

# Artificial Intelligence and Human-Agent Teaming: The Future of Large-Scale Combat

A Monograph

by

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## Abstract

Artificial Intelligence and Human-Agent Teaming: The Future of Large-Scale Combat, by MAJ Ian R. Morris, 43 pages.

America is at risk of being overrun in conventional combat by not developing and deploying Artificial Intelligence (AI) fast enough. Adversaries, specifically China, are embracing AI and attempting to capitalize on a perceived US vulnerability. China plans to be the AI world leader by 2030 and continues to invest heavily in AI capabilities in both its civilian and military sectors. The Chinese view employment of lethal autonomous weapons (LAWS) as inevitable and are developing this capability across all domains. AI is a force multiplier, but the United States is uncomfortable with employing LAWS in combat. China and the United States have contrasting strategies for future AI employment. The Chinese over-reliance on AI over humans is a mistake. In order for the US military to both maximize AI's full potential and maintain international rule of law, human-agent (H-A) teaming is essential in future large-scale conflict.

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## Abbreviations

AGI	Artificial General Intelligence
AI	Artificial Intelligence
AIDP	New Generation Artificial Intelligence Development Plan
ARL	Army Research Laboratory
AWS	Autonomous Weapon System
CCP	Communist Party of China
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DODD	Department of Defense Directive
H-A	Human-Agent
HRED	Human Research and Engineering Directorate
LAWS	Lethal Autonomous Weapon Systems
LSCO	Large-Scale Combat Operations
PLA	People's Liberation Army
PRC	People's Republic of China
UN	United Nations
US	United States

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## Introduction

In the world of autonomy, as we look at what our competitors might do in that same space, the notion of a completely robotic system that can make a decision about whether or not to inflict harm on an adversary is here. It's not terribly refined, it's not terribly good, but it's here.

—Air Force General (R) Paul Selva, Speaking at a Washington think tank in 2016

Today, many Americans interact with Artificial Intelligence (AI) daily without recognizing it. They are blind to AI technology, specifically the software that perform functions that once normally required a human to execute. A perfect example of this is the new “self-parking” car feature.<sup>1</sup> People also use facial recognition technology, a form of AI, to secure their Apple iPhones, create emojis, and even age photos of themselves. Applications like Siri and Alexa are changing the way we access information and they are improving lives. Amazon recently announced that it had sold more than 100 million Alexa devices and last year it accounted for seventy percent of smart speakers in the United States.<sup>2</sup> Information is readily available; all people have to do is ask their smart device a question.

These are just a few of numerous examples of how AI is advancing the world we live in. However, AI possesses the ability to severely damage or even destroy our country if used against us. Near peer competitors are investing heavily in AI in both civilian and military sectors. Terrorist groups could potentially wield an AI technology before the US military is prepared to act. Drone swarms are an evolving tactic as recently observed during the Iranian backed strike on Saudi Arabia's oil facilities in September 2019. Terrorists could potentially couple drone swarms with AI to attack US military targets overseas and even key infrastructure on American soil. A drone swarm attack controlled by AI against a major public event on US soil, like the Super

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<sup>1</sup> Louis Del Monte, *Genius Weapons: Artificial Intelligence, Autonomous Weaponry, and the Future of Warfare* (Amherst: Prometheus Books, 2018), 34.

<sup>2</sup> Katie Robertson, “Amazon Bets on an Empathetic Alexa,” *The New York Times*, March 3, 2019, accessed October 29, 2019, <https://www.nytimes.com/2019/03/03/business/amazon-alexa-david-limp.html>.

Bowl, could kill or injure thousands of civilians. Local law enforcement and conventional military units are currently unequipped to defeat a massive AI controlled attack. We must assume our adversaries recognize their window to effectively utilize AI is diminishing as the US military rapidly advances its AI capabilities.

America is becoming at risk of being overrun in conventional large-scale combat operations (LSCO) by not developing AI technology fast enough. AI is a critical aspect of our adversaries' strategic approach to war going forward. Advances in this realm could be the potential key to victory in future LSCO. This is why it is imperative the United States military continues to research and develop AI to maintain a competitive advantage. Pentagon simulations in 2013 which focused on theoretical conflicts with China or Russia made it clear that the US technological edge was starting to evaporate.<sup>3</sup> In 2014, Russia's Deputy Prime Minister stated that Russia intends to employ, "robotic systems that are fully integrated in the command and control system, capable not only to gather intelligence and to receive from the other components of the combat system, but also on their own strike."<sup>4</sup> Two years later, China unveiled the Junweikejiwei, a new military research and development agency based on the US Defense Advanced Research Projects Agency (DARPA) to increase its AI capability.<sup>5</sup> China and Russia both recognize AI is a vital capability to exploit before the US military can catch up.

