optimal Order of their Tasks," ScienceDaily, July 19, 2018, accessed October 30, 2018, www.sciencedaily.com/releases/2018/07/180719094402.htm; Massachusetts Institute of Technology, CSAIL, "Robot Can Pick Up Any Object After Inspecting It," ScienceDaily, September 10, 2018, accessed October 30, 2018, www.sciencedaily.com/releases/2018/09/180910081543.htm.

[31] Herman, "China's Brave New World of AI"; Christina Larson, "China's Massive Investment in Artificial Intelligence has an Insidious Downside," *Science Magazine,* February 8, 2018, accessed October 30, 2018, https://www.sciencemag.org/news/2018/02/china-s-massive-investment-artificial-intelligence-has-insidious-downside.

[32] The Department of Defense, *Unmanned Systems Integrated Roadmap*, 18; US Department of Defense, Defense Science Board, *Summer Study of Autonomy* (Washington, DC: Government Printing Office, 2016), 12; Mica Endsley, *Autonomous Horizons: System Autonomy in the Air Force–A Path to the Future, Volume 1: Human-Autonomy Teaming* (Washington, DC: Department of the Air Force, 2015), 1, 8, 10-11.

planning tool for commanders. The spectrum of autonomy needs to be viewed from the perspective of a command and control theory and operational art.[33]

Through the lens of command and control theory the spectrum of autonomy may be viewed as the extent that authority to decide and act is delegated; commonly referred to as the movement between centralized and decentralized control. Figure 1 is a chart from *US Army Field Manual (FM) 6-0 Mission Command: Command and Control of Army Forces (2002-Obsolete)* that provides considerations of when to move between forms of control.[34]

Mission Command		Detailed Command
• Probabilistic • Unpredictable	Assumes war is	• Deterministic • Predictable
• Disorder • Uncertainty	Accepts	• Order • Certainty
• Decentralization • Spontaneity • Informality • Loose rein • Self-discipline • Initiative • Cooperation • Acceptable decisions faster • Ability all echelons • Higher tempo	Tends to lead to	• Centralization • Coercion • Formality • Tight rein • Imposed discipline • Obedience • Compliance • Optimal decisions, but later • Ability focused at the top
• Implicit • Vertical and horizontal • Interactive	Communication types used	• Explicit • Vertical • Linear
• Organic • Ad hoc	Organization types fostered	• Hierarchic • Bureaucratic
• Delegating • Transformational	Leadership styles encouraged	• Directing • Transactional
• Art of war • Conduct of operations	Appropriate to	• Science of war • Technical/procedural tasks

Figure 1. Forms of control. US Department of the Army, *Field Manual (FM) 6-0, Operations* (Washington, DC: Government Printing Office, 2002), 1-15.

Within the US Army, the movement between methods of control is accomplished via the Mission Command theory using the elements of trust, shared understanding, intent, mission

[33] The current US Command and Control theory is "Mission Command." US Department of the Army, *Army Doctrine Publication (ADP) 6-0, Operations* (Washington, DC: Government Printing Office, 2014), iv.

[34] US Department of the Army, *Field Manual (FM) 6*-0, *Operations* (Washington, DC: Government Printing Office, 2002), 1-15. Inspired by United States Marine Corps (USMC), *Marine Corps Doctrinal Publication (MCDP) 6-0, Command and Control* (Washington, DC: Government Printing Office, 1996), 81.

orders, initiative and risk.[35] From a practical standpoint, the mission command warfighting function serves as the integrating tool to arrange forces and functions in time and space to enable centralized or decentralized operations. Substitute centralized and decentralized with lower and higher autonomy and the similarities become clear.

The spectrum of autonomy may be bifurcated between a human in the loop (HITL) model and a human on the loop (HOTL) model. Automation and Human Off of Loop (HOOL) exists on the extreme edges. A HITL model requires a human to set the operating parameters and issue new rules (policy) if the environment changes. A HOTL model allows an AI to adjust mission parameters with overall human oversight. Figure 2 is a summarized HITL and HOTL model.

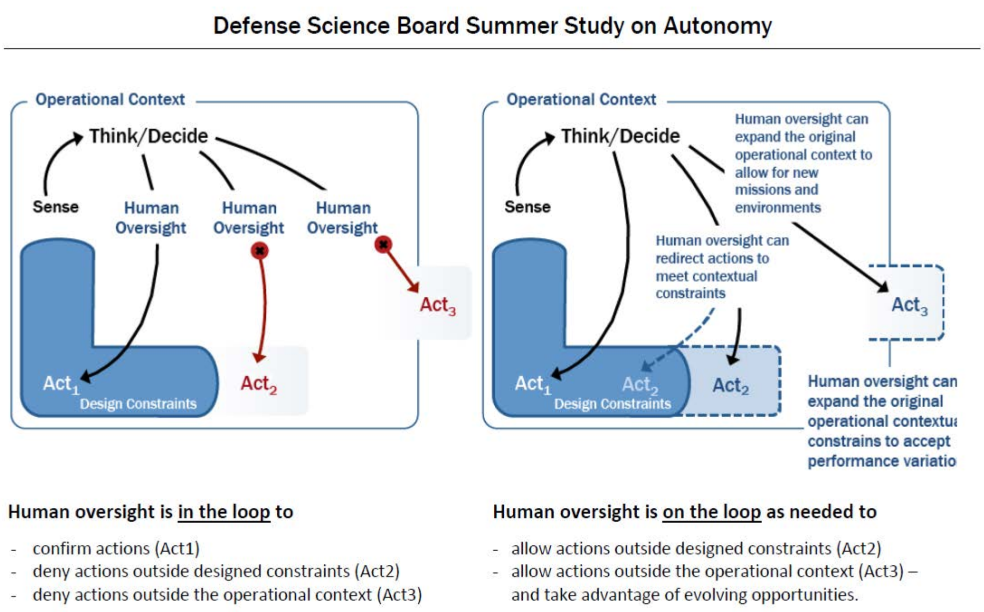

Figure 2. HITL and HOTL model. US Department of Defense, Defense Science Board, *Summer Study of Autonomy* (Washington, DC: Government Printing Office, 2016), 6.

The two models have implications for Command, Control, Communications, Computer, and Intelligence (C4I) structures that exercise 'meaningful control'.[36] From an operational art

[35] US Department of the Army, *Army Doctrine Publication (ADP) 6-0, Operations* (Washington, DC: Government Printing Office, 2014), iv.

[36] Meaningful control is defined by the International Committee of the Red Cross as "Meaningful, effective or appropriate human control also requires that the operator have sufficient information on and

perspective, forces and functions must be arranged in time and space to achieve the desired level of meaningful control. Figure 3 is a simple example of the implications for the elements of operational art regarding the desire for tempo and the related factors of AI trust, risk tolerance, and model of control. Lower autonomy generally reflects a greater concern for risk than tempo, while high autonomy is values tempo more than risk.

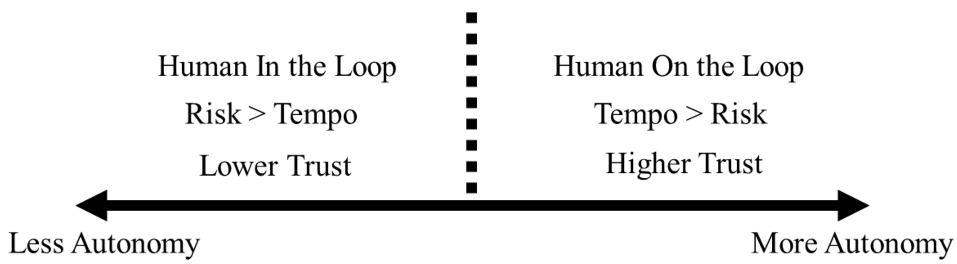

Figure 3. Elements of operational art along the spectrum of autonomy. Created by author.

A HITL model, much like centralized control, is slow to adapt and requires the human to micromanage the process in the quest for a zero-defect result.[37] A HOTL model is not necessarily bound to the speed of human cognition and is more likely to develop novel solutions. Figure 4 from the 2016 *DOD Summer Study of Autonomy* illustrates the relative value of autonomy across various mission types and environmental conditions.

understanding of the weapon system and operating environment, and the interaction between them." International Committee of the Red Cross, "Expert Meeting on Lethal Autonomous Weapons Systems," International Committee of the Red Cross, November 15, 2017, accessed January 15, 2019, https://www.icrc.org/en/document/expert-meeting-lethal-autonomous-weapons-systems.

