The Principles of Mission Command Applied to Lethal Autonomous Weapon Systems

A Monograph

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This monograph examines the seven principles of mission command and their application to lethal autonomous weapon systems. Innovative technologies like robotics and artificial intelligence are rapidly reshaping societal norms. Only within the last few years has the US military seriously considered the ramifications of autonomous technologies on the battlefield. As political and military leaders tackle this new era of warfare, novel questions regarding the role of humans and machines in war await. Despite the nascent knowledge and limited experience surrounding autonomous systems, there is an established framework that is combat tested and well suited to addressing ambiguity, the principles of mission command. The principles of mission command are a wise approach for employing lethal autonomous weapons. These seven principles serve as a steady, guiding hand that helps military commanders negotiate the complexities of war. More importantly, the principles ensure that the commander is the ultimate decision-maker and that people and trust are the focus of mission command. The importance of trust in this new age of warfare cannot be understated. Trust ensures cohesiveness and unity of military operations. Understanding the human-machine trust relationship in autonomous weapon systems will be essential for unlocking the competitive advantage of the human-machine team as well as preserving the national security interests of the United States.

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Abstract

The Principles of Mission Command Applied to Lethal Autonomous Weapon Systems, Maj Curtis R. Michael, 56 pages.

This monograph examines the seven principles of mission command and their application to lethal autonomous weapon systems. Innovative technologies like robotics and artificial intelligence are rapidly reshaping societal norms. Only within the last few years has the US military seriously considered the ramifications of autonomous technologies on the battlefield. As political and military leaders tackle this new era of warfare, novel questions regarding the role of humans and machines in war await. Despite the nascent knowledge and limited experience surrounding autonomous systems, there is an established framework that is combat tested and well suited to addressing ambiguity, the principles of mission command. The principles of mission command are a wise approach for employing lethal autonomous weapons. These seven principles serve as a steady, guiding hand that helps military commanders negotiate the complexities of war. More importantly, the principles ensure that the commander is the ultimate decision-maker and that people and trust are the focus of mission command. The importance of trust in this new age of warfare cannot be understated. Trust ensures cohesiveness and unity of military operations. Understanding the human-machine trust relationship in autonomous weapon systems will be essential for unlocking the competitive advantage of the human-machine team as well as preserving the national security interests of the United States.

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Abbreviations

AC-TUV	Anti-Submarine Warfare Continuous Trail Unmanned Vessel
ADP	Army Doctrine Publication
AGI	Artificial General Intelligence
AI	Artificial Intelligence
ANI	Artificial Narrow Intelligence
AS	Autonomous System
CRAM	Counter Rocket, Artillery, and Mortar
C2	Command and Control
DARPA	Defense Advanced Research Projects Agency
DMZ	Demilitarized Zone
DoD	Department of Defense
DSB	Defense Science Board
JFO	Joint Fires Observer
JTAC	Joint Terminal Attack Controller
LAWS	Lethal Autonomous Weapon System
LOAC	Law of Armed Conflict
LRASM	Long Range Anti-Ship Missile
NCO	Non-Commissioned Officer
NDS	National Defense Strategy
NSS	National Security Strategy
PLA	Peoples Liberation Army
ROE	Rules of Engagement
UN	United Nations

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Introduction

> The first ultraintelligent machine is the *last* invention that man need ever make, provided that the machine is docile enough to tell us how to keep it under control. It is curious that this point is made so seldom outside of science fiction. It is sometimes worthwhile to take science fiction seriously.
>
> — Irving John Good, *The First Ultraintelligent Machine*

The kaleidoscopic character of conflict is perhaps more apparent today than ever before. Hybrid warfare, cyber-attacks, and non-state actors are continually making the battlespace more uncertain, dynamic, and ambiguous. Revolutionary technologies such as hypersonic weapons, artificial intelligence (AI), and autonomous systems (AS) further add to this complexity. The unprecedented reliance on innovative technologies by commercial and military industries appears to be the catalyst for the changing character of war, possibly the nature of war as well. Commenting on this topic of AI and warfare, former Secretary of Defense, Jim Mattis, stated, "I'm certainly questioning my original premise that the fundamental nature will not change. You've got to question that now."[1] As political and military leaders carefully or recklessly jump into this new era of warfare with little precedent, new questions regarding the role of humans and machines in war await them.

In 2014, former Undersecretary of Defense Robert Work and his colleague published a report explaining what the future of warfare would look like. They argued that future wars would be fought primarily by robotic technologies such as unmanned and autonomous weapons.[2] The primary driver for this movement towards the Robotic Age is innovations from commercial companies, not the military-industrial complex funded by government research and development

[1] Aaron Mehta, "AI Makes Mattis Question 'Fundamental' Beliefs about War," *C4ISRNET*, last modified February 20, 2018, accessed September 2, 2019, https://www.c4isrnet.com/intel-geoint/2018/02/17/ai-makes-mattis-question-fundamental-beliefs-about-war/.

[2] Robert O Work and Shawn Brimley, *20YY Preparing for War in the Robotic Age*, Report (Washington, DC: Center for a New American Security, 2014), 5, accessed September 27, 2019, https://s3.amazonaws.com/files.cnas.org/documents/CNAS_20YY_WorkBrimley.pdf?mtime=20160906082222.

programs.[3] While these novel technologies benefit numerous civilian industries such as healthcare and finance, militaries, as well as terrorist organizations, increasingly rely upon them. The attacks on Saudi Arabia's energy infrastructure in September of 2019 is one example where terrorists easily modified a small number of drones and disrupted half of the country's oil and natural gas production.[4] Additionally, over the past ten years, the number of sovereign countries who field military drones is ninety-five, an increase of fifty-eight percent.[5]

From a commercial perspective, the market for robotics and autonomous technologies has grown considerably. For instance, industrial robot sales have increased every year for the past six years resulting in a stock of more than 2.4 million robots across the world.[6] Additionally, there were 16.3 million service robots used for domestic purposes in 2018, an increase of 59% from the previous year.[7] Another example that illustrates the growing trend of autonomous technologies is self-driving cars. Automated vehicles hold considerable promise commercially as well as militarily. Vehicles modified with advanced sensor suites can potentially eliminate the need for a human operator or reduce human error by increasing the situational awareness of the driver.[8] The fundamental technology in vehicle automation or smart robotics is AI.

The US military uses AI to enhance national security through lethal and non-lethal applications. One non-lethal application of AI is a software suite called Project Maven. Project

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[3] Robert O Work and Shawn Brimley, *20YY Preparing for War in the Robotic Age*, 37.

[4] Nayla Razzouk and Javier Blas, "Saudi Oil Production Cut in Half After Drone Attack from Yemen," *Bloomberg Markets*, last modified September 14, 2019, accessed January 11, 2020, https://www.bloomberg.com/news/articles/2019-09-14/saudi-aramco-contain-fires-at-facilities-attacked-by-drones.

[5] Dan Gettinger, *The Drone Databook* (Hudson, NY: Bard College, 2019), viii, accessed September 27, 2019, https://dronecenter.bard.edu/projects/drone-proliferation/databook/.

[6] Junji Tsuda, "President's Report," *IFR International Federation of Robotics*, last modified June 26, 2019, accessed October 3, 2019, https://ifr.org/ifr-press-releases/news/presidents-report-03-2019.

[7] Ibid.

[8] US Office of the Under Secretary of Defense Comptroller, "Defense Budget Overview" (Government Printing Office, March 2019), 71, accessed October 26, 2019, https://comptroller.defense.gov/Budget-Materials/Budget2020/.

Maven is a DoD AI application that studies the imagery and video feeds of remotely piloted aircraft with the intent to improve drone strikes.[9] Lethal applications of AI, also called Lethal Autonomous Weapon Systems (LAWS), are fielded not only by the US military but militaries all over the world. This monograph defines LAWS as a weapon system that, once activated, can select and engage targets without further intervention by a human operator.[10]

Examples of LAWS include the Israeli Defense Forces HARPY missile. The HARPY is a loitering munition designed to attack enemy air defenses selectively.[11] Similarly, the US Air Force recently fielded its first autonomous cruise missile, the Long-Range Anti-Ship Missile (LRASM). The design of LRASM is unique as it can autonomously detect and engage enemy warships based on their image recognition, infrared, radar, and other sensor profiles.[12]

The Department of Defense (DoD) defines AI as a machine's ability to perform tasks that normally require human intelligence, whether digitally or as the smart software behind autonomous physical systems.[13] Essentially, AI is a fusion system that processes data to identify patterns, learn, recommend courses of action, or direct actions.[14] Much like the commercial industry, the military recognizes the benefits of AI-enabled hardware and software.

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[9] Jill Aitoro, "Forget Project Maven. Here Are a Couple Other DoD Projects Google Is Working On," *C4ISRNET*, last modified March 13, 2019, accessed October 3, 2019, https://www.c4isrnet.com/it-networks/2019/03/13/forget-project-maven-here-are-a-couple-other-dod-projects-google-is-working-on/.

[10] US Deputy Secretary of Defense, *Autonomy in Weapon Systems*, Department of Defense Directive 3000.09 (Washington, DC: Government Printing Office, 2017), 13, accessed August 11, 2019, https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/300009p.pdf?ver=2019-02-25-104306-377.

[11] Claudia Nieroda, "Killer Robots & Autonomous Machines… 3 New Technologies You Need to Know About," *NAOC*, last modified December 13, 2016, accessed October 3, 2019, http://natoassociation.ca/killer-robots-autonomous-machines-3-new-technologies-you-need-to-know-about/.

[12] Theresa Hitchens, "Navy Warships Get New Heavy Missile: 2,500-Lb LRASM," *Breaking Defense*, July 26, 2017, accessed October 3, 2019, https://breakingdefense.com/2017/07/navy-warships-get-new-heavy-missile-2500-lb-lrasm/.

[13] US Department of Defense, "Summary of the 2018 Department of Defense Artificial Intelligence Strategy" (Government Printing Office, 2019), 5, accessed August 11, 2019, https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

[14] Ibid.