The US Department of Defense (DoD) recognizes its adversaries' innovations and AI's potential for future combat. However, the United States must develop answers to challenging questions as AI continues to advance. Specifically, what happens when AI becomes more efficient than soldiers at certain tasks? How can the US military couple these new capabilities

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<sup>3</sup> Zachary Fryer-Biggs, "Coming Soon to a Battlefield: Robots That Can Kill," *The Atlantic*, September 3, 2019, accessed October 30, 2019, <https://www.theatlantic.com/technology/archive/2019/09/killer-robots-and-new-era-machine-driven-warfare/597130/>.

<sup>4</sup> Del Monte, *Genius Weapons*, 11.

<sup>5</sup> Fryer-Biggs, "Coming Soon to a Battlefield."

with human creativity and ingenuity? How does the US maintain its moral credibility if it considers using lethal autonomous weapon systems (LAWS) in combat? As AI evolves, these are the tough questions that American civilian and military leadership must attempt to answer and eventually capitalize on during future LSCO.

## Ghost in the Machine

AI is quickly beginning to catch up with human capabilities in ways many could never imagine. Research teams around the globe are racing to improve algorithms to make AI faster than humans at image-recognition. ImageNet, a collection of over 3.2 million images tagged by humans, was created by Fei-Fei Lei to help train AI algorithms. In 2015, teams from Microsoft and Google used these data sets to help create algorithms that could perform better than humans. During testing, humans labeled images incorrectly slightly above five percent of the time, Google's and Microsoft's algorithms attained error rates below five percent.<sup>6</sup> This is just one example of AI's superiority over humans in terms of processing copious amounts of data quickly and providing relatively accurate solutions.

Most people have heard the decades old news story of Deep Blue, IBM's supercomputer, defeating the world chess champion Garry Kasparov in New York in 1997. This astonished people at the time, and they started to believe that machines could outthink humans.<sup>7</sup> Less than twenty years later in 2016, Google's AI DeepMind AlphaGo played and defeated the world's best Go player. Go is an ancient Chinese game played on a 19 x 19 gameboard, with a total of 361 stones which corresponds to the number of intersections. There is a total of over 130,000 moves during a game of Go and some have said the search space is a number greater than atoms in the universe.<sup>8</sup> The ultimate goal of the game is to control more territory than your opponent. Many

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<sup>6</sup> Fryer-Biggs, "Coming Soon to a Battlefield."

<sup>7</sup> Del Monte, *Genius Weapons*, 29.

<sup>8</sup> "Google AI Defeats Human Go Champion," *BBC News*, Technology, May 25, 2017, accessed October 30, 2019, <https://www.bbc.com/news/technology-40042581>.

consider it one of the world's most complex games and much more difficult for AI than chess.<sup>9</sup> The remarkable thing about this victory is Go players rely heavily on intuition and strategy. Since Go is considered one of the ultimate strategy games, AI is primed to challenge or help human strategists beyond board games, potentially in terms of political or even military strategy.<sup>10</sup> These are just two examples of how AI is beginning to outperform humans. The United States and its adversaries recognize these rapid advances and are doing everything in their power to continue developing AI systems quicker than their competitors.

## AI in Great Power Competition

The US DoD wants to leverage AI as a force multiplier and is aggressively pursuing this rapidly advancing technology. In 2018, the US DoD spent a total of \$649 billion (US) on defense, which equates to slightly above three percent of the US gross domestic product (GDP). China, the second-largest spender in the world, increased its military expenditure by five percent to \$250 billion in 2018.<sup>11</sup> The DoD's upcoming 2020 budget plans to allocate \$4 billion toward artificial intelligence and machine learning research and development (R&D) activities. This is a significant increase of over \$2.5 billion when compared to 2019's budget.<sup>12</sup> Even with a larger budget, the United States has limits in place for its development and use of lethal autonomous weapon systems (LAWS).

The United States is the first country to draft a specific policy to address and prohibit the use of autonomous weapons. Such a ban may only be temporary as our adversaries continue to

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<sup>9</sup> "Google AI Defeats."

<sup>10</sup> Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence* (New York: Alfred A. Knopf, 2017), 89.