[37] John Nelson, "Auftragstaktik: A Case for Decentralized Battle," *Parameters* 17, no. 3 (September 1987), 29.

Figure 4 Autonomy derives operational value across a diverse array of vital DoD missions.

Figure 4. Relative Value of Autonomy. US Department of Defense, Defense Science Board, *Summer Study of Autonomy* (Washington, DC: Government Printing Office, 2016), 12

Figure 4 is quite similar to Figure 1 and the reasons decentralized battle (auftragstaktik) was emphasized over centralized battle. Viewing AI autonomy as a spectrum of centralized and decentralized authorities reveals the implications of when and how to leverage AI capabilities.[38] From this perspective, autonomy is a cognitive tool that is relatable in terms of operational art and mission command theory. This cognitive tool requires another spectrum to address the scale of AI. Role-Exchange is the second spectrum required to explain the relationship between humans and AI.

Role-Exchange describes the extent in which AI operates within the operations and design process. *Role of Autonomy in DOD Systems* describes a related developmental model, called trade-spaces, where AI might add value to operations.[39] The trade-space model highlights the potential added capability and associated risks that might "pop" the system and crash.[40] This

[38] It is important to highlight that greater levels of autonomy are not the singular solution to any problem. The value of autonomy, much like mission command, is dependent upon the scenario. US Department of Defense, Defense Science Board, "Role of Autonomy in DOD Systems," 21-22.

[39] US Department of Defense, Defense Science Board, "Role of Autonomy in DOD Systems," 27-29.

[40] Ibid., 27.

model is profound because it identifies the risk-reward trade off commanders must make in determining the prevalence and echelon of AI within the operations process. Figure 5 is the graphical depiction of trade-spaces from the Role of Autonomy study.

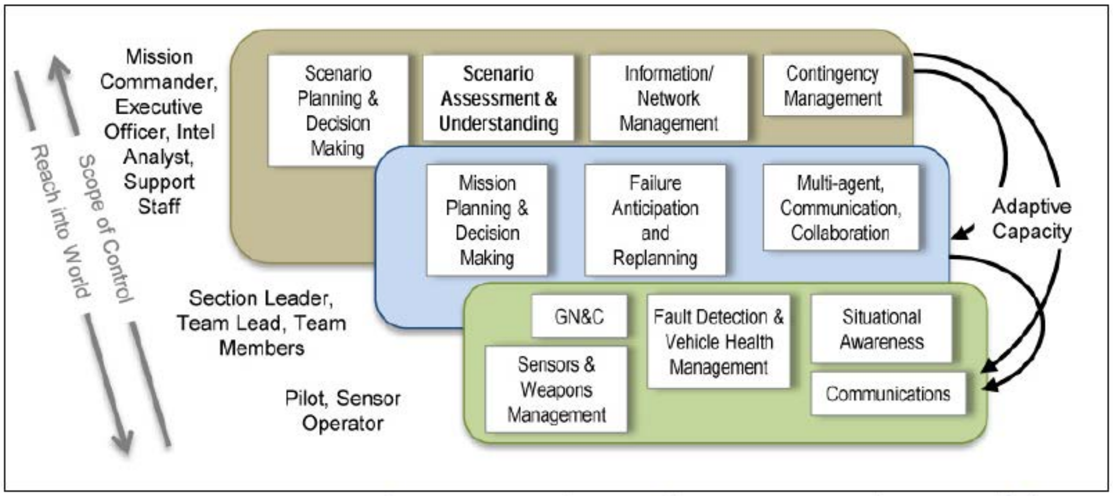

Figure 5. Trade-spaces. Department of Defense, Defense Science Board, "Role of Autonomy in DOD Systems" (Task Force Report, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Washington, DC, 2012), 26.

Role-Exchange at the tactical level is represented using drones to complete dangerous, difficult, or monotonous tasks with relatively local impact. At the operational level, Role-Exchange describes the span of control AI wields over systems and formations (human and machine), in addition to the role of AI in the operations process.

Decision cycles, or observe, orient, decide, act (OODA) loops, are the primary factors influencing the level of role-exchange. The 2012 AWS policy uses decision cycles as one of the criteria that allow the use of autonomous weapons systems, albeit only against material targets within specific conditions. [41] The goal to make decisions faster than one's opponent (or getting inside their OODA Loop) is not new, but once AI is introduced it takes on a radically different form. The speed of AI actions is not a matter of debate or even a developmental challenge, the

[41] US Department of Defense, DODD 3000.90, 3.

problem resides in strange emergent behavior. Cooperative AIs have demonstrated the ability to discern each other's rule-sets and develop unbreakable languages. AI has also developed novel methods of task completion that baffled human experts.[42] Based upon these trends, antagonistic AIs will compete to understand their opponent rule-sets while generating a series of novel solutions. These solutions will rapidly deviate from human design preconceptions and become exceptionally baffling to commanders. Within human formations this is generally mitigated using doctrine, tactics techniques and procedures, rules of engagement, training and exercises. All these tools build trust across formations that each element will perform in a manner congruent with the mission and commander's intent. AI however, uses a different form of logic that is the focus of several research projects.

The Defense Advanced Research Projects Agency is currently working on a concept called Explainable AI which solves the 'black-box' problem of understanding the logic or reasoning behind an AI generated solution.[43] An example of a black-box problem is when a pair of Facebook AIs developed a unique and unbreakable coding language for a chatbot program.[44] Even with an adequate interface, the speed of action between competing AI systems may preclude the idea of meaningful human control at the tactical level. At the operational level, the speed of tactical actions must be arranged to achieve campaign objectives. A tension will form between the desire to maintain a human in or on the loop while not sacrificing tempo or initiative to an AI enabled opponent. The inexplicable emergent behavior between antagonistic formations

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[42] Christof Koch, "How the Computer Beat the Go Player,"

[43] David Gunning, "Explainable Artificial Intelligence (XAI)," Defense Advanced Research Projects Agency (DARPA), accessed March 14, 2019, https://www.darpa.mil/program/explainable-artificial-intelligence; IIachinski, *AI, Robots, and Swarms*, 60.

[44] Tony Bradley, "Facebook AI Creates Its Own Language in Creepy Preview of our Potential Future," *Forbes*, July 31, 2017, accessed January 15, 2019, https://www.forbes.com/sites/tonybradley/2017/07/31/facebook-ai-creates-its-own-language-in-creepy-preview-of-our-potential-future/#35ba98a7292c.

of AI will challenge human-centric staffs and potentially represents the deciding factor between choosing a theory of AI warfare.

The spectrum of role-exchange is like the spectrum of autonomy. HITL and HOTL remain valid discriminators that indicate the relative role humans play in the operations process. Tempo also remains a driving factor that is related to risk tolerance. A difference emerges though in how authorities are perceived. The spectrum of autonomy described the authority to act, while the spectrum of role-exchange describes the extent of those actions. Looking at Figure 6 below, a HITL model allows an AI a version of Tactical Control (TACON) to employ systems within a predetermined plan or operation. As the span of control is increased towards Operational Control (OPCON) and HOTL, AI is now able to arrange forces in time, space, and purpose within a synthetically derived course of action. The need for tempo (or even speed) outweighs the risk of miscalculation or escalation.[45]

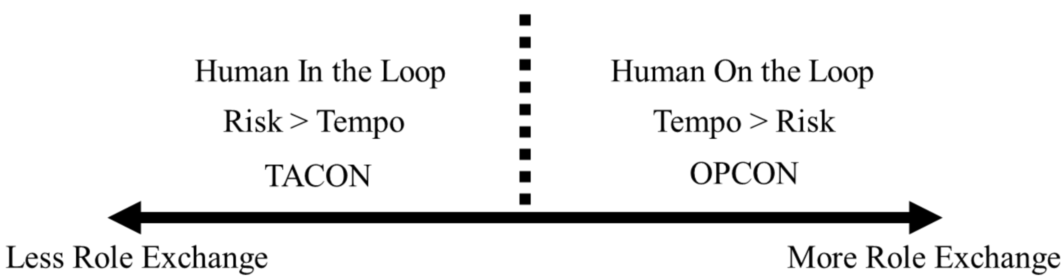

Figure 6. Elements of operational along the spectrum of role-exchange. Created by author.