As autonomous weapon development and their use become prominent, questions related to their ethical use and trustworthiness will surface. Julia Macdonald and Jacquelyn Schneider conducted one survey that demonstrates the current obstacle to trust for unmanned aerial vehicles. Their survey showed that Joint Terminal Attack Controllers (JTAC) and Joint Fires Observers (JFO) saw unmanned drones "as riskier and less trustworthy than manned aircraft." Additionally, they concluded that in "domains where humans are in direct contact with the enemy, troops would be reluctant to delegate decisions to machines." However, their limited survey did reveal that JTACs and JFOs were more likely to prefer unmanned aircraft when they had more experience with them. This discovery suggests that experience may help resolve some of the trust issues controllers have with unmanned aircraft.[15]

The previous example illustrates one of the many challenges the DoD's acquisition and development enterprise encounters in developing LAWS. New weapon systems developed by the military undergo extensive testing and policy reviews. In some instances, this process takes many years to complete. However, the overall objective of this deliberate and pragmatic process is to field a capable and robust weapon that military commanders can employ with confidence on the battlefield. LAWS are unique as they challenge this traditional model of weapon acquisition and deployment. Further complicating the development of LAWS is DoD Directive 3000.09. The directive states that commanders and operators must exercise appropriate levels of human judgment over the use of force.[16] What "appropriate levels of judgment is" is not clearly defined in the directive. Moreover, when placed within the current operational environment where adversaries are focusing on contesting, denying, and degrading communication systems, an understanding of appropriate control becomes even less clear.

[15] Jacquelyn Schneider and Julia Macdonald, "Why Troops Don't Trust Drones," January 5, 2018, accessed September 5, 2019, https://www.foreignaffairs.com/articles/united-states/2017-12-20/why-troops-dont-trust-drones.

[16] US Deputy Secretary of Defense, *Autonomy in Weapon Systems*, 2.

The pervasiveness of AI technologies and their extensive growth throughout the civilian and military sectors indicate that the character of war is changing. America's core political and military strategy documents, the National Security Strategy (NSS), and the National Defense Strategy (NDS) recognize the significance of these technologies as they direct that the US prioritize and maintain a competitive advantage in emerging technologies.[17] More specifically, they call for the development of artificial and autonomous technologies. In future conflicts, these emerging technologies will most likely exceed the capabilities of human comprehension. Robert Latiff writes that time will be more precious, and the sheer speed of battle will stress decision making.[18] With this context of future war in mind, militaries should expect the pendulum of military initiative to gradually swing away from the military commander, and travel to autonomous agents. To prepare and succeed in an AI dominated battlespace, commanders will need to extend some of the principles of mission command to LAWS.

[17] President of the United States, "National Security Strategy of the United States of America" (The White House, 2017), 20, accessed October 26, 2019, https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

[18] Robert H. Latiff, *Future War: Preparing for the New Global Battlefield* (New York: Knopf, 2017), 24.

Literature Review

> Alfred Nobel proposed that his invention of dynamite would have such a momentous effect that future wars would be impossible. Richard Gatling wanted his invention of the machine gun to make war so horrible that it would end wars altogether. It hasn't quite worked out that way. The fact is, technology continues to make killing more efficient, and the idea is to win wars.
>
> —Robert H. Latiff, *Future War: Preparing for the New Global Battlefield*

Section Introduction

This section will present a comprehensive review of topics relevant to LAWS. The first segment of the literature review will discuss the current state of AI, LAWS, and future applications. The remainder of the literature review will discuss the concept of trust and trustworthiness, particularly as it relates to military operations. A clear understanding of these two topics is essential to understand the importance of and interplay between mission command and LAWS.

The Current State of AI

There are many definitions and descriptions of what AI is and is not. The DoD defines AI as a machine's ability to perform tasks that normally require human intelligence, whether digitally or as the smart software behind autonomous physical systems.[19] However, contemporary author Nick Bostrum defines AI as an agent that has some faculty for extracting useful concepts from sensory data and internal states.[20] Another unique definition from a university textbook defines AI as agents that receive percepts from the environment and perform actions.[21] These three definitions, while different, illustrate the essential elements of AI: the ability to observe an

[19] US Department of Defense, "Summary of the 2018 Department of Defense Artificial Intelligence Strategy," 5.

[20] Nick Bostrom, *Superintelligence: Paths, Dangers, Strategies* (Oxford, United Kingdom ; New York, NY: Oxford University Press, 2016), 27.

[21] Stuart J. Russell, Peter Norvig, and Ernest Davis, *Artificial Intelligence: A Modern Approach*, 3rd ed., Prentice Hall series in artificial intelligence (Upper Saddle River, NJ: Prentice Hall, 2010), viii.

environment, interpret or draw conclusions from its observations, and consequently recommend or perform a behavior-based upon its interpretation.

It is essential to understand that AI is an all-encompassing term enabled by the processes of machine learning and its associated subfields. Machine learning powers AI as it gives computers the ability to learn without being explicitly programmed.[22] The processes of supervised learning, unsupervised learning, and reinforcement learning are the processes that permit machine learning.[23] Each of these sub-processes of machine learning is driven by algorithms that identify patterns, interpret the environment, and predict things without pre-programmed rules and models.[24] This is an important distinction as it highlights the differences between human learning and machine learning. People tend to learn via characteristics while machines learn through pattern recognition.[25] Lastly, the infrastructure that supports machine learning is deep learning, often referred to as neural networks. Neural networks contain layers of nodes, similar to the human brain, which perform calculations. Conceptually, each nodal layer refines the data calculations from the layer below it.[26]

At the current moment in time, the AI produced by machine learning algorithms is narrow. Systems exhibiting Artificial Narrow Intelligence (ANI) are simply those technologies that can effectively perform a narrowly defined task.[27] In contrast, strong AI or Artificial General Intelligence (AGI) is an AI technology that can successfully perform any intellectual task that a

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[22] Vishal Maini and Samer Sabri, "Machine Learning for Humans," 2017, 9, accessed September 5, 2019, https://www.dropbox.com/s/e38nil1dnl7481q/machine_learning.pdf?dl=0.

[23] Ibid.

[24] Ibid.

[25] Luke Hartig, "Solving One of the Hardest Problems of Military AI: Trust," *Defense One*, last modified April 1, 2019, accessed August 11, 2019, https://www.defenseone.com/ideas/2019/04/solving-one-hardest-problems-military-ai-trust/155959/.

[26] Ben Buchanan and Taylor Miller, *Machine Learning for Policymakers*, Paper, The Cyber Security Project (Harvard Kennedy School, 2017), 14, accessed September 5, 2019, https://www.belfercenter.org/sites/default/files/files/publication/MachineLearningforPolicymakers.pdf.

[27] Maini and Sabri, "Machine Learning for Humans," 10.

human can. Even though contemporary systems do not exhibit AGI, the worry among AI subject matter experts is that AGI will lead to an "intelligence explosion" referred to as singularity. Vishal Maini and Samer Sabri write that once AI reaches the threshold of AGI and can recursively improve, it would be "impossible to predict what will happen."[28]

Entertainment, shopping, and social media companies all leverage AI's ability to interpret an environment and recommend actions. Netflix, the web-based entertainment company, uses AI software to recommend movie and show titles based upon the customer's previous viewing history.[29] Similarly, the online entertainment and retail company, Amazon, uses AI-based software to recommend products based on a customer's purchase history.[30] The healthcare industry has also taken advantage of AI applications.

The healthcare industry's interest in AI is less motivated by profit; instead, it believes AI will help foster trust between doctors and patients.[31] In the medical field, the successful treatment of an ailment is the primary generator of trust. One remarkable instance where AI helped cement trust between a doctor and a patient's family was in the case of a young infant who was suffering from unexplainable seizures. The Rady Children's Hospital in San Diego, California, had the challenging task of finding the cause of the child's seizures. As a leading pediatric hospital utilizing AI technologies, Rady's doctors were able to sequence the infant's genome and identify five million genomic anomalies in a relatively short amount of time. Of those anomalies, AI medical software identified 962 gene combinations known to cause disease. After comparing these anomalies to the child's phenotypic data, an AI-enabled software suite identified the likely

[28] Maini and Sabri, "Machine Learning for Humans," 11–12.

[29] Matthew Lynch, "An AI Implementation Lesson from Netflix - The Tech Edvocate," *The Tech Advocate*, last modified February 21, 2019, accessed October 24, 2019, https://www.thetechedvocate.org/an-ai-implementation-lesson-from-netflix/.

[30] "How Amazon Has Reorganized Around Artificial Intelligence And Machine Learning," accessed October 24, 2019, https://www.forbes.com/sites/blakemorgan/2018/07/16/how-amazon-has-re-organized-around-artificial-intelligence-and-machine-learning/#1badd9873618.

[31] Eric Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again* (New York, NY: Basic Books, 2019), 121.

cause of the seizures as a gene anomaly that occurs in less than 0.01 percent of the population. Fortunately, a dietary supplement could suppress the deleterious effects of the gene. Once the child's diet was modified, the seizures stopped. The child was discharged from the hospital thirty-six hours later.[32]

The accuracy and speed of AI in identifying rare diseases such as the one previously mentioned is remarkable. Medical practitioners welcome these innovative technologies as they reduce errors in diagnosis as well as reduce the workload of accomplishing mundane medical tasks that steal valuable time from the personal interactions related to patient care.[33] While the healthcare industry has only recently started to incorporate autonomous and AI technologies, the gaming industry has been using AI for over twenty years.