<sup>11</sup> Nan Tian, et al., "Trends in World Military Expenditure, 2018," *Stockholm International Peace Research Institute (SIPRI) Fact Sheet* (Solna: SIPRI, April 2019), accessed October 30, 2019, <https://reliefweb.int/report/world/sipri-fact-sheet-april-2019-trends-world-military-expenditure-2018>.

<sup>12</sup> Chris Cornillie, "Finding Artificial Intelligence Money in the Fiscal 2020 Budget," *Bloomberg Government*, March 28, 2019, accessed October 31, 2019, <https://about.bgov.com/news/finding-artificial-intelligence-money-fiscal-2020-budget/>.

operate under no such prohibition. Department of Defense Directive (DODD) 3000.09 defines LAWS as, “weapon system[s] that, once activated, can select and engage targets without further intervention by a human operator.” It also requires that all systems, including LAWS, be designed to “allow commanders and operators to exercise appropriate levels of human judgement over the use of force.”<sup>13</sup> This paper will go into further detail on the ethical and moral implications of using LAWS in a later section. While the United States has prohibited the use of LAWS, its main competitors have made no such pledge and are also determined to expand their AI capabilities to stay ahead.

Adversaries, particularly China and Russia, recognize the unlimited potential of AI and are spending huge sums of money to gain a competitive advantage. In July 2017, the State Council of China laid out a plan to become the world leader in AI by 2030 by building a domestic AI industry worth \$150 billion.<sup>14</sup> Chinese investors poured an estimated \$4.5 billion into more than 200 AI companies from 2012-2017.<sup>15</sup> It is clear these investments will expedite both civilian and military applications of AI against China’s potential foes in the future. Russia’s annual domestic investment in AI is a paltry \$12.5 million but their strides in electronic warfare (EW) are startling. They are collecting electronic signatures from United States and NATO allies which they will feed into an AI system that will improve Russian EW.<sup>16</sup> Both adversaries are embracing

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<sup>13</sup> US Department of Defense, Directive 3000.09: *Autonomy in Weapon Systems*, November 21, 2012, accessed October 31, 2019, <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/300009p.pdf>.

<sup>14</sup> Paul Mozur, “Beijing Wants A.I. to Be Made in China by 2030,” *The New York Times*, July 20, 2017, accessed October 31, 2019, <https://www.nytimes.com/2017/07/20/business/china-artificial-intelligence.html>.

<sup>15</sup> Vikram Barhat, “China is determined to steal A.I. Crown from US and nothing, not even a trade war, will stop it,” *CNBC*, May 4, 2018, accessed October 31, 2019, <https://www.cnbc.com/2018/05/04/china-aims-to-steal-us-a-i-crown-and-not-even-trade-war-will-stop-it.html>.

<sup>16</sup> Samuel Bendett, “In AI, Russia Is Hustling to Catch Up,” *Defense One*, April 4, 2018, accessed October 31, 2019, <https://www.defenseone.com/ideas/2018/04/russia-races-forward-ai-development/147178/>.

AI capabilities and their weaponization. The United States must stay ahead while simultaneously adhering to international rule of law.

## Why Human-Agent Teaming?

While AI is a force multiplier, American policy makers and military commanders are currently apprehensive about the use of LAWS in future combat. This policy may be up for debate if one or more adversaries deploys LAWS against the United States or its allies. A potential solution to this problem is teaming AI with human counterparts. A human-agent (H-A) team is a network where both intelligent systems (agents) and people cooperate effectively within one group, creating synergy by reinforcing each other's strong points and anticipating each other's weak points.<sup>17</sup> Teamwork characteristics and properties vary from model to model, but the one concept that is consistent throughout is the importance of interdependence.<sup>18</sup> H-A teaming depends on this interdependence between the person and AI system to be successful.

DeepMind's previously mentioned AlphaGo is a perfect example of how to effectively pair AI with human counterparts. In 2017, the same year AlphaGo defeated the Go world champion a second time, two human professionals were partnered up with the AI system. In "Pair Go" the human and AlphaGo alternated moves, with each having to learn from, and adapt to, the moves their teammate was making.<sup>19</sup> This coupling allowed humans to learn from their AI counterpart and become better players. Lian Xiao, a Chinese Go grandmaster paired with AlphaGo, explained, "AlphaGo is very confident, and he gives me confidence. He helps me

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<sup>17</sup> "What is Human-Agent Team," IGI Global, accessed November 1, 2019, <https://www.igi-global.com/dictionary/role-organization-agent-systems/13408>.