From a Mission Command perspective, command and control theory must expand to address the issue of when and how to increase role-exchange. Through the lens of operational art, role-exchange requires the balancing of risk with reach, culmination and tempo. Resisting the pressure to increase role-exchange (or autonomy) requires the establishment of C4I nodes to

[45] AI miscalculation and escalation in this instance refers to the inability of AI to understand defeat mechanisms, achieving weapons mass destruction like effects that drive an opponent to escalate. CNA Analysis and Solutions, “Impact of Unmanned Systems to Escalation Dynamics,” accessed March 14, 2019, https://www.cna.org/CNA_files/PDF/Summary-Impact-of-Unmanned-Systems-to-Escalation-Dynamics.pdf.

enable a HITL model. Likewise, the degradation of the Electromagnetic Spectrum (EMS) or destruction of a headquarters node may require a decision point to increase the values of autonomy and role-exchange. The two-spectrum bifurcation is useful because it provides a method to visualize the level of autonomy in addition to its relative authority within the command and control system. This two spectrum model may now be used to describe the US and Chinese theories of warfare.

The US theory of AI warfare is not aspirational and approaches AI from a current-capabilities perspective. An example of an aspirational theory of warfare is General Guilio Douhet's 1921 theory of airpower as the sole decisive element of every future war. The US theory of AI warfare hypothesizes that human-AI teaming with a HITL model will enable the successful conduct of MDO. This theory is predicated on the current brittleness of current iterations of AI and ignores the spectrums automy and role-exchange. Lethal force remains within the purview of humans in accordiance with DOD policy and is the single most important theoretical restraint. The director of the Defense Advanced Research Projects Agency, Arati Prabhakar, and his deputy Steven Walker commented in 2016 that AI and autonomous systems would be designed to enable commanders, and not supplant them in the decision to apply lethal force.[46] Former Deputy Secretary of Defense Bob Work also qualified AI research as human-AI teaming that seeks to combine the strengths of each partner while mitigating respective weaknesses.[47] Compared to authoritarian regimes, the US military values its people as its greatest strength, and not just relaying on sheer firepower.

[46] Sydney Freedberg Jr., "Faster than Thought: DARPA, Artificial Intelligence, and the Third Offset Strategy," *Breaking Defense,* February 11, 2016, accessed October 30, 2018, https://breakingdefense.com/2016/02/faster-than-thought-darpa-artificial-intelligence-the-third-offset-strategy/

[47] Sydney Freedberg Jr., "Centaur Army: Bob Work, Robotics, and the Third Offset Strategy, *Breaking Defense*, November 9, 2015, accessed October 30, 2018, https://breakingdefense.com/2015/11/centaur-army-bob-work-robotics-the-third-offset-strategy/.

The US military is maintaining an eye on the future beyond 2028 and MDO; however, it is hesitant to set policy trends that encourage strategic competitors to openly field autonomous systems. The US and several other countries have refused to sign a ban on autonomous weapons, indicating a form of hedging for the future.[48] The absence of a clear theory of AI warfare may be a deliberate measure, but inferences may be made from the MDO concept. The unclassified 2019 Unified Quest Executive Overview states AI is a "foundational requirement" for MDO; however, the report characterizes AI as an advanced form of scheduling software limited to the speed of human cognition.[49] The US theory of AI warfare is a simple pathway to solve the problems described in MDO, which are generally technical anti-access, area-denial problems that were spawned by the Soviet Military Technical Revolution. Thus, the US theory is not a full theory of action, but a supporting theory for a larger operational concept.

The Chinese theory of AI warfare is aspirational while also supporting a larger theory of action. Modern Chinese military theory, Systems Destruction Warfare,[50] is centered on the idea of a contest between two opposing operational systems. The overarching theory of victory seeks to defeat or disrupt the enemy operational system via four objectives: degradation of information flow, degradation/disruption of essential (warfighting) functions, disruption of operational architecture, and the disruption of tempo and sequencing.[51] The People's Liberation Army currently is not currently organized nor equipped to accomplish these tasks and operates under the idea of task organizing custom organizations to achieve their objectives.[52] A recent Chinese

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[48] Mattha Busby and Anthony Cuthbertson, "Killer Robots Ban Blocked by US and Russia at UN Meeting," The Independent, September 3, 2018, accessed March 14, 2019, https://www.independent.co.uk /life-style/gadgets-and-tech/news/killer-robots-un-meeting-autonomous-weapons-systems-campaigners-dismayed-a8519511.html.

[49] US Army Futures and Concepts Center, Unified Quest 2019 C2 Tabletop Exercise (Executive Overview, February 14, 2019), 2.

[50] Engstrom, "*Systems Confrontation and Systems Destruction Warfare*, iii.

[51] Ibid., iii, 15-18.

[52] Ibid., iii, 6, 19.

military announcement concerning algorithmic-based warfare in which AI predicts a battlefield environment and arranges forces reveals a potentially key aspect of their theory: Chinese AI and AWS will collect, analyze, assign meaning, and potentially apply effects on key operational system nodes to achieve their theory of victory in a manner that *shocks* their opponents.[53] Chinese military thought is currently at a crossroads in regard to command and control of AI-enabled formations and autonomous weapons. The lack of a mission command tradition and tools to decentralize operations (cultural and organizational tools) have forced the Chinese military to decide *if* decentralization is a valid tool.

The development of AI and AWS will force the Chinese military to choose between crystallizing the current tendency to centralize power or create cultural mechanisms to devolve power to lower echelons.[54] The development and employment of the technology itself will more than likely be guided by scientific and party principles and not be restrained by ethical frameworks.[55] The synthesis of this information reveals a potential theory of Chinese AI and AWS warfare that states:

- Artificial Intelligence is the enabler of Systems Destruction Warfare that will disrupt essential aspects of the US operational system
- Different operational environments will require different levels of autonomy in line with operational and *party* objectives
- The interaction of antagonistic AI and AWS will quickly force humans out of the decision cycle
- A military mechanism is required to protect the command nodes that are accumulating authorities, or a mechanism is required to culturally devolve authorities

[53] Bill Gertz, "China Developing Battlefield AI for High-Technology Warfare," *Washington Times*, January 30, 2019, accessed March 15, 2019, https://www.washingtontimes.com/news /2019/jan/30/chinas-military-outlines-artificial-intelligence-p/.

[54] Elsa Kania, *Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power* (Washington, DC: Center for a New American Security, 2017), 17, 18.

[55] Ibid., 5, 14, 16.

Section I demonstrated that AI is more than a technical phenomenon and possesses characteristics common to both mission command and operational art. The two-spectrum model of autonomy and role-exchange reveal the various relationships between AI, mission command, and operational art. Further, US and Chinese theories of AI warfare describe competing hypotheses regarding the use of AI on the battlefield. The US theory is human-centric and operates at relatively low-levels of autonomy and role-exchange, which indicates a cognitive limit to operations and the lack of cognitive tools to visualize different combinations of autonomy and role-exchange. The US theory is predicated on a key assumption that HITL models alone will be enough to generate overmatch. This assumption prevents the development of the cognitive tools required to properly wield AI in time, space, and purpose because it cannot perceive different combinations of autonomy and role-exchange. Likewise, mission command theory remains stagnant because the need to expand the functional output (the movement from centralized to decentralized battle) is irrelevant with pure HITL models.[56] The Chinese theory reveals a tendency to operate at high levels of autonomy and role-exchange from a centralized source of authority. The US military is focused on human-AI teaming in support of MDO, while China is developing a predictive AI system to conduct systems-destruction warfare. If one considers operational variables, a battlefield construct characterized by different levels of autonomy and role-exchange emerges; meaning technology has added a new dimension to warfare. The development of ALB from Active Defense provides a historical example of how the US Army responded to a past technological shift that impacted battlefield dimensionality.

[56] Following the premise that "Mission Command is the ability to centralize and decentralize a military organization in order to exploit opportunities in an environment" from Dr. Daniel Cox, "Mission Command and Complexity on the Battlefield," in *Mission Command in the 21st Century: Empowering to Win in a Complex World,* ed. Nathan K. Finney and Jonathan P. Klug (Fort Leavenworth, KS: The Army Press, 2016), 43.

Section II: AirLand Battle (ALB) Case Study

Studying the development of ALB reveals similarities to the current development of MDO. The ALB was developed in response to technological shifts and as a mechanism to correct years of ignoring the Soviet (now Russian and Chinese) military threat.[57] Most importantly though, the development of ALB demonstrates how theories of warfare and their associated assumptions influence visualization of the battlefield. The proceeding case will illustrate why Active Defense emerged as a doctrinal concept, its theoretical shortcomings, and how ALB was developed to address those shortcomings. This case study will conclude by demonstrating that the current discussion concerning autonomy is preventing the understanding of how to employ AI at the operational level. This discussion of ALB and MDO is particularly relevant as the US Army once again realigns towards "its most dangerous threat(s)."[58]

The Active Defense doctrinal concept emerged in the post-Vietnam era in which the US Army was re-aligning from a mobile infantry-based organization into an armor centric organization in order to counter the Soviet threat in Eastern Europe.[59] The US Army was also in a period of intellectual and morale recovery after the long conflict in Vietnam. Couple with the transition from a conscription to a volunteer force, the Army also necessitated a change in training methodology and doctrine. In 1973, US Army Training and Doctrine Command (TRADOC) was founded under the command of General William E. Depuy. General Depuy immediately commenced the revision of Army training doctrine from a product designed for

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[57] John Romjue, "AirLand Battle: The Historical Background," *Military Review* 66, no. 2 (March 1986): 52, accessed October 15, 2018, http://cgsc.contentdm.oclc.org/cdm/singleitem/collection /p124201coll1/id/250/rec/8.