In 1997 the IBM computer, Deep Blue, defeated world-renowned chess player Gary Kasparov. Kasparov's defeat became a turning point in the gaming industry as it demonstrated the dominance of a machine over a human, albeit in a very narrow sense. Newsweek magazine dedicated a story to the experience entitled "The Brain's Last Stand."[34] Since this initial seismic shift in gaming, AI's sphere of supremacy in gaming has expanded. This is primarily due to the constant refinement and advancement of AI-related algorithms, digital neural networks, and computer processing power. All of these improvements have allowed AI to surpass the skill level of humans in games.[35] The program AlphaGo illustrates the magnitude of the technological advancements in gaming since Kasparov chess match. In 2016, AlphaGo defeated Lee Sedol, a Chinese world champion in the game of Go.[36] The game Go has been played for over 3,000 years

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[32] Eric Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, 5.

[33] Ibid., 117.

[34] Steven Levy, "The Brains Last Stand," *Newsweek*, May 4, 1997, accessed October 25, 2019, https://www.newsweek.com/man-vs-machine-173038.

[35] Topol, *Deep Medicine*, 78.

[36] Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence* (New York, NY: Knopf, 2017), 87.

and has roughly 2.081681994 x 10^{170} game positions.[37] What is truly remarkable about the program AlphaGo was that it trained itself by learning from 30 million moves that occurred in 160,000 real games.[38] In 2017 a follow-on program to AlphaGo was developed, AlphaGo Zero. This new program trained itself on Go not by learning from previous matches, but by playing against itself. Programmed only with the basic rules, AlphaGo Zero played five million games of Go against itself and was playing at a higher level than its predecessor.[39]

In a more recent AI study in 2019, researchers discovered the emergent properties that AI-powered multi-agent competition can produce in a simple virtual game of "Hide and Seek." During the initial iterations of the game, the virtual agents merely ran from one another, however, after 380 million gaming attempts the agents had learned to coordinate actions, move objects to build shelters or block their opponents as well as use ramps to jump onto or over obstacles placed by those hiding.[40]

The retail, medical, and gaming industries all illustrate how AI technologies are changing the character of civil society. Recommending courses of action, processing large amounts of data, and developing strategies to defeat extremely skilled game players appear to only scratch the proverbial surface of what AI technologies can do. The performance of AI in games of strategy has led to the realization that AI has considerable benefit in military applications. With this in mind, the following paragraphs expand upon the discussion of AI by explaining how the American, Chinese, and Russian militaries envision the use of AI in warfare.

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[37] American Go Association, "A Brief History of Go," *American Go Association*, accessed October 25, 2019, https://www.usgo.org/brief-history-go.

[38] Topol, *Deep Medicine*, 79.

[39] Ibid.

[40] Karen Hao, "AI Learned to Use Tools after Nearly 500 Million Games of Hide and Seek," *MIT Technology Review*, 6, last modified October 17, 2019, accessed October 25, 2019, https://www.technologyreview.com/s/614325/open-ai-algorithms-learned-tool-use-and-cooperation-after-hide-and-seek-games/.

Military Perspectives of AI

Lee Sedol's defeat in the game of Go by the software program AlphaGo was a watershed event for the Chinese military. In response to the games results, the People's Liberation Army (PLA) organized several seminars and symposiums focused on intelligentized command decision-making.[41] The PLA believes that the complex strategizing exhibited by AlphaGo is comparable to that required for war. Consequently, the Chinese believe that AI demonstrates potential in operational command, military wargaming, and decision support.[42] Additionally, they believe the speed and tempo of future conflict will outpace human cognition and take the human out of the loop in certain environments.[43] Chinese military efforts to capitalize on AI are not hyperbole considering that the country has a national AI development plan that aims to build a 146 billion dollar AI core industry by the year 2030.[44]

Russian AI technology pursuits are no less ambitious than the Chinese. However, their current investments in the technology are 12.5 million dollars, a fraction of what the Chinese are spending.[45] The focus of AI development in Russia is on four primary lines of effort: image recognition, speech recognition, control of autonomous systems, and support for weapons life-cycle.[46] Additionally, analysts believe that the Russian military is seeking to develop AI as a critical component of decision support systems, and weapon platforms such as fighter aircraft and unmanned systems.[47]

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[41] Benjamin Angel Chang et al., *AI, China, Russia and the Global Order: Technological, Political, Global, and Creative Perspectives*, White Paper, A Strategic Multilayer Assessment (SMA) Periodic Publication (Department of Defense, December 2018), 157.

[42] Ibid.

[43] Ibid., 156.

[44] "China's New Generation of Artificial Intelligence Development Plan," *FLIA*, July 30, 2017, accessed October 26, 2019, https://flia.org/notice-state-council-issuing-new-generation-artificial-intelligence-development-plan/.

[45] Chang et al., *AI, China, Russia and the Global Order: Technological, Political, Global, and Creative Perspectives*, 178.

[46] Ibid., 179.

[47] Chang et al., *AI, China, Russia and the Global Order: Technological, Political, Global, and*

The national leaders of Russia and China both recognize the importance of AI in the future. Russian President Vladimir Putin boldly stated that "Whoever becomes the leader in this sphere [AI] will become the ruler of the world."[48] The Chinese appear to have a similar viewpoint as their national AI development plan states that AI will "profoundly change human social life and the world."[49] Their plan goes on further to state that China will "lead the artificial intelligence development trend of the world."[50]

From an ideological standpoint, the American perspective on AI development is quite different from the Chinese or the Russians. Former Deputy Secretary of Defense, Bob Work, concluded that China and Russia "see automation as a way of imposing central, top-down control and bypassing fallible human subordinates."[51] The US military, in contrast, sees "AI as a tool to empower human beings all the way down to individual pilots in the cockpit and junior Non-Commissioned Officers (NCO) in the trenches."[52]

From a policy perspective, the NSS for the United States of America delivered on December 2019, stated that the United States "will prioritize emerging technologies critical to economic growth and security, such as . . . artificial intelligence."[53] In response to this directive, the DoD developed a comprehensive artificial intelligence strategy. The document states that the US military is focusing its AI efforts towards thoughtful, responsible, and human centered adoption of AI to strengthen our national security and transform the speed and agility of US

Creative Perspectives,178–180.

[48] David Meyer, "Whoever Leads in Artificial Intelligence Will Rule the World, Says Vladimir Putin," *Fortune*, last modified September 4, 2017, accessed October 27, 2019, https://fortune.com/2017/09/04/ai-artificial-intelligence-putin-rule-world/.

[49] "China's New Generation of Artificial Intelligence Development Plan," 1.

[50] Ibid., 3.

[51] Breaking Defense, "Artificial Intelligence: The Frontline of a New Age in Defense," *Breaking Defense*, 18, last modified September 18, 2019, accessed October 26, 2019, https://breakingdefense.com/2019/09/dod-growth-in-artificial-intelligence-the-frontline-of-a-new-age-in-defense/.

[52] Ibid.

[53] President of the United States, "National Security Strategy of the United States of America," 20.

military operations.[54] Department of Defense funding seems to reflect the prioritization of AI technologies as well. Since 2017 the DoD's budget for technology has increased from 13.4 billion dollars to 15.7 billion dollars in 2019. As an overall percentage of the DoD budget during this time, the investment in advanced technologies, which includes AI, has increased from 2.3% to 2.6%.[55]

While the NSS and the DoD's AI strategy recognize that AI will play an essential role in the national security of the US, DoD Directive 3000.09 is the governing policy that defines the use of AI in military actions. Figure 1 lists the core directives for the employment of LAWS in the US military.

In addition to the LAWS discussed in the introduction of this monograph, the US Navy employs the Phalanx weapon system and AEGIS battleships. Similarly, the US Army fields the Counter Rocket, Artillery, and Mortar (C-RAM), Patriot missile battery, and Active Protection System, both used in a self-defensive manner.[56] The military benefits of these systems are significant; however, their operation is not without risk.

LAWS are valuable in the sense that they reduce the risk not only to military service members but potentially non-combatants as well. Some scientists and defense industry experts believe that LAWS will make war more humane. Ronald Arkin argues that LAWS may be more ethical than humans in war as they can clear the fog of war. For instance, LAWS could react more conservatively, understand the environment more objectively through exquisite sensors, act without emotion, and monitor ethical behavior on the battlefield.[57] The research of the American-

[54] US Department of Defense, "Summary of the 2018 Department of Defense Artificial Intelligence Strategy," 17.

[55] US Office of the Under Secretary of Defense Comptroller, "United States Department of Defense Fiscal Year 2020 Budget Request," 56.

[56] Breaking Defense, "Artificial Intelligence: The Frontline of a New Age in Defense," 10.

[57] Ronald C. Arkin, "Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberative/Reactive Robot Architecture," in *Proceedings of the 3rd International Conference on Human Robot Interaction - HRI '08* (presented at the the 3rd international conference, Amsterdam, The Netherlands: ACM Press, 2008), 6–7, accessed October 27, 2019,

Israeli psychologist, Daniel Kahneman, reinforces this notion of human fragility. He writes that humans are irrational, biased, and that the human perception of the world is distorted by emotional intensity resulting in the emotional tail wagging the rational dog.[58]

DOD DIRECTIVE 3000.09 POLICIES	
1.	Autonomous and semi-autonomous weapon systems shall be designed to allow commanders and operators to exercise appropriate levels of human judgement over the use of force.
2.	Persons who authorize the use of, direct the use of, or operate autonomous and semi-autonomous weapon systems must do so with appropriate care and in accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement (ROE).
3.	Autonomous and semi-autonomous weapon systems intended to be used in a manner that falls within the policies below will be considered for approval.
3a.	Semi-autonomous weapon systems (including manned or unmanned platforms, munitions, or sub-munitions that function as a semi-autonomous weapon systems or as subcomponents of semi-autonomous weapon systems) may be used to apply lethal or non-lethal, kinetic or non-kinetic force. Semi-autonomous weapon systems that are onboard or integrated with unmanned platforms must be designed such that, in the event of degraded or lost communications, the system does not autonomously select and engage individual targets or specific target groups that have not been previously selected by an authorized human operator.
3b.	Human-supervised autonomous weapon systems may be used to select and engage targets, with the exception of selecting humans as targets, for local defense to intercept attempted time-critical or saturation attacks for: 1) Static defense of manned installations and 2) Onboard defense of manned platforms.
3c.	Autonomous weapon systems may be used to apply non-lethal, non-kinetic force, such as some forms of electronic attack, against materiel targets in accordance with DoD Directive 3000.03E.

Figure 1. DoD Directive 3000.09 Policies. Created by the author with data from paragraph four in DoD Directive 3000.09, "Autonomy in Weapon Systems," May 8, 2017.

However, others believe that removing humans from the targeting and kill chain process crosses a "moral and ethical Rubicon."[59] Mary Ellen O'Connell writes that the human qualities of

http://portal.acm.org/citation.cfm?doid=1349822.1349839.

[58] Daniel Kahneman, *Thinking, Fast and Slow*, 1st edition. (New York, NY: Farrar, Straus and Giroux, 2013).

[59] Paul Scharre, *Army of None: Autonomous Weapons and the Future of War* (New York, NY: W. W. Norton & Company, 2018).

conscience, common sense, intuition are unprogrammable and that humans should "always make the awesome, ultimate decision to kill."[60]

While the ethical use of LAWS is not the focus of this paper, it nonetheless is embedded in the concept of mission command, particularly as it relates to trust. With this in mind, the focus of the literature review pivots from the discussion of AI and LAWS to that of mission command and the importance of trust in the military. Both of which are necessary prerequisites for the employment of LAWS.

Mission Command and the Centrality of Trust

Joint Publication 3-0, *Joint Operations,* defines mission command as a key component of the Command and Control (C2) joint function, which enables military operations through decentralized execution based on mission-type orders.[61] Army Doctrine Publication (ADP) 6-0, *Mission Command*, is similar but offers a more nuanced definition stating that decentralized execution is executed "appropriate to the situation."

Throughout history, the idea and elements of mission command have always been present. However, mission command was only recently codified by the US Army in 2003 when it first introduced the term into its doctrine.[62] The foundation for the US military's philosophy of mission command is deeply rooted in the Prussian doctrine of mission orders, also referred to as Auftragstaktik. Prussian General Helmuth Von Moltke described the essence of mission orders stating that "subordinate commanders will understand how to act in war according to the wishes of the superior commander, even when the latter cannot expressly state his will because of time

[60] Mary Ellen O'Connell, "Banning Autonomous Killing," in *The American Way of Bombing: How Legal and Ethical Norms Change* (Ithaca, NY: Cornell University Press, 2013), 13, accessed October 27, 2019, https://scholarship.law.nd.edu/law_faculty_scholarship/63.

[61] US Department of Defense, Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, 2018), xi.

[62] Gen Stephen Townsend, Maj Gen Douglas Crissman, and Maj Kelly McCoy, "Reinvigorating the Army's Approach to Mission Command," *Military Review* (2019): 5.

and conditions."[63] The importance of decentralized execution and empowered subordinates, as conveyed by Auftragstaktik, was fostered throughout Prussian-German military culture by extensive education and training programs.

Prussian-German officer and NCO programs created competent leaders and established trust throughout their chain of command. Officer development was comprehensive and strenuous. Training to become an officer was a three-year process and consisted of extensive training in modern technologies. Additionally, officers served as NCOs for a short time and had to pass difficult, standardized tests. The development of NCOs was no less difficult. In addition to leadership classes, informal professional development occurred through routine interactions with officers in conferences and discussions of field exercises.[64] All of these efforts created a military that was professional, competent, trustworthy, and grounded in the concept of mission orders.

In keeping with the spirit of Auftragstaktik, the US military's approach to mission command rests upon seven principles: competence, mutual trust, shared understanding, commander's intent, mission orders, disciplined initiative, and risk acceptance.[65] These seven principles of mission command are essential for successful military operations as they guide commanders, subordinates, and staff throughout the operations process. The ultimate goal of the mission command approach is to make it easier for commanders to make decisions in a timely matter and exploit opportunities.[66]

The first principle is competence. Commanders develop competent subordinates through challenging training and education programs, much like the Germans and Prussians did in the 19th

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[63] Helmuth von Moltke, *Moltke on the Art of War: Selected Writings*, ed. Daniel Hughes (New York, NY: Presidio Press, 1995), 156–157.

[64] James S. Corum, *The Roots of Blitzkrieg: Hans von Seeckt and German Military Reform*, 1st edition. (Lawrence, KS: University Press of Kansas, 1992), 68–96.

[65] Townsend, Crissman, and McCoy, "Reinvigorating the Army's Approach to Mission Command," 7.

[66] US Department of the Army, Army Doctrine Publication (ADP) 6-0, *Mission Command* (Washington, DC: Government Printing Office, 2019), 57.

and 20th centuries. Professional military education, coupled with realistic training, creates professional competence, teamwork, shared understanding, and trust. All of which are needed when successfully exercising mission command.[67]

Of all the principles of mission command, mutual trust is perhaps the most important. Army doctrine states that trust is essential to successful mission command and that it must flow throughout the chain of command. Developing trust in military organizations is lengthy and effortful. Leaders and subordinates build trust within their teams and organizations through shared experiences and training. Social interactions and open communication are vital when fostering the development of trust in military operations.[68]

The third principle of mission command, shared understanding, both supports and is an extension of the principle of mutual trust previously discussed. Like trust, it requires communication and time. Collaboration is critical in this process. To understand the operational environment, the tensions influencing it, and the approaches needed to solve the problems within it, information must flow both horizontally and vertically throughout the military organization. Ensuring that the flow of information to the lowest levels ensures subordinates are empowered to take the initiative. The tenet of decentralized execution in mission command is difficult to accomplish without a shared understanding of the environment.[69]

Commanders' intent and mission orders are the fourth and fifth principles of mission command. Commanders' intent is the clear and concise expression of the purpose of a military operation and the desired end state that supports mission command. Additionally, it focuses on the staff and assists subordinates in achieving the commander's desired results without further

[67] US Department of the Army, ADP 6-0, *Mission Command*, 19.

[68] Ibid., 19–20.

[69] Ibid., 20.

orders, even when the operation does not unfold as planned. The commander's intent is the basis and common thread that links operational plans to mission orders.[70]

Mission orders are an extension of the commander's intent. They are the directives that emphasize the desired results. Their focus is to help subordinates understand the situation and describe the essential tasks required for the situation. Well written mission orders embody the concept of decentralized execution as they should not dictate how a task is to be accomplished.[71]

Well communicated mission orders coupled with a comprehensive understanding of the environment helps foster disciplined initiative, the sixth principle of mission command. ADP 6-0 describes disciplined initiative when subordinates have the discipline to follow their orders and adhere to the plan until they realize their orders are no longer appropriate for the situation they encounter. Mission command climates that foster a culture of disciplined initiative, in turn, foster a culture of trust. In these organizations, commander's trust that subordinates will act within the bounds of established intent and subordinates trust that commanders will endorse their actions.[72]

Closely related to the principle of disciplined initiative is the final principle of mission command, risk acceptance. Doctrine defines risk as the exposure of someone or something to danger. A plethora of variables influence risk acceptance; examples include the organization's competence, trust, communication, and understanding of the operational environment.[73]

Executed correctly, mission command allows a commander to understand the operational environment and exploit the opportunities presented therein. Essential to this process are empowered subordinates. Dynamic environments demonstrate the importance of empowered subordinates as it allows them to act decisively and take initiatives when previous orders are no longer appropriate. Viewing modern war from this perspective, the importance of trust becomes

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[70] US Department of the Army, ADP 6-0, *Mission Command*, 22.

[71] Ibid., 23.

[72] Ibid., 24.

[73] Ibid., 24–25.

clear. In ADP 6-0, five of the seven principles of mission command use trust in their description.[74] Thus, trust appears to be the golden thread woven throughout the philosophy of mission command. The ensuing paragraphs continue the dialogue of trust concentrating on the establishment of trust and its extension to AI and LAWS.

Trust Development

The purpose of this final section is to present a broad overview of research conducted with regards to the nature and development of trust. This section will begin by defining what trust is, followed by an explanation of its development, and lastly, why trust is essential. Particular emphasis is placed on studies related to the concept of trust in military teams, military operations, and automated technology.

There are many definitions of trust throughout the research community. One definition of trust, based upon close relationships, is "a state involving confident predictions about another's motives concerning oneself in situations entailing risk."[75] A technology-based definition of trust characterized by Lippert and Swiercz is "an individual's willingness to be vulnerable to a technology based on person-specific expectations of the technology's predictability, reliability, and utility as a moderated by the individual's predisposition to trust the technology."[76] Lastly, in a recent US Air Force publication that discusses the way forward for incorporating autonomous technologies, the service uses the definition "[Trust] is a willingness of a party to be vulnerable to the action of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that party."[77] Despite the

[74] US Department of the Army, ADP 6-0, *Mission Command*, 15–26.

[75] Barbara D Adams and Farquhar Webb, Robert D.G., *Trust in Small Military Teams*, Report (Defence and Civil Institute of Environmental Medicine (Canada), Humansystems Incorporated, 2003), 1, accessed January 16, 2020, http://www.dodccrp.org/events/7th_ICCRTS/Tracks/pdf/006.PDF.

[76] Neville A. Stanton, ed., *Trust in Military Teams* (Burlington, VT: Ashgate Publishing Company, 2017), 222.

[77] Greg Zacharias, *Autonomous Horizons: The Way Forward* (Maxwell Air Force Base, AL: Government Printing Office, 2019), 78.

diversity of definitions with regards to trust, the common elements among them are risk, vulnerability, and predictability.

The commonalities between the three definitions of trust illustrate many of the obstacles that military teams must negotiate. Overcoming these impediments is essential as military operations take place in dynamic environments where the consequences failure may have catastrophic effects not only at the tactical level but also at the strategic level. In reconciling these tensions, researchers Barbara Adams and Robert Webb state that there are two models of trust development, person-based trust, and category-based trust. Person-based trust centers on the relationships between people and "best emphasizes the idea of trust conferred directly on a known person, as a result of direct interaction with this person." Contrasting person-based trust is category-based trust. Adams and Webb describe category-based trust "as the product of the perceived membership of the other person in a group or category of people that we have come to trust." Additionally, category-based trust can arise from the "shared membership in a group with another person."[78] A critical discriminator between these two models of trust development is time.