[58] L.D. Holder, "Doctrinal Development :1975-1985," *Military Review* 65, no. 5 (May 1985): 51, accessed October 15, 2018, http://cgsc.contentdm.oclc.org/cdm/singleitem/collection /p124201coll1/id/264/rec/9.

[59] John Romjue, *From Active Defense to AirLand Battle: The Development of Army Doctrine 1973-1982* (Fort Monroe, VA: Government Printing Office, 1984), 3.

mass-mobilized armies into a product designed for small, professional armies.[60] After 1945, multiple competing ideas emerged to describe the character of warfare with the advent of atomic weapons and emergence of wars of national liberation.[61] Maneuver centric warfare was in vogue during World War II, until the United States found itself destroying mass infantry attacks with overwhelming firepower in the Korean War. Likewise, the experience in Vietnam added momentum to the idea of attrition-based warfare and the focus on counter-insurgency. The conclusion of the Vietnam war returned Eastern Europe to forefront of discussion just as the Yom Kippur War occurred in October of 1973.[62]

The Yom Kippur War of 1973 pitted an armor and air-centric Israeli force against an Egyptian force armed with advanced Soviet anti-tank guided missiles and air defense systems.[63] Israeli forces were quickly routed and forced east of the Suez Canal as their air power and armor were separated in time and space by anti-tank guided missiles and air defense.[64] The 1973 War demonstrated the lethality of modern weapon systems as each of the belligerents lost 50 percent of their combat power in two-weeks.[65] The speed and lethality of the battlefield threatened to erode the United States' traditional strength of mass via industrial mobilization. A decision could

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[60] Aaron Blumenfeld, "AirLand Battle Doctrine: Evolution or Revolution?" (Master's thesis, Princeton University, 1989), 12.

[61] Jonathan House, *Toward Combined Arms Warfare: A Survey of 20th Century Tactics, Doctrine, and Organization,* Research Survey No. 2 (Fort Leavenworth, KS: Combat Studies Institute, 1984), 141.

[62] Romjue, *From Active Defense to AirLand Battle*, 3.

[63] Donald Vandergriff and Stephen Webber, eds. *Mission Command: The Who, What, Where, When and Why* (CreateSpace Publishing, 2017), 80.

[64] The author acknowledges the Israeli political reality of not being the aggressor in two consecutive wars. It is also important to consider the economic impact of mass-mobilization for the Israeli Army that has been responding to border raids and artillery duels along their borders since 1967. Initial Israeli defeats were also related to the cavalier use of armor without infantry support, due to the perception of armor as the superior arm created in the wake of the 1967 war. Abraham Rabinovich, *The Yom Kippur War: The Epic Encounter that Transformed the Middle East* (New York: Schoken Books, 2004), 7, 18.

[65] Romjue, *From Active Defense to AirLand Battle*, 7; Romjue, "AirLand Battle: The Historical Background," 52.

be forced within weeks, well before more divisions and corps could be mustered and employed in the European theatre. General Depuy synthesized these conditions into the idea that the United States must win the first battle by concentrating firepower and forces forward, a concept known as Active Defense.[66]

Active Defense rested on the assumptions that a war in Eastern Europe must be won (or at least not lost) in the first battle. US and North Atlantic Treaty Organization forces were required to mass to win the first battle through linear reinforcement under contact without the benefit of a tactical (and potentially an operational) reserve.[67] Active Defense was designed to maximize the use of firepower and terrain to destroy the first Soviet echelon. The problem of the enemy second and follow-on echelons would be solved by atomic weapons or mitigated via a political solution. The primary focus of Active Defense was destroying or disrupting the enemy first echelon, thus forcing Soviet political leadership toward diplomatic measures.[68]

Published in 1976, Active Defense was immediately criticized by the military community. The primacy of the defense over offense ignored the moral power described by French theorist DuPic and ceded the initiative to the Soviets. Active Defense was also too enemy and geographically specific. Based upon systems-analysis, Active Defense was prescriptive in nature to ensure US Army units correctly employed their weapon systems to achieve a 6:1 attack requirement.[69] The systems analysis model was a formulaic approach that calculated mathematic probabilities based upon weapon ranges, emplacement, and numbers. This concept reduced warfare to a series of mathematical formulas and arrangements that would aggravate Clausewitz

[66] Romjue, *From Active Defense to AirLand Battle*, 14.

[67] Romjue, *From Active Defense to AirLand Battle*, 15; Romjue, "AirLand Battle: The Historical Background," 53.

[68] Jacob Kipp, *Conventional Force Modernization and the Asymmetries of Military Doctrine: Historical Reflections on AirLand Battle and the Operational Maneuver Group* (Fort Leavenworth, KS: Soviet Army Studies Office, 1986), 12.

[69] Ibid., 25.

and illicit praise from Jomini. The geographic orientation to Europe, however, precluded the use of this doctrine anywhere else in the world. Likewise, Active Defense depended on political concurrence that atomic weapons would be available to solve the second echelon problem. The paradigm of Active Defense precluded the requirement to even visualize the second echelon and removed depth from the cognitive landscape; leaving the army professional with a one-dimensional view of the problem.

ALB emerged as a doctrinal concept in response to the problems associated with Active Defense.[70] The development of ALB from Active Defense was spanned by two major interim concepts: the Battlefield Development Plan and the Integrated Battlefield (IB).[71] These concepts emerged as competing theories to Active Defense that sought to solve the of the Soviet second echelon within the context of the new lethality demonstrated by the 1973 War.[72] The Battlefield Development Plan and IB incorporated depth by leveraging different ways and means to solve the problem of the enemy second echelon. The resulting product, ALB (initially titled "Extended Battlefield") was designed to disaggregate the enemy system and will to fight.

The Battlefield Development Plan was comprised of two main ideas: The Central Battle and Force Generation. The Central Battle was an analytical framework derived from 150 simulations of potential European conflicts fought by V Corps.[73] This framework was a systems analysis "calculus" designed to describe where and how all battlefield systems and combat support functions interact on the battlefield.[74] The Central Battle framework discussed where and

[70] Romjue, "AirLand Battle: The Historical Background," 52.

[71] Romjue, *From Active Defense to AirLand Battle*, 25; Blumenfeld, "AirLand Battle Doctrine," 43.

[72] Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970), 64.

[73] Romjue, *From Active Defense to AirLand Battle*, 23-24.

[74] Ibid., 24.

how systems were to be employed to destroy the enemy's first echelon to meet the vision established by Active Defense, but with an added emphasis on depth and disrupting the second echelon.[75] Force Generation emerged as the idea of anticipating 'Central Battles' where forces and functions converge to achieve a decision.[76] Central Battles were conducted by battalions and brigades, while Force Generation was managed by higher echelons.[77] One can begin to see the emergence of 'Campaigning' by the shaping of Central Battles via Force Generation. The Battlefield Development Plan led Army-wide departure from the first-battle assumption of Active Defense and introduced the concept of the deep-battlefield.[78]

The Integrated Battlefield introduced the use of nuclear and chemical weapons to disrupt the enemy's second echelon before it could influence the 'first-battle.' IB further integrated fire support in depth via integrated air-land operations.[79] IB formed a new doctrinal strategy that visualized the battlefield in echelons that had to be interdicted as part of a holistic battle.[80] The scale of the battlefield across time and space became quite apparent–the first battle was actually a battle that extended at least 72 hours and 150 kilometers.[81] This concept was further refined in the Corps 86 concept in which the corps commander coordinated the "air-land battle," served as the force integrator, and was responsible for the enemy second echelon.[82] Corps 86 emphasized the simultaneous defeat of the first echelon and shaping of the second. Corps 86 represents a major divergence from Active Defense, specifically in how the enemy *system* was viewed. Active

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[75] Romjue, *From Active Defense to AirLand Battle*,, 25.