In person-based trust, trust takes place over time, characterized by three developmental stages. In the first stage of person-based trust, individuals establish trust through interactions and consistent patterns of positive behavior. Consequently, these interactions help the trustor assess the predictability of the trustee. In the second stage of person-based trust, the trustor views the trustee from a holistic perspective. It is in this stage where the trustor comes to understand the product of the trustee's true motives. The last stage of person-based trust development is referred to as a "leap of faith." Since people will not always be able to assess the motives and abilities of

[78] Adams and Webb, Robert D.G., *Trust in Small Military Teams,* 3–4.

others in every situation, people in this stage trust that their "partner is motivated to behave consistently and with positive intentions."[79]

Essential moderators that can accelerate or slow the development of trust in person-based systems are the trustee's competence, the trustor's propensity to trust, and the quality of interactions between trustee and trustor. Qualities of the trustee that influence the trust relationship are competence, benevolence, and integrity. Trust history and the propensity to trust are attributes that influence the trustor. Lastly, communication methods, shared values, and similarity (age, sex, race, background) are the overarching interactions that moderate trust among individuals.[80]

Unlike person-based trust, category-based trust is not an aggregate of interactions between individuals; instead, it "exists in situations that do not offer the opportunity for the development of person-based trust." At the core of category-based trust is one's perception of trustworthiness on the "basis of their membership in a particular group or category." Examples of category-based trust include individuals who trust others based upon their profession or position of authority. Some factors that affect the development and quality of category-based trust are membership, ingroup bias, stereotypes, roles, and rules.[81]

It is within this context that military teams develop trust, according to Adams and Webb. The interplay of these two trust developmental models help explain how individuals can trust automated technologies such as AI or LAWS. From a person-based perspective, some researchers argue that predictability, dependability, and faith are the basis for trust in machines. Other researchers expand upon this by theorizing that trust in automated systems is an iterative process and that it must be continuously validated. This hypothesis seems appropriate considering that advanced technologies require "updates" or "patches" to maintain their relevance. The

[79] Adams and Webb, Robert D.G., *Trust in Small Military Teams*, 4.

[80] Ibid., 5–6.

[81] Ibid., 12–13.

requirement for periodic updates, however, introduces a third party into the trust relationship. Not only must individuals trust their automated technologies, but it suggests that trust may be dependent upon their trust in the designers of the systems as well.[82]

In addition to the barriers of trust listed previously, the Defense Science Board (DSB) in 2016 identified six additional problems related to trust in Automated Systems (AS). The first potential problem identified was the lack of analogical thinking by an AS. This idea stems from the possibility of an AS approaching a problem from a perspective that humans do not understand. Another issue identified by the DSB was the lack of traceability or low transparency in an AS solution. The premise of this is that humans are less likely to trust an AS if it cannot explain how it arrived at a solution. The third potential problem of an AS is a lack of self-awareness or environmental awareness. System failures and environmental conditions could unknowingly affect system performance and lead an AS to overstate its "confidence in an AS-based solution." Fourth, when AS and humans work together, there may be little mutual understanding of common goals, which ultimately degrades trust. Limited or non-natural communication interfaces may also affect the level of trust between AS and humans. The last hurdle identified by the DSB is the potential for lack of appropriate training and exercises. Limited opportunities for training, as well as lack of commonality in training, hinders one's ability to trust, as explained in the first stage of person-based trust development.[83]

To address the problems identified by the DSB, the US Air Force is recommending that AS development focus on four tenets of trust: cognitive congruence and transparency, situation awareness, human-systems integration, and human-systems teaming and training. Cognitive congruence and transparency state that AS should solve problems in a manner that humans can understand, effectively making an AS decision auditable. Situational awareness includes sensors

[82] Adams and Webb, Robert D.G., *Trust in Small Military Teams*, 14–15.

[83] Zacharias, *Autonomous Horizons*, 79.

that not only focus on the external environment but the internal environment as well, such as system health and friendly situation. Human systems integration ensures that the AS interface is optimized to allow the human to monitor system performance as well as control it as needed. Lastly, the human-system teaming and training recommendation stemmed from the requirement for humans to train with AS across diverse mission sets, and environments under nominal and degraded conditions. All of these recommendations acknowledge the importance of trust as well as address the fragility and barriers to trust in AS.[84]

Section Conclusion

In closing, this section reviewed the topics of AI, LAWS, mission command, and the concept of trust. From this discussion, one can see that there are challenges in establishing trust with new technologies such as AI and LAWS. Reliability, predictability, time, and values all affect the nature of trust. These common themes show that trust is not binary; instead, it is multifaceted and a matter of degree.[85] Nevertheless, there appears to be some convergence in the development of trust between humans and AS. Finally, this section showed the growing relationship between technology and national security.

[84] Zacharias, *Autonomous Horizons*, 83–115.

[85] Heather M. Roff and David Danks, "'Trust but Verify': The Difficulty of Trusting Autonomous Weapons Systems," *Journal of Military Ethics* 17, no. 1 (January 2, 2018): 2–3.

Methodology

> If we don't wrest back a measure of control, these future WMDs will feel mysterious and powerful. They'll have their way with us, and we'll barely know it's happening.
>
> —Cathy O'Neil, *Weapons of Math Destruction*

Section Introduction

The methodology for evaluating the extension of mission command to LAWS will be Peter Schwartz's strategic planning framework. Using Schwartz's framework, this monograph will identify realistic future scenarios related to the use of LAWS. Each of the scenarios will then be evaluated against the principles of mission command to determine its relevance in future operations with AI-enabled technologies. The following paragraphs explain Schwartz's strategic planning process and the steps followed in developing this paper's AI scenarios.

Schwartz's Scenario Planning Process

The Schwartz scenario planning process is a method used to envision possible futures. What distinguishes this planning process from most is that its purpose is not to predict the future. Instead, the process establishes the environment where future decisions play out. Correctly executed, the Schwartz process reduces the opaqueness of the future and helps "arrange factors so they illuminate the decision, instead of obscuring it."[86]

To begin the scenario planning process, one must identify the issue at hand or a critical decision. The next step is to list the driving factors that will influence the issue or decision at hand. Typically, these factors are the variables, trends, and events that frame the environment. After identifying the driving factors, they are classified as "certainties" or "uncertainties" and

[86] Peter Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World*, Reprint edition. (New York: Crown Business, 1996), 4–6, 193.

ranked in importance.[87] Ranking them establishes a catalog of factors that will determine the future of the area in question.[88]

Once the driving factors are cataloged, planners then map out the possible future scenarios. A conceptual technique recommended by Schwartz to "flesh out" these scenarios is to draw a two by two grid with the axes being the two most essential uncertainties (Figure 1). Each quadrant of the grid represents a potential future representing the interplay of the most important driving forces.[89] After describing what the future state will look like, the planner develops strategies to address each of the future states. The strategy development process starts by listing the implications of each scenario, followed by the required actions to prepare the planner's organization for a range of possibilities. Table 1 is an illustration of the steps in the Schwartz planning process.[90]

[87] Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World*, 227–239.

[88] Peter Schwartz, "Your Future in 5 Easy Steps: Wired Guide to Personal Scenario Planning Step 1," *Wired*, July 20, 2009, accessed September 3, 2019, https://www.wired.com/2009/07/future-5-easy-steps-wired-guide-personal-scenario-planning/.

[89] Ibid.

[90] Schwartz, *The Art of the Long View*, 227–239.

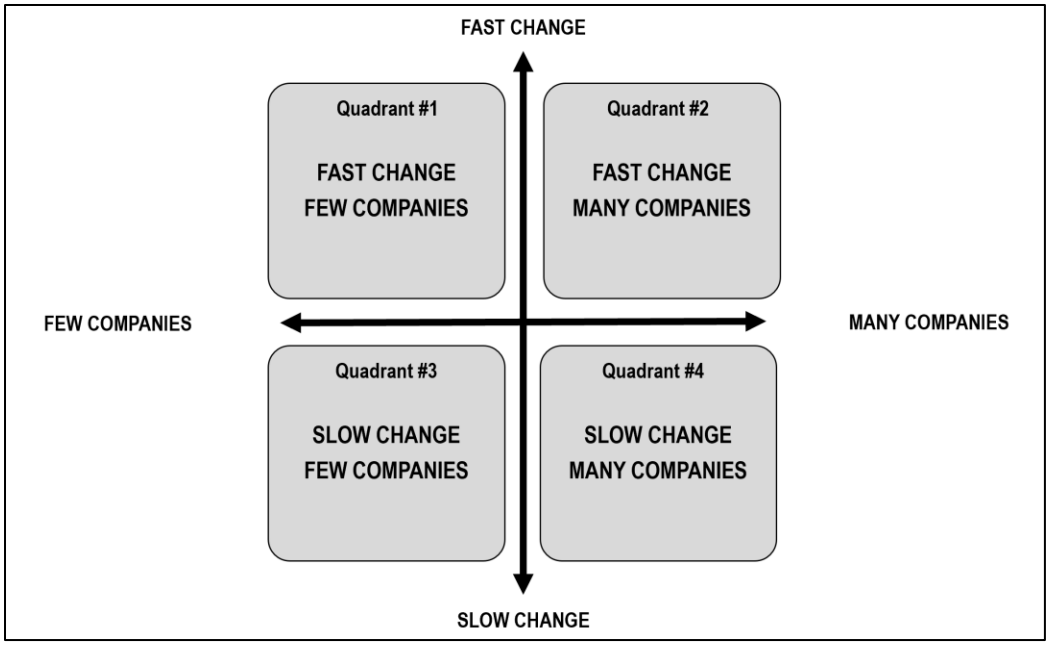

Figure 2. Schwartz Scenario Grid. Created by the author with data from Peter Schwartz's, "Your Future in 5 Easy Steps: Wired Guide to Personal Scenario Planning Step 1." *Wired*, July 20, 2009.