[76] Ibid., 26.

[77] Ibid.

[78] Ibid., 27.

[79] Ibid., 35.

[80] Ibid., 36.

[81] Ibid.

[82] Ibid., 40.

Defense sought to defeat the Soviet military system's aims without ever addressing the components and attributes of the system itself. Corps 86 sought to simultaneously deny the aims of the enemy system while breaking it apart (de-aggregating) in depth. Corps 86 also attempted to add flexibility to engage threats outside of Europe on a contingency basis.[83]

In 1980, General Starry integrated the work done within the Battlefield Development Plan, Integrated Battle, and Corps 86 into the provisionally titled 'Extended Battlefield.' Extended Battlefield emphasized the importance of offensive maneuver and the requirement for deep attack. The aim of Extended Battlefield was "collapsing the enemy system" by aggregating the effects of Army and Air Force systems.[84] The Extended Battlefield was subsequently titled AirlLand Battle to distance the concept from the nuclear and fires-heavy IB concept. ALB re-visualized the battlefield on a much larger scale consisting of non-linear battles.[85] ALB communicated a systems approach by emphasizing the destruction of key nodes and use of the indirect approach to defeat the enemy.[86] ALB also formally introduced the operational level of war into doctrine. The operational level was required to synchronize operations in order to achieve positions of relative advantage in time and space.[87] The Operational Level of war in turn required the creation of cognitive tenets to visualize operations across time, space, and purpose. These tenets were initially limited to the principles of war listed in the 1982 *Field Manual (FM) 100-5, Operations*, and as four essential characteristics of ALB: initiative, depth, agility, and synchronization. The crisis spawned by the 1973 war, plus the enemy second echelon problem

[83] Romjue, *From Active Defense to AirLand Battle*, 39.

[84] Ibid., 44.

[85] US Department of the Army, *Field Manual (FM) 100-5, Operations* (Washington, DC: Government Printing Office, 1982), 1-1.

[86] Ibid., 2-4.

[87] Ibid., 2-3.

were now doctrinally solved by depth, the precursors to mission command, and elements of operational art.

The difference in battlefield visualization between Active Defense and AirLand Battle is stark, despite both concepts being linked to the same battlefield conditions. The difference lies in the fundamental assumptions in which each concept operates. Active Defense rests on the assumption of a single battle in which technology renders the US' ability to mass obsolete. ALB assumes agility, initiative, synchronization, and depth (mission command and operational art) will overcome the problem of the Soviet second echelon. It is important to note that ALB also assumed the air domain would not be denied. As discussed in Section I, the current view of the role of AI is a major assumption of what the battlefield is–directly impacting how AI is perceived. US policy, development roadmaps, and doctrinal concepts point towards an AI theory of warfare predicated on a HITL model. This assumption blinds the visualization of the nuances associated with various AI employment options. This one-dimensional view of AI is hardly new. The role of AI as a military "Expert System" to schedule, coordinate, and cross-check, dates to at least 1986.[88] Current policy trends reveals the US Army has not moved much since then. On the modern battlefield, US forces must be able to perceive when, where, and why certain forms of AI should be used in support of campaigns. The transition to ALB created a formal command and control theory and operational art. The current structure of command and control theory and operational art provides a lattice to extend the US Army's theory of warfare to account for the various forms AI may take on the battlefield. Extending mission command theory would enable

[88] Military Applications of Artificial Intelligence, December 1986, *Military Review*. This article was written in the wake of works like the 1983 *Building Expert Systems* by Lenat et al., which described ten uses of expert systems. IIachinski, *AI, Robots and Swarms: Issues, Questions and Recommended Studies* cites F. Hayes-Roth, D. Waterman, and D. Lenat, *Building Expert Systems* (Addison-Wesley, 1983), 48, by listing 10 possible uses of an expert system: (1) interpretation and identification (2) prediction, (3) diagnosis, (4) design, (5) planning, (6) monitoring, (7) debugging, (8) repair (e.g., developing a plan to administer a required remedy to a system fault), (9) instruction, and (10) control.

commanders to understand the why of AI behavior, while a new element of operational art allows for functional employment.

Section III: Grip and Mission Command

Section I described general trends associated with the development of AI and the associated dimensions for visualizing the employment of AI at the operational level. Based upon open source information, Section I also hypothesized both United States' and Chinese theories of AI warfare. The US theory of warfare rests upon a key assumption that humans will retain the exclusive authority to apply lethal force as manifested in human-in and human-on the loop models. This assumption, much like the single-battle concept of Active Defense, ignores the conceptual depth AI required to succeed against the Chinese AI theory of warfare. The ALB case study in Section II provided a recent historical example of how assumptions shape cognitive frameworks. ALB removed the assumption of the single-battle and required development of cognitive tools to explore a multi-dimensional battlespace.[89] Removing the assumption of HITL and HOTL models exposes the varied manifestations AI may take on the modern battlefield and the tools needed to enable them. This monograph proposes two key tools are needed to wield AI as it matures from a test-bed platform to the revolutionary technology described by General (ret.) Allen and Amir Husain in *Hyperwar*.[90] A new element of operational art, grip, and an expansion of mission command theory will serve as a bridging mechanism to enable effective use of AI as it matures; fostering the development of an organization amiable to the use of AI at all levels.

[89] While Active Defense rested on the idea of the 'single-battle,' AirLand Battle depended on achieving a form of air superiority in order to enable deep shaping fires required to destroy neatly arranged Soviet echelons. Multi-Domain Operations (TRADOC Pamphlet 525-3-1, 2018) is a great example of how concepts shift with assumptions; in this case layered anti-access, area-denial designed to separate the Joint Force in time and operations short of combat. The change in assumptions forced the Army to rethink how the battlespace is viewed in order to solve the problems addressed in MDO-2018 via convergence, force posture, and task organization.

[90] John Allen and Amir Hussain, "On Hyperwar," *US Naval Institute Proceedings* 143, no. 7 (July 2017): 30-37.

Grip at its most fundamental level is the relationship between a human decision maker (commander) and an autonomous system. The word *grip* relates to a concrete feeling when someone wields a weapon, tool, or steering mechanism. Different forms of *grip* are used to generate different effects in different situations. The name also implies the potential to use an incorrect form of grip. Grip represents the operational level aspects of a complex and changing technology in a relatable manner, as opposed to a polymorphic concept such as autonomy. Grip is the function of the two spectrums of AI: autonomy and role-exchange. The intersection of each spectrum indicates the amount of autonomy and role-exchange present at a given point in time, phase, location, or unit. The development of the model follows the step-wise logic show in Figures 7-12.

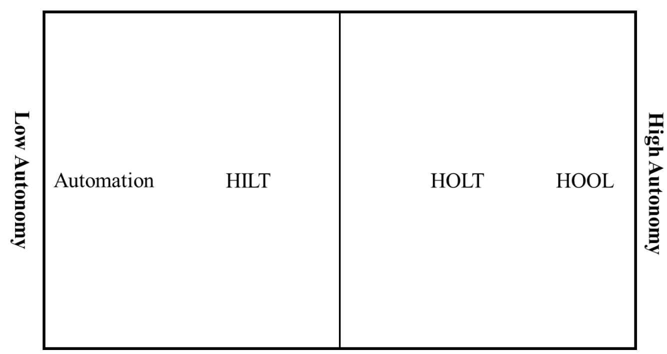

Figure 7. Step 1: The scale of autonomy is bifurcated between HITL and HOTL, with automation and Human out of the loop (HOOL) at the extremes. Created by author.

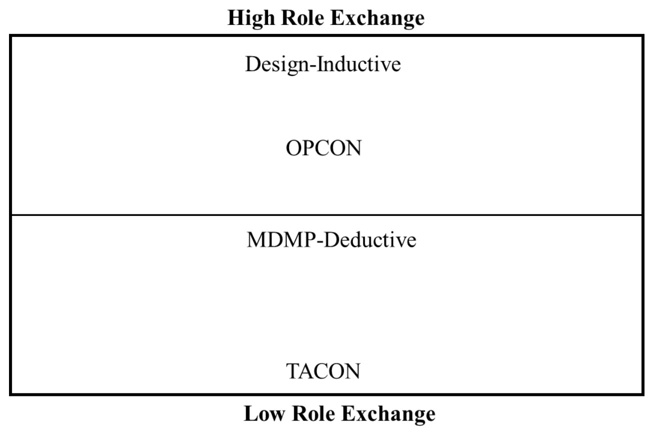

Figure 8. Step 2: The scale of role-exchange is bifurcated between Design-Inductive reasoning and MDMP-Deductive reasoning. High role-exchange is characterized by the ability to redesign operations, forces, and missions (Operational Control), while low role-exchange is limited to the (TACON) employment of forces within a human design. Created by author.