Table 1. Schwartz Scenario Planning Process

Schwartz's Scenario Planning Process	
Step	**Description**
1	Identify Focal Issue or Decision to be Made
2	List Driving Forces
3	Classify Driving Forces as Certainties or Uncertanties
4	Rank Driving Forces In Order of Importance
5	Imagine Possible Futures and Develop Scenarios
6	List the Implications of Each Scenario
7	Develop Actions that Enable Success
8	Track Indicators

Source: Created by the author with data from Peter Schwartz's, *The Art of the Long View: Planning for the Future in an Uncertain World*. New York, NY: Crown Business.

Section Conclusion

The Schwartz planning process is a decision support model well suited to illustrate the applicability of mission command in future operational environments. By overlaying current doctrine on future operational environments, heavily characterized by AI technologies and LAWS, one will see the alignment of doctrine with the perceived battlefield of the future. The following section addresses this question explicitly by examining "snapshots" of possible strategic environments and their implications to US military doctrine.

Analysis

> As a believer in chess as a form of psychological, not just intellectual, warfare, playing against something with no psyche was troubling from the start.
>
> —Garry Kasparov, *Deep Thinking*

Section Introduction

This section will evaluate the appropriateness of mission command as it applies to future wars increasingly characterized by new technologies such as AI and LAWS. The framework used to develop these future scenarios is the Schwartz Planning Process, previously discussed in the methodology section of this paper. This section concludes with the evaluation of the suitability of mission command for LAWS.

Future Scenarios Involving AI and LAWS

In following the steps of Schwartz's scenario developing process, this paper frames the environment from the outside-in. Simply put, the pervasive presence of AS with varying degrees of human control and oversight will characterize the future operational environment. Framed in this manner, one of the primary issues the US military will need to address is: Is current US military doctrine appropriate, specifically the doctrine of Mission Command, for the new character of warfare driven by innovative technologies such as LAWS?

This monograph establishes that two overriding factors will shape the development of future US military doctrine. The two most important factors are US domestic policy and international policy related to AI and LAWS. Hence US military strategies and corresponding doctrine will be governed by the intersection of the predetermined element of accelerating autonomous technologies and the critical uncertainties of domestic military policies and the international policies of American allied and adversarial nations.

The author believes that these two factors will be the primary influencers that shape future battlefields. The strategic trajectory of the US and its current near-peer competitors support

this claim. America's 2017 NSS and the 2018 NDS both reinforce the importance of innovative technologies, specifically autonomous technologies, in achieving the nation's national security objectives. From an international perspective, Russia and China are both aggressively pursuing autonomous technologies. China expects to be the world leader in AI by 2030, while Russia sees AI as a critical component to its military force.[91] Table 2 lists additional driving factors that will shape the future use of LAWS and AI.

Table 2. Future Artificial Intelligence Variables

FUTURE ARTIFICIAL INTELLIGENCE VARIABLES	
KEY CERTAINTIES	**KEY UNCERTAINTIES**
Increase in automated technologies	US Domestic policy related to AI
Increase in computer processing power	International policy related to AI
Increase in computer storage capability	Non-State Actor use of AI enabled technologies
Increase in the use of robotics	Level of human oversight required for AI technologies
Higher presence of automated technologies (military and civilian)	US Military budget
Increased production and established norm of products that are part of the "Internet of Things"	Military structure and organization
Increasing presence and need for technology savvy employees	Global or regional wars
Civil and military institutional use of human-machine teams	Transparency of AI technologies
	Cultural perceptions of AI

Source: Created by the author.

With the two most important driving factors identified, the axes of the scenario grid become domestic policies and international policies (See Figure 3). A nation's level of restraint in employing LAWS defines the spectrum for each axis. Put another way, it is the degree of

[91] Andrew Feickert et al., *U.S. Ground Forces Robotics and Autonomous Systems (RAS) and Artificial Intelligence (AI): Considerations for Congress*, Congressional Research Service Report, November 20, 2018, 2.

human oversight deemed appropriate by the government of a sovereign nation. Unrestrained policies imply that there is little to no human oversight, while restrained policies indicate that LAWS and AI technologies will have more human oversight. Framed in this way, four possible scenarios manifest from the convergence of these policies.

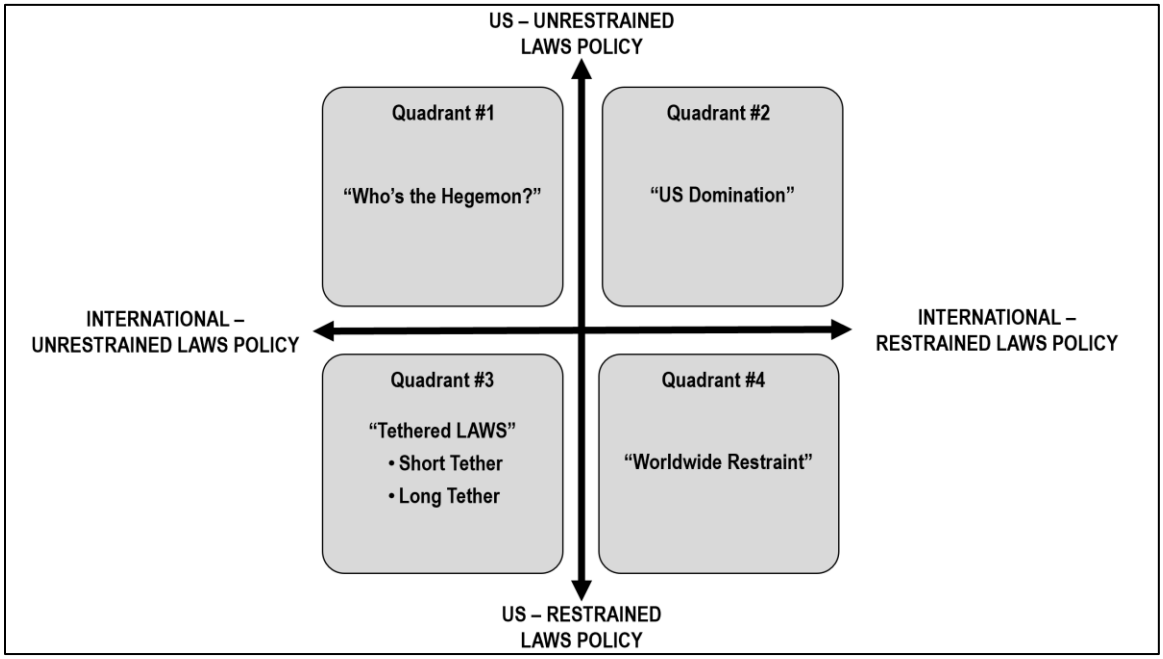

Figure 3. Future LAWS Scenarios. Created by the author.

The first scenario, quadrant one, is characterized by domestic and international policies that are unrestrained. Quadrants two and three reveal a future where domestic and international policies regarding the use of LAWS and AI are at opposing ends of the spectrum. Finally, the fourth quadrant establishes a future that restrains the use of LAWS on the battlefield from both a domestic and international perspective.

In assessing the feasibility of these future outcomes, it appears that quadrants one and three are the most likely. Excluded from this discussion are quadrants two (US Domination) and three (Worldwide Restraint), as the current trend in the international environment is leaning towards the use of LAWS in an unrestrained manner. China and Russia, in particular, appear to be aggressively pursuing LAWS. In November 2019, US Secretary of Defense, Mark Esper, acknowledged that China was selling drones to Middle East countries "capable of full autonomy,

including the ability to conduct lethal targeted strikes."[92] Similarly, Russia argues that there is no legal precedent for a preemptive ban on LAWS and has "continually emphasized the national security benefits of LAWS."[93]

Quadrant One – Who's the Hegemon?

In the current environment, US policy is gradually becoming the unknown variable. Formally, the United States has a strict policy on the development of LAWS, as explained in DoD Directive 3000.09; however, it has invested heavily in its research and potential use. Furthermore, like the Russians, US delegations have consistently opposed preemptive international regulations that ban autonomous weapons.[94] Thus, it seems like there is a growing tension between established AI policy (DoD Directive 3000.09) and current strategic directives outlined in the 2017 NSS and 2018 NDS, which appear to support autonomous technologies aggressively.

Other potential obstacles that may impede the use of LAWS from both a domestic and international standpoint are third party special interest groups and non-governmental agencies. The trend among American industry and influential special interest groups like the Campaign to Stop Killer Robots is to ban the use of LAWS.[95] Powerful corporations and international organizations have followed suit as well. Google, for instance, pulled its support from the DoD's Project Maven program,[96] and the United Nations (UN) insists that autonomous weapons be banned. In a March 2019 message, the UN Chief stated that "machines with the power and

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[92] Patrick Tucker, "SecDef: China Is Exporting Killer Robots to the Mideast," *Defense One*, last modified November 5, 2019, accessed November 7, 2019, https://www.defenseone.com/technology/2019/11/secdef-china-exporting-killer-robots-mideast/161100/?oref=d-topstory.

[93] Zelin Liu and Michael Moodie, *International Discussions Concerning Lethal Autonomous Weapon Systems*, Congressional Research Service Report, August 16, 2019, 2.

[94] Ibid., 1.

[95] "The Campaign To Stop Killer Robots," accessed November 30, 2019, https://www.stopkillerrobots.org/learn/.

[96] "Google Will Not Renew Pentagon Contract That Upset Employees - The New York Times," accessed November 30, 2019, https://www.nytimes.com/2018/06/01/technology/google-pentagon-project-maven.html.

discretion to take lives without human involvement are politically unacceptable, morally repugnant and should be prohibited by international law."[97] With the situation framed in this context, quadrants one and three appear to be viable environments surrounding the use of LAWS.

Unrestrained both by domestic and international policies, quadrant one, characterizes the use of LAWS and AI in a very unrestricted manner. In contrast, unrestrained international policies and restrained domestic policies characterize quadrant three. Of the two outcomes, quadrant three seems the most likely in the near term with quadrant one more likely in the far term. Upon closer inspection, it is plausible that quadrant three has two unique sub-environments; one environment categorized by human-machine teaming (short-tether), and the other categorized as LAWS loosely tethered to human oversight (See Figure 3).

The commonality between quadrants one and three is an international environment that abstains from regulating LAWS or AI for military applications. This does not mean that all nations believe that LAWS should be unregulated, instead, it merely means that international institutions will fail to achieve consensus on how to regulate innovative technologies or individual nations can legitimately rationalize their use. The Law of Armed Conflict (LOAC) does not explicitly prohibit the use of autonomous weapons.[98] Instead, it "comprises prohibitions, restrictions, and obligations designed to balance a State's interest in effectively prosecuting the war with its interest in minimizing harm to those involved in a conflict."[99] Lastly, regulating LAWS may not be in a nation's best interest. Less populous nations, as well as those with limited military budgets, would most likely look with favor on LAWS and AI-driven military systems.

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[97] United Nations Office for Disarmament Affairs, *Perspectives on Lethal Autonomous Weapon Systems*, 2017.

[98] Office of General Counsel, *Department of Defense Law of War Manual* (Washington, DC: Government Printing Office, 2016), 353, accessed January 11, 2020, https://dod.defense.gov/Portals/1/Documents/pubs/DoD%20Law%20of%20War%20Manual%20-%20June%202015%20Updated%20Dec%202016.pdf?ver=2016-12-13-172036-190.

[99] Michael N Schmitt and Jeffrey S Thurnher, "'Out of the Loop': Autonomous Weapon Systems and the Law of Armed Conflict," *Harvard National Security Journal* 4, no. 231 (2013): 232.

Innovative technologies shrink military capability gaps allowing smaller nations to field competent, capable, and lethal military capabilities relatively cheaply.

In contrast to the shared aims of the international actors, American domestic policy differs between quadrants one and three. Quadrant one categorizes American domestic policy as unrestrained while quadrant three restrains the capabilities of LAWS in the future. The revocation of DoD Directive 3000.09 without the passage of a replacement directive would be one indicator that American domestic policy is leaning towards a more liberal use of LAWS and AI in military applications.

Another circumstance that could warrant the deregulation of autonomous technologies is operational necessity. Michael Schmitt and Jeffrey Thurnher point out that "operational realities will likely drive the United States to discard its practice of keeping a human in the loop for lethal targeting decisions."[100] Driving forces behind this may be advanced systems that push the tempo of warfare outside of a human's physical and cognitive capability.[101] Other contributing operational factors that may lead to the unrestrained use of LAWS are mass attacks, contested domains, and new weapon systems. Drone swarms and hypersonic munitions are two such examples that illustrate the "speed of adoption" of new military technologies, which increases the probability that the US will be "surprised by an adversary's ability to field advanced military capabilities."[102] Lastly, advanced weapon systems could very well create environments that are too risky for traditional manned military systems.

In summary, quadrant one appears to be the quintessential realist approach to autonomous weapons. If future domestic policies seek to advance American interests by maximizing and maintaining its military advantage, then quadrant one appears to be a likely path.

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[100] Michael N Schmitt and Jeffrey S Thurnher, "'Out of the Loop': Autonomous Weapon Systems and the Law of Armed Conflict," 237.

[101] Ibid., 238.

[102] Breaking Defense, "Artificial Intelligence: The Frontline of a New Age in Defense," 35.

However, if American domestic policy advocates a doctrine of restraint where it takes the moral high ground, as desired by the UN, then quadrant three perhaps best describes the use of LAWS in future conflicts.

Quadrant Three – Tethered LAWS

For quadrant three, LAWS and AI military applications would be governed by firm, yet flexible policies. Directives such as DoD Directive 3000.09 would be modified from its current state as the American military will adopt a less restrained policy regarding the use of LAWS. The changes made to this directive, along with other complementary policies, would drive LAWS and AI development along one of two possible paths: short-tethered LAWS or long-tethered LAWS. Human-machine teaming would be an example of a short-tethered LAWS while the human-machine relationship in a long-tethered LAWS would not be tightly coupled and have limited human oversight.

Human-machine teaming is advantageous for many reasons. First, it nicely straddles the military moral dilemma of machines. The proximate location of a human and the degree of collaboration with an AI-enabled system implies that there will always be human oversight. Close collaboration with machines avoids weakening the moral foundations that society expects the military profession to exhibit. Peter Scharre writes that if "we lean on algorithms as a moral crutch it weakens us as moral agents. . . it says something about our morality that someone sleeps uneasy at night."[103]

Secondly, teaming mitigates the inherent shortfalls of people and machines. Human-machine collaboration overcomes a human's innate weakness in speed and attention, while humans mitigate a machine's shortcomings in interpretation. This becomes especially important as AI is terrible at "Unknown Knowns." Joshua Gans writes that machines can produce an exact

[103] Scharre, *Army of None*, 290.

answer, but the answer can be very wrong as AI does not understand the decision process that generated the idea.[104]

Lastly, human-machine teaming satisfies the international community's requirement for "meaningful human control" of autonomous weapon systems. In essence, this allows autonomy to complement human decision making and may allow autonomy to take over in specific situations when timelines are short, or the loss of life is imminent.[105] The F-35 Loyal Wingman drone demonstrates this concept of meaningful control. A loyal wingman drone is designed to work with a manned aircraft and operates at the behest of the pilot along a spectrum control. Depending upon the situation, the pilot determines how autonomous the drone will be.[106]

If the tightly coupled human-machine teaming path is not selected, then the alternate path selected will most likely be the extended or long-tethered LAWS. Unlike human-machine teaming, a long-tethered LAWS operates more autonomously and has limited or less proximate human oversight. The distinction between a quadrant one LAWS and a long-tether LAWS is that DoD Directive 3000.09 would be amended and allow the targeting of humans. Other distinctions that indicate American policies are heading in the long-tether direction is 1) a transition from defensive to offensive LAWS, 2) extended periods where a LAWS is operating without human oversight, 3) the level of human oversight is dependent upon the domain in which the LAWS operates in, and 4) a LAWS programmed with mission-type orders, commander's intent, and the LOAC. In a Judge Advocate General Paper, Lieutenant Colonel Adam Cook argues that elements two, three, and four could collectively determine whether a LAWS is operating under

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[104] Ajay Agrawal, Joshua Gans, and Avi Goldfarb, *Prediction Machines: The Simple Economics of Artificial Intelligence* (Boston, MA: Harvard Business Review Press, 2018), 47–54.

[105] Zacharias, *Autonomous Horizons*, v.

[106] Colin Clark, "US 'Loyal Wingman' Takes Flight: AFRL & Kratos XQ-58A Valkyrie," *Breaking Defense*, last modified March 7, 2019, accessed December 1, 2019, https://breakingdefense.com/2019/03/us-loyal-wingman-takes-flight-afrl-kratos-xq-58a-valkyrie/.

"meaningful human control."[107] The following paragraphs elaborate on each of these elements in more detail.

The recent trend in AI-enabled weapon systems is that they are offensively oriented. Legacy autonomous military weapon systems such as the US Navy's Phalanx weapon system, Israel's Iron Dome anti-missile system, and the US Army's Patriot surface to air missile systems are overtly self-defensive. Additionally, all of these systems operate under the close and watchful eye of trained military professionals who can quickly intervene if necessary.[108] Nevertheless, newer autonomous weapon systems such as the Israeli Harpy and the LRASM mentioned earlier in this paper have no human control once released. Open-source information states that the Harpy can stay airborne for over an hour searching for a target, while the LRASM can navigate autonomously around enemy defenses without human supervision.[109] The development and employment of these two weapon systems indicate that loitering munitions are the weapons that transition the LAWS status quo from a defensive to an offensive weapon capability.

Another weapon system that highlights the increasing offensive nature of LAWS and their ability to operate for long periods without human control is the Anti-Submarine Warfare Continuous Trail Unmanned Vessel (AC-TUV). This weapon system was developed by the Defense Advanced Research Project Agency (DARPA) to autonomously conduct anti-submarine warfare for months at a time over thousands of kilometers of open seas.[110]

The AC-TUV also demonstrates how a geographic region or domain can influence the level of autonomy a LAWS exhibits. Generally speaking, in the sub-surface environment, there is

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[107] Adam Cook, "Taming Killer Robots: Giving Meaning to the 'Meaningful Human Control' Standard for Lethal Autonomous Weapon Systems," *The JAG School Papers*, no. 1 (2017): 20.

[108] Scharre, *Army of None*, 165–166.

[109] Hitchens, "Navy Warships Get New Heavy Missile: 2,500-Lb LRASM."

[110] "ACTUV 'Sea Hunter' Prototype Transitions to Office of Naval Research for Further Development," *Defense Advanced Research Agency*, last modified January 30, 2018, accessed December 1, 2019, https://www.darpa.mil/news-events/2018-01-30a.

a relatively low risk of encountering a civilian submersible. The South Koreans apply this same mentality to their employment of the SGR-A1 sentry bot along the Demilitarized Zone (DMZ). While the South Koreans state that a human is required to be on the loop for the weapon to operate, there is documentation that describes the sentry bot as fully autonomous. The placement of an autonomous weapon system in a region with low probabilities of harming noncombatants or causing collateral damage illustrates how a nation could assess risk in the use of a LAWS.[111]

Finally, operating within the confines of quadrant three would require commanders to operate autonomous weapon systems with an appropriate level of human judgment, as stated in DoD Directive 3000.09. Mechanisms that could suffice this requirement are LAWS explicitly programmed with mission-type orders, commander's intent, rules of engagement, and the LOAC. The advantage of a short-tethered LAWS that utilizes human-machine teaming is that the AI-enabled machine would not need to be explicitly programmed with these orders as the military operator would exhibit them throughout his interactions with the machine. Frequent human interaction mitigates risks as unforeseen situations are less likely to produce undesired effects due to human supervision. Moreover, humans are more likely to grasp the commander's guidance, especially in instances where guidance does not lend itself to be "easily programmable" or understood by a LAWS. In these situations, the receipt of military orders by a human and acknowledged by verbal expression or body language seems preferable to a blinking green light or other machine-generated acceptance messages. In the absence of human oversight such as in long-tethered LAWS, the AI-enabled weapon system will need to be programmed with these directives as well as the logic to discern the legality of an engagement. This situation mandates that LAWS have advanced sensor suites able to identify targets as well as evaluate collateral damage concerns.[112]

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[111] Scharre, *Army of None*, 104–105.