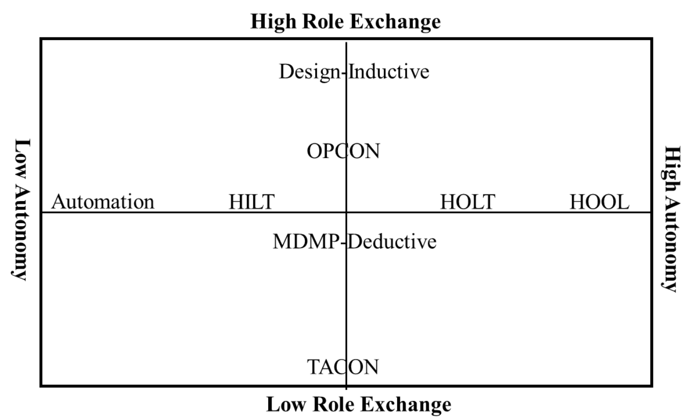

Figure 9. Step 3: Combining scales reveals a general pattern of increasing AI authority to the top-right quadrant. Each corner represents extreme combinations that increase risk. Created by author.

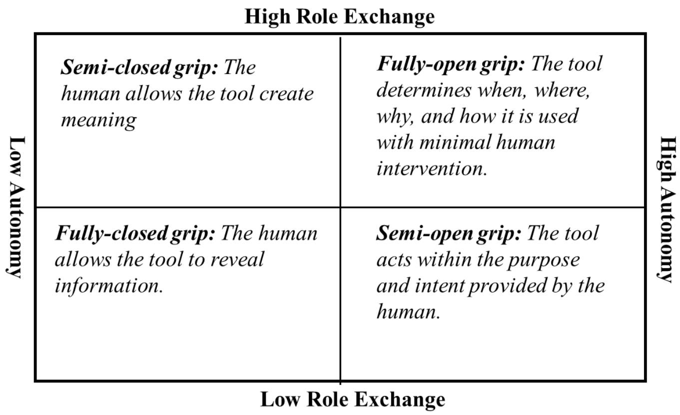

Figure 10. Step 4: The allegory of grip allows AI to be viewed as a hand held-tool, a lever, or a steering wheel. Forms of grip impart allowing the tool to add value while reducing human input.

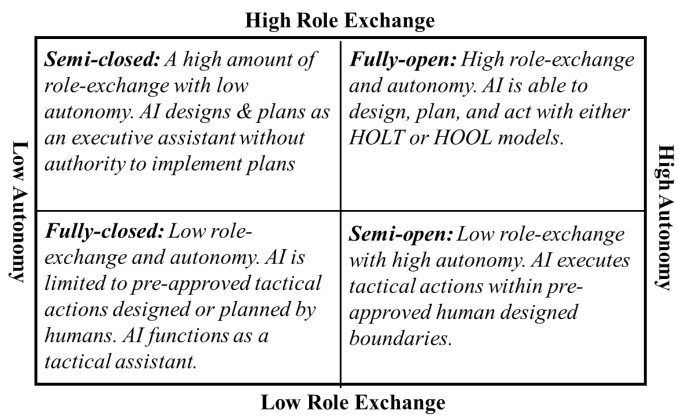

Figure 11. Step 5: Grip visualized as a narrative composed of four distinct quadrants. Created by author.

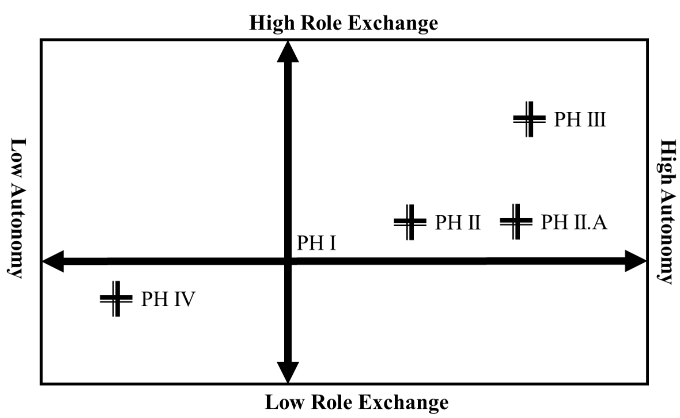

Figure 12. Grip visualized as a relative combination of autonomy and role-exchange. This model allows for a more nuanced view and the ability to graphically depict a desired change. Created by author.

The *Fully-closed* form of grip is very similar to the 'expert-system' software discussed in 1986.[91] This form of grip enhances essentially human processes by revealing patterns, making resource deconfliction recommendations, and making combat power employment recommendations. The inherent risks associated with AI such as brittleness, spoofing, or misidentification remain low due to the HITL configuration and human retention of authorities. This form requires C4I infrastructure to support the HITL and is most appropriate in EMS permissive environments. Tempo remains limited to the speed of human thought and is incapable of matching the speed of AIs with more authorities. This form of grip solves the scheduling complexity problem of MDO against an opponent without AI– but no more.

The *Semi-closed* form of grip is characterized by human decisions based upon an AI led design and operations process. *Semi-closed* retains the primacy of the human decision maker in an environment in which decision speed is not a decisive factor. This form of grip is more likely to produce novel concepts of operation while struggling to explain the how and the why to a human decision maker. This form of grip may also reveal unbiased authority changes and task-organizations to a commander that would normally be outright rejected.[92] This form requires the same HITL C4I but is able to achieve a higher tempo limited only by the commander's ability to make a meaningful decision.[93] This form of grip is also ideal for human-AI reinforcement learning during exercises or in preparation for combat operations.

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[91] Ricky Lynch and Michael McGee, "Military Applications of Artificial Intelligence and Robotics," *Military Review* 66, no. 11 (December 1986): 51.

[92] In this case, either a JTF commander or higher with the need to reorganize forces or change authorities such as space, cyber, or title responsibility to accomplish a mission. A novel solution that would generally be outright rejected would involve separating components of a Marine Air Ground Task Force (MAGTF) or placing a fires asset in reserve.

[93] Meaningful in this case, meaning the commander has time to fully assimilate the information provided and make an informed decision instead of 'rubber-stamping' a series of AI developed courses of action. Dr. Greg L. Zacharias, *Autonomous Horizons: The Way Forward* (Maxwell AFB, AL: Air University Press, 2019), Chapter 3, describes how the use of unfamiliar reasoning may cause humans to dissect AI decisions at the cost of speed–and ultimately tempo. Page 17 of the same document also describes the behavior challenge associated with providing information without corresponding rationale.

Semi-open grip is primarily characterized by AI autonomously executing human courses of action, but below the threshold of interpreting intent. This form of grip generates high tempo within the bounds of a human-designed campaign or operation. This form also generates additional risk of escalation due to the potential of generating rapid effects. *Semi-open* grip will also manifest novel emergent behavior in the pursuit of objectives, which may inhibit measurements of performance or effectiveness. The requirement for C4I infrastructure is lowered; however, rules of engagement to limit effects in time and space are needed. AI under a *semi-open* grip that is isolated from outside communication (denied EMS) will over time operate under a different context than forces in communication. This may lead to different portions of the battlefield executing different branch plans or sequels. This form of grip will exhibit strange behavior when confronting an antagonistic AI, but the overall response options will be limited by human design. *Semi-open* grip is anticipated to become the most common form as AI and autonomous weapons become more prevalent.

Fully-open grip generates the highest tempo and risk. This grip allows AI to design, develop courses of action, and act upon them with either a HOTL or HOOL model. Grip will tend to become more *fully-open* when an AI competes against another AI. Commanders will tend towards a *fully or semi-open* grip when faced with a peer AI-enabled adversary in order to maintain the integrity of the OODA loop. The OODA loop in this case is measured in microseconds with no lag between thought and action. The increasing OODA loop speed at the tactical level will drive a proportional increase at the operational level. The speed of action will create situations in which the commander must once again ‘catch-up’ to the battle. Tempo occurs at the highest possible rate, especially if a *fully-open* AI is competing against a similar form of AI. Conflict between AI systems will generate unpredictable emergent behavior in the attempt to disaggregate the enemy system. A *fully-open* AI will require initial boundaries in time and space, and commanders will have to make decisions on when to expand or reduce those boundaries based upon recommendations by the staff and the AI.

No form of grip pre-approves the application of lethal force by a machine; that decision will more than likely reside with a senior commander or national authorities. The use of lethal force may also be authorized in specific locations, times, and conditions in accordance with policy. Similarly, fail-safe and fail-deadly authorities will likely be held at combatant command or higher levels.[94] Phasing, tempo, and risk are current elements of operational art that each share aspects of grip but fail to explain the relationship between AI and humans in a concise manner. Forms of grip are not limited to broad phase designations as shown in Figure 12. Phasing is a planning and execution tool that is used to divide an operation in duration or activity, and usually involves a change of mission, task organization, or rules of engagement.[95] A change in grip does not necessitate a phase change, nor does it necessarily change a mission, task organization, or the rules of engagement. A denied EMS may impact portions of the formation and trigger a decision point without changing phases or conducting a transition. The grip at the Forward Line of Troops may be different than the grip used in the consolidation area against bypassed forces. Different forces and functions may be in the same space at the same time, yet operate under different levels of grip, complicating the efficacy of using phasing alone to describe AI and autonomy. The element of tempo by itself is also insufficient.

Tempo is the relative speed and rhythm of military operations with respect to the enemy.[96] Various levels of grip impart different effects to tempo. The ability to self-select material targets for engagement may increase the tempo of suppression of enemy air defense compared to the enemy's ability to repair an integrated air defense system. Grip may be changed as a decision point when tempo decreases, or when initiative is shifting to the enemy. Different

[94] Fail-Safe describes an autonomous weapon system shutting itself down or entering a 'safe-mode' when contact with higher headquarters is lost. Fail-Deadly is the inverse in which an isolated AWS continues to fight until it is destroyed.

[95] US Army, *ADRP 3-0* (2017), 2-7.

[96] Ibid., 2-37.

areas of the battlefield may also require different levels of tempo at different times. Actions in the consolidation area or during phases IV and V may require more human oversight, and thus potentially slower response times. Tempo does not address actions in which comparative scales are irrelevant, such as a *semi-closed* grip. In addition to tempo, each form of grip also connotes risk calculus.

Risk is the probability and severity of loss linked to hazards and is associated with a corresponding gain.[97] Grip illustrates the risk and reward of various combinations of role exchange and autonomy. The element of risk is an abstract tool that balances the hazards of audacity and imagination with the corresponding gain. The broadness of risk makes it unwieldy for arranging the relationship between humans and autonomy in time and space. Risk acceptance will change as forms of grip become desirable based upon trends in technology, enemy theories of warfare, and policy. The element of risk may explain the phenomenon associated with AI, albeit in a cumbersome manner. Any aspect of an operation could theoretically be qualified under risk; however, other cognitive tools exists to aid the practitioner. Command and control theory is more apt a tool to explain how to lower the risk of moving between centralized and decentralized operations, with grip acting as the tool to indicate when a decision should be made.

The grip model allows a comparison of the Chinese and US theories of AI warfare. Each quadrant represents a dimension in which different decisions are required to effectively use AI. Removing the assumption of HITL battlefield, much like the idea of the 'single battle,' creates space in which forces and functions must be arranged. In Figures 13 and 14, the grey solid line areas represent 'within-theory' space while dotted lines represent provisional space that requires a decision. Looking at AI from the perspective of operational art reveals additional dimensions that require requisite tools to arrange forces. Moving through these dimensions also requires a tool to

[97] US Army, *ADRP 3-0* (2017), 2-10.

enable the transition between forms of grip. The US theory of command and control, mission command, requires an adjustment in order to move between forms of grip.

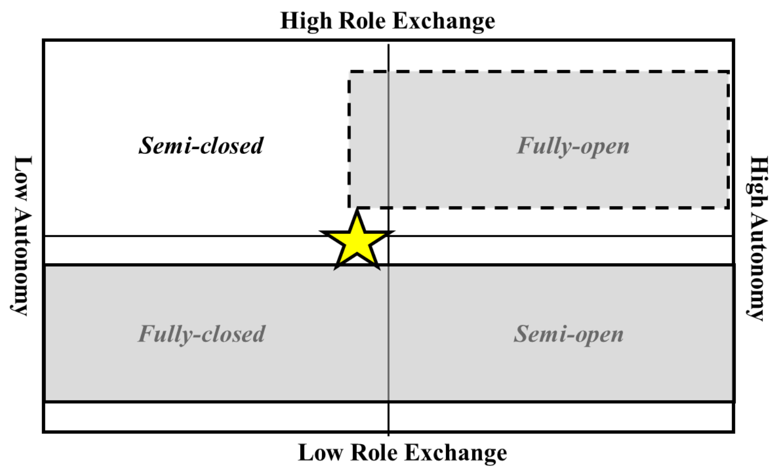

Figure 13. The Chinese theory of AI warfare accounts for *semi-open* and *fully-closed* dimensions of AI to enable systems-destruction warfare. The People's Liberation Army is pending a decision on whether to centralize or decentralize authorities inherent to role-exchange. Created by author.

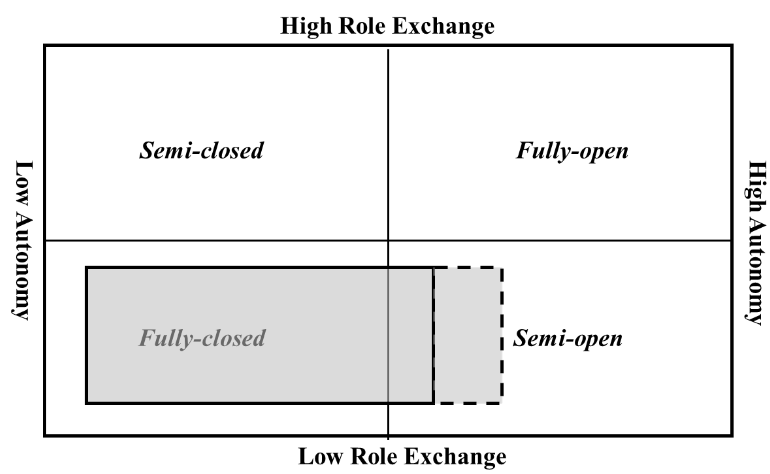

Figure 14. The current US theory of AI warfare accounts for the *fully-closed* dimension with a small amount of hedging via technology development for more autonomous systems. The US theory enables MDO as an expert system is human-centric and lacks the tools to operate within 75 percent of the theoretical space. Created by author.

A New Perspective of Mission Command Theory

US Army mission command theory in Army Doctrine Publication (ADP) 6-0 uses six elements to enable the movement between centralized and decentralized methods of control.[98] Mission command theory uses these elements as components of a non-linear system to generate the emergent effect represented by the commander's decision on which form of control to use. The non-linearity reflects subjective weighting a commander makes in judging competence, levels of trust, and risk. Changes in each element do not cause proportional changes in the commander's decision to centralize or decentralize operations.

The elements of mission command are addressed indirectly in AI development roadmaps, using terms such as: trust, context, agency, learning, and mutual understanding. Different roadmaps and studies use different terms in accordance with their respective goals; however, there is a tendency among the literature to address two key issues: trust and risk. The concept of trust has been dissected by numerous studies into domains, areas of investment, research questions, and challenges.[99] AI associated risk has typically been characterized as risk to mission, risk to forces, and risk associated with the ethical employment. The 2012 (including the May 8th, 2017 revisions) DoDD 3000.9 *Autonomy in Weapon Systems* addresses risk by qualifying the use of AWSs during time sensitive and saturation attacks, in addition to retaining the use of lethal force as a human decision. The 2012 *Role of Autonomy in DOD Systems* approaches risk as a trade off between potential gains and potential losses.[100] Shared understanding, commander's

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[98] The elements are: mutual trust, shared understanding, commander's intent, mission orders, initiative, and risk acceptance. US Department of the Army, *Army Doctrine Publication (ADP) 6-0, Operations* (Washington, DC: Government Printing Office, 2014), iv.

[99] US Department of Defense, Defense Science Board, *Summer Study of Autonomy*, 14; United States Air Force, *Unmanned Aircraft Systems Flight Plan: 2009-2040*, 41; Endsley, *Autonomous Horizons: System Autonomy in the Air Force –A Path to the Future,* 8; Zacharias, *Autonomous Horizons: The Way Forward*, 77.

[100] Defense Science Board, *Department of Defense Task Force Study: Role of Autonomy in DOD Systems*, (Washington DC, 2012), 7.

intent, and the use of mission orders are all aspects underpinning the development of explainable artificial intelligence.[101] Initiative (a bias for action) in and of itself represents an expression of autonomy guided by the other elements of mission command.