[112] Cook, "Taming Killer Robots: Giving Meaning to the 'Meaningful Human Control' Standard for Lethal Autonomous Weapon Systems," 20–21.

Future Scenario Summary

The preceding paragraphs described how domestic and international policies would influence the future development of LAWS. Using Schwartz's planning future planning process, two scenarios appear most plausible. The first future scenario is "Who's the Hegemon?" and is characterized by the inability or unwillingness to regulate LAWS both domestically and internationally. The second future scenario is "Tethered LAWS" and differs from the other environment in that America exhibits some degree of restraint in the development and employment of LAWS when compared to the prevailing international community perspective. The principles of mission command and their application to these two future scenarios is the focus of the following subsection.

LAWS and Mission Command

In each of the future environments, one sees that machines will not entirely supplant human involvement and oversight. Instead, there will be a revolutionary change in the human-machine relationship. ADP 6-0 reinforces the significance of the human element as it states that people are the most important element in the command and control process.[113] It is within this context that one sees the transcending importance of trust between humans and innovative technologies. To that end, the most reliable avenue for developing and fostering trust is to apply the principles of mission command to autonomous technologies.

The intent of applying the principles of mission command to the future scenarios discussed earlier is to assess their impact on the human-machine relationship and understand what trust "looks like." In this instance, trust is the golden thread. It stitches the patchwork of mission command principles together as a comprehensive whole and provides a framework for how the military can trust innovative technologies regardless of the context in which LAWS are employed in a future conflict.

[113] US Department of the Army, ADP 6-0, *Mission Command*, I–20.

The first mission command principle, mutual trust, addresses the core dilemma surrounding the use of LAWS. To build mutual trust, time, and shared experiences are needed. Evaluating the scenarios with these two criteria in mind, it appears that the trust threshold for a LAWS, as explained in quadrant one, will be much higher than a LAWS from quadrant three. The benefit of a quadrant three LAWS from a mutual trust perspective is that human oversight is more proximate and thus more responsive to assist or guide a LAWS if it encounters a unique situation. A quadrant one LAWS, in contrast, would require significantly more testing as human intervention is severely limited once it is operationally employed. Thus, a quadrant one LAWS requires a more comprehensive testing and training regimen than a quadrant three LAWS.

Two other mission command principles that are essential and undergird the concept of mutual trust is shared understanding and competence. Developing and training competent LAWS will not be easy. The acquisition, fielding, and deployment of a LAWS will be significantly different from current DoD weapon systems. Time and resources are finite, and difficult decisions will confront those who determine their apportionment. Perhaps the best way to approach this challenge is to decide whether nations want "superior machines" or "superior people." The above statement aligns well with a quadrant one LAWS, while the latter statement is a good description of a quadrant three LAWS. Ideally, nations want both superior machines and superior people. Adam Biggs and Rees Lee believe that human performance should not be enhanced separate from advancing technology, but that human performance should be enhanced through technology.[114] Irrespective of the chosen strategy, the centrality of trust remains. Whether built through person-based experiences, category-based experiences, or a mixture thereof, AS must exhibit a level of trust and competence to build, improve, or augment situational awareness in the battlespace.

[114] Adam Biggs and Rees Lee, "The Role of the Human Operator in the Third Offset Strategy," *Naval War College Review* 71, no. 3 (2019): 108.

Consequently, communicated or networked situational awareness creates shared understanding across the battlefield. Autonomous systems and structures built to ensure unambiguous information exchange between humans and machines arms military commanders with information to make effective decisions and enable decentralized decision-making throughout the echelon.[115] Additionally, interoperability and information sharing across platforms, military services, and military alliances will be even more critical in order to achieve unity of effort in the battlespace. The competence, interoperability, and information integrity of a LAWS will, in turn, have a profound effect on the risk a military leader is likely to accept.

The principles of risk and disciplined initiative have a symbiotic relationship in mission command. Risk is the substrate on which disciplined initiative rests. With LAWS, risk calculations will be more strategically oriented. Assuming LAWS reduce the footprint of manned weapon systems on the battlefield, the risk to forces at the tactical level becomes significantly reduced. With this risk minimized and transferred to the background, the strategic considerations of risk to mission, risk of escalation, risk to noncombatants, and collateral damage considerations come to the forefront and will dominate risk discussions.

Viewing risk from this perspective, LAWS employment will have immediate strategic implications. Former Chairman of the Joint Chiefs of Staff, General Martin Dempsey, writes that "decentralized operations at the tactical level with strategic implications will be increasingly the norm."[116] With LAWS having a more strategic effect on the battlefield, the toleration of mistakes or the probability of encountering an unforeseen contingent situation will guide the level of risk and disciplined initiative a commander is willing to accept. The fusion of the mission command

[115] Martin Dempsey, *Mission Command*, White Paper (Washington, DC: Government Printing Office, April 3, 2012), 4, accessed January 8, 2020, https://www.jcs.mil/Portals/36/Documents/Publications/missioncommandwhitepaper2012.pdf.

[116] Dempsey, *Mission Command*, 3.

principles of mutual trust, competence, shared understanding, risk, and disciplined initiative guides the commander when issuing his intent and mission orders.

Relating these principles to the scenarios previously discussed, one can infer that risk establishes the "threshold" or likelihood for the use of LAWS. Mission orders and commander's intent are the manifestation of a commander's risk, which in turn determines the degree of disciplined initiative a LAWS will have. Depending upon the situation and strategic implications of their use, LAWS could be used more conservatively, like a deterrent, or more liberally.

Section Conclusion

Applying the principles of mission command principles to LAWS is a useful model for developing trust with new innovative military technologies. Used correctly, these principles mitigate the tensions and challenges associated with new technologies. In particular, the mission command principles of mutual trust, shared understanding, and competence are the foundation that cultivates trust for autonomous technologies. At the nexus of these three principles is risk. Subsequently, risk bounds and shapes a military commander's guidance to subordinates. Commander's intent and mission orders are the manifestation of this guidance and establish the left and right limits of a subordinate's initiative. With the advent of LAWS, these limitations become all the more critical as their neglect will have profound implications.

Conclusion

> One of the great ironies within fighter aviation during the period from 1950 to 1980 is that the systems the pilots once feared would push them out of the cockpit in fact became increasingly reliant on skilled pilots remaining in the cockpit.
>
> —Steve Fino, *Tiger Check*

The principles of military command are a useful framework for LAWS and AI development of military technologies. As a concept, mission command is understood and practiced by all branches of the military. Although each service interprets and executes mission command in its own unique way, all services acknowledge its importance in accomplishing the mission. In a 2012 whitepaper then Chairman of the Joint Chiefs of Staff, General Martin Dempsey, stated that mission command "is critical to our future success . . . in an increasingly complex and uncertain environment" and that the Joint Force must ensure it is a common attribute to the Profession of Arms.[117]

Since all US military services ascribe to the idea of mission command, the development of any weapon system, especially a LAWS, should be compatible with and designed with it in mind. Using mission command as a cognitive framework ensures that autonomous systems are more likely to act at a level on par with human performance behaviorally.[118] If designed in this manner, the military commander, a human with skin-in-the-game, will remain the central figure in mission command as necessitated by doctrine.[119]

Building trust in autonomous weapon systems will be difficult. It requires expenditures of time, effort, resources, and assumptions of risk. All of these elements are familiar to the military commander. Commanders manipulate these elements to assess and direct action on the battlefield while executing mission command. The fundamental challenge commanders will experience with

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[117] Dempsey, *Mission Command*, 3–8.

[118] Zacharias, *Autonomous Horizons*, 142.

[119] US Department of Defense, JP 3-0, *Joint Operations*, II–1.

LAWS is no different from the challenge they currently face when determining the right balance of control and trust.[120] Regardless of the future domestic and international policies that regulate LAWS, trust will be essential.

In closing, the principles of mission command are a wise approach for employing LAWS and other AI-enabled military technologies. They serve as a steady, guiding hand that helps military commanders negotiate the complexities of war. Additionally, the principles ensure that the military commander is the ultimate decision-maker and that mission command is people-based.[121] More importantly, however, the principles create an environment of trust. The importance of trust in this situation cannot be understated as it ensures the cohesiveness and unity of military operations while reducing tension. Understanding the human-machine trust relationship in new autonomous weapon systems will be the key to "unlocking the competitive advantage of the human-machine team"[122] as well as preserving the national security interests of the United States.

[120] Ryan Orsini, "U.S. Army Mission Command at a Crossroads," *The Strategy Bridge*, last modified October 29, 2019, accessed October 30, 2019, https://thestrategybridge.org/the-bridge/2019/10/29/us-army-mission-command-at-a-crossroads.

[121] US Department of the Army, ADP 6-0, *Mission Command*, I–20.

[122] Eric Van Den Bosch, *Human Machine Decision Making and Trust*, Report, Closer Than You Think: The Implications of the Third Offset Strategy for the U.S. Army (Department of Defense: Strategic Studies Institute, US Army War College, 2017), 116, accessed November 11, 2019, https://www.jstor.org/stable/resrep12117.14.

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