From a macro view, the external behavior exhibited by an immature AI and a military organization with a poor mission command climate are similar. The description: “lacks trust, unable to assume risk, unable to maintain shared understanding, lacks ability to communicate mission order or intent” could equally apply to a human or machine problem. Human mission command problems have centuries of studies, psychology, culture, and basic biology to draw from for solutions. AI mission command problems are approached from a primarily technological perspective. This monograph proposes to hybridize the mission command theory for AI into a process-output model in which staffs shape the technical aspects influencing the elements of mission command, while the commander weighs the relative values of trust and risk in order to shift between forms of grip.

[101] See page 75 Figure 2.6 for a concise description of explainable artificial intelligence in relation to understanding, intent, and mission orders. Greg Zacharias, “Autonomous Horizons: The Way Forward.” (Washington, DC, 2019), 75.

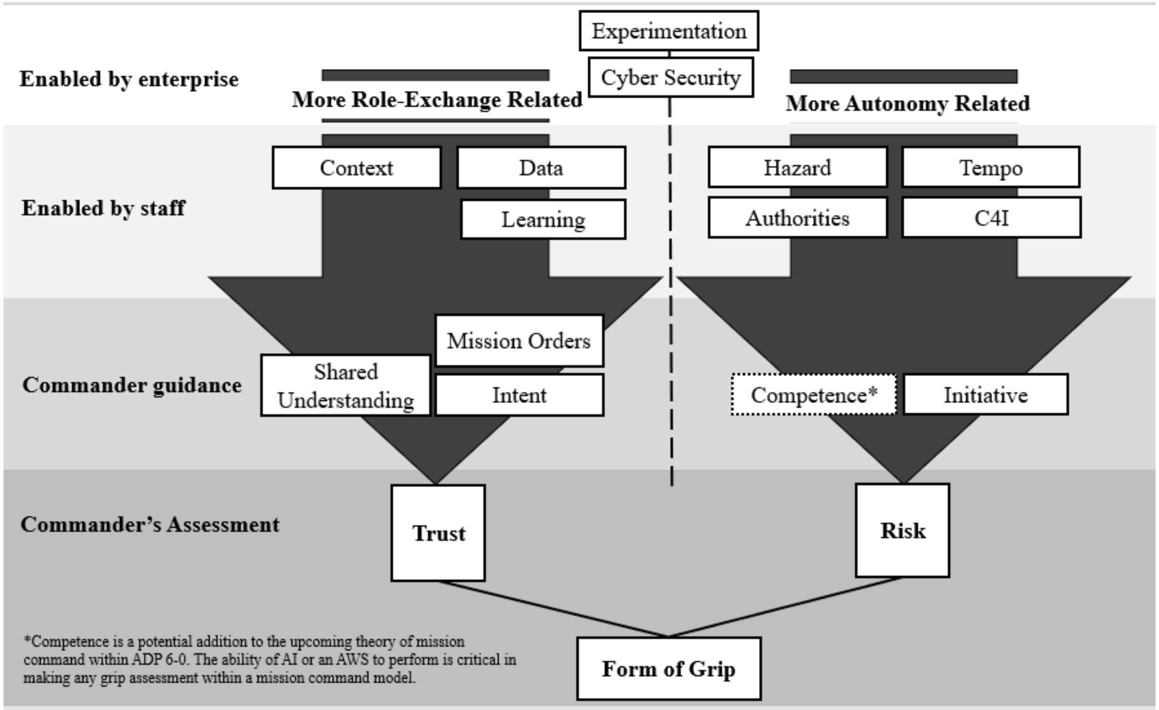

Figure 15. Mission command process-output model. Created by author.

Figure 15 is a process-output model for mission command in which several echelons work together to enable the commander to make an informed decision concerning grip. The DOD enterprise enables through policy, technology development, and via investment in enterprise wide architectures such as cyber security. The staff maximizes the potential of the current iteration of AI by building mechanisms to address the context in which AI operates, providing learning mechanisms for human-AI teaming, and deliberately approaching data as key terrain. The staff also analyzes the relative hazards of operations compared to AI capability, determines (or shapes) the desired tempo of operations, arranges forces and function in time to enable grip changes, and finally provides the commander an assessment of what authorities are needed to change grip. The commander provides guidance, through the lexicon of mission command, to the staff of what conditions are needed to change grip. The staff concurrently communicates with the commander when grip changes might occur. The ultimate product is a subjective calculation of risk and trust the commander makes based upon the holistic process.

The current lack of wide-spread AI does not preclude the need for a mission command model; ALB anticipated the Corps 86 set of equipment in addition to the implications of a deep battlefield. The primary problem restraining the discussion of mission command and AI is 'cerebral' in a similar manner as ALB. [102] Current AI literature is primarily developmental, technical, and generally not relatable. Mission command theory provides a relatable model to view AI, while the idea of an element of operational art forces practitioners to view AI in time and space. The rapid technological evolution of AI creates a tendency to focus on the tactical and technological aspects while ignoring the wider implications at the operational level. Rosenau's broadness remains critical when discussing AI theory and the Army must be 'tolerant with ambiguity' to an extent. The AI mission command process-output model provides that broadness while allowing iterative refinement over time.

Conclusion

AI is bound to change the character of war in the 21st century. AI development is progressing from rules-bound to rules-discovering systems, towards an overall trend characterized by a general-explainable AI. Defining AI remains an enduring challenge due to not understanding of the theoretical limits of AI in addition to our opaque understanding of human cognition. The complexity surrounding AI contributes to a dearth of theories of action that are relatable and understandable. AI is commonly defined using a gradient of autonomy, which is only half the picture. AI has two essential spectrums: autonomy and role-exchange. Through the lens of command and control theory, autonomy represents the degree the authority to act is delegated, while role-exchange represents the scope these authorities within the organization. In other terms, autonomy represents the span of control while role-exchange represents the scale.

[102] Wayne Hall, "A Theoretical Perspective of the AirLand Battle Doctrine," *Military Review* 66, no. 2 (March 1986): 32, accessed October 15, 2018, http://cgsc.contentdm.oclc.org/cdm/singleitem/collection/p124201coll1/id/250/rec/8.

A theory of AI warfare represents a hypothesis of if (x) then (y) within a larger theory of warfare. Multi-Domain Operation represents the current mainstream concept of warfare in which an AI warfare operates. A tentative US theory of AI warfare exists, albeit in a disaggregated form spread across policy and development documents. The US Army hypothesizes that a human-centric is superior to a machine-centric model. This theory perceives one dimension of human-machine interaction in which a human is in the loop and the final arbiter on the use of lethal force. In contrast, the Chinese theory of AI warfare is nested within an aspirational model of systems destruction warfare. The Chinese theory of warfare focuses on disaggregating system components to achieve operational shock. The Chinese view AI as a ubiquitous enabler to a predictive form of warfare. The Chinese theory perceives several dimensions of the human-AI relationship; primarily the dimensions accounting for roles and authorities. The presence of two different theories has two key implications; the likely occurrence of conflict between antagonistic AIs and different forms of human-AI relationships across time and space.

The ALB case study highlights a similar historical case in which technologic development formed radically different assumptions of the battlefield. The 1973 Arab-Israeli war demonstrated the increased lethality of the modern battlefield. Over a nine-year period, two major theories attempted to address the revolutionary lethality of modern equipment. Active defense assumed the war must be fought and won in the first battle, while ALB assumed a conflict must be won by fighting in depth. ALB heralded the development of formal cognitive tools to aid the arrangement of forces in time and space (operational art) in addition to a form of mission command theory. Viewing AI through the lens of operational art and mission command theory reveals multiple dimensions of the human-AI relationship – despite the current US theory of AI warfare.

This monograph proposes a new element of operational art, grip, to account for the different relationships that exist between humans and AI. Grip accounts for various levels of authorities of AI while revealing considerations related to the arrangement of forces in time and space. Moving between forms of grip requires the deliberate arrangement of actions facilitated by an extension of mission command theory. Each form of grip imparts a change in the relative roles of humans and AI in a manner similar to the movement between centralized and decentralized operations. The current theory of mission command is suitable for explaining how to move between the different forms grip. Arranging the theory of mission command into a process-oriented structure allows the commander to issue guidance while the staff and larger DOD enterprise work to shape the factors influencing the AI elements within mission command. The theory of grip and the related expansion of mission command integrates AI into the operational level of war. Grip provides a conceptual framework to understand the 'why' behind the arrangement of forces required to properly employ AI. Extending the theory of mission command enables commanders to rationalize the behavior of AI in a relatable manner; creating clarity from opacity.

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