<sup>18</sup> Matthew Johnson and Alonso Vera, "No AI Is an Island: The Case for Teaming Intelligence," *AI Magazine* 40, no. 1 (Spring 2019): 18, accessed November 1, 2019, <https://www.aaai.org/ojs/index.php/aimagazine/article/view/2842>.

<sup>19</sup> Alex Hern, "DeepMind's AlphaGo to play on team with humans and to challenge five at once," *The Guardian*, April 10, 2017, accessed November 1, 2019, <https://www.theguardian.com/technology/2017/apr/10/deepminds-alphago-to-take-on-five-human-players-at-once>.

believe I should take the helm.”<sup>20</sup> While humanity’s defeat at the hands of AlphaGo is disappointing to some, it is actually a blessing in disguise. H-A teaming has the potential to augment and perhaps even improve what humans are currently capable of.<sup>21</sup>

This paper will attempt to answer how the US military will leverage both AI and H-A teaming in preparation for large-scale combat in the next ten to twenty years. In order for the US military to both maximize the potential of AI and maintain international rule of law, H-A teaming is essential in future conflict. Through the lens of theory, history, doctrine, completed research projects, and potential future scenarios, this research will help answer what the future of AI in US military operations looks like. Evidence will focus on the positive and negative aspects of utilizing autonomous weapon systems (AWS) and AI.

This paper will also explore the capabilities of H-A teaming and whether performance improves when the two are coupled. The results will address the likelihood of “The Terminator Conundrum,” specifically whether or not to use autonomous machines if they offer a marked advantage. While the topic is relatively new, there are numerous books, journal articles, and news reports on AI research and usage in the US military. Research will expand on the topic and present ways ahead in terms of teaming AI and humans on future battlefields. AI has the potential to lead the next revolution in military affairs (RMA); however, the United States cannot achieve AI’s full potential during large-scale combat unless it becomes part of an effective team with a human.

## A Brief Overview of Artificial Intelligence and Autonomy

### What is Intelligence?

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<sup>20</sup> Cade Metz, “Google’s AlphaGo Trounces Humans-But It Also Gives Them a Boost,” *WIRED*, May 26, 2017, accessed November 1, 2019, <https://www.wired.com/2017/05/googles-alphago-trounces-humans-also-gives-boost/>.

<sup>21</sup> Metz, “Google’s AlphaGo Trounces.”

For the purpose of this paper, it is important to define intelligence, artificial intelligence, and robot. Max Tegmark defines intelligence simply as the “ability to accomplish complex goals.”<sup>22</sup> This is the definition that will be referenced in this paper. He goes on to define AI as “non-biological intelligence” or machines that can accomplish complex goals.<sup>23</sup> These definitions are broad but the word “complex” encapsulates other variations of the definition which includes but are not limited to logic, understanding, and self-awareness. Paul Dumouchel and Luisa Damiano define robots as having two criteria, engineering and socio-functional. In terms of an engineering criterion, a robot is an autonomous automatic mechanism capable of adapting to changes in its environment and transforming its behavior as a result. Secondly, a socio-functional criterion, is working in our place, doing the work of human workers.<sup>24</sup> Autonomous robots self-learn and adapt to their environments through the use of AI.

The main difference between human intelligence and AI is the distinction between narrow and broad intelligence. Tegmark explains the previously mentioned IBM Deep Blue chess computer, which defeated chess champion Garry Kasparov, could only accomplish a very specific narrow task of playing chess. However, despite its computing power, it could not beat a four-year-old at tic-tac-toe.<sup>25</sup> Conversely, human intelligence is distinctively broad and can accomplish a vast number of tasks and skills. Humans can learn languages, play games, and accomplish complex tasks. Currently, AI is more efficient at specific tasks but still does not come close to equaling human intelligence. However, experts in the field believe that in the future, AI will equal and then eventually surpass human-level intelligence.

## Machine Learning and Deep Reinforcement Learning

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<sup>22</sup> Tegmark, *Life 3.0*, 50.

<sup>23</sup> *Ibid.*, 39.

<sup>24</sup> Paul Dumouchel and Luisa Damiano, *Living With Robots*, trans. Malcolm DeBoise (Cambridge: Harvard University Press, 2017), 3.

<sup>25</sup> Tegmark, *Life 3.0*, 51.

Tegmark expounds on this idea by explaining the dream goal of AI research to build “general AI” or artificial general intelligence (AGI).<sup>26</sup> AGI is infinitely broader and has the ability to accomplish a variety of goals, which includes learning. AGI is a term that is synonymous with human-level artificial general intelligence meaning the ability to accomplish complex goals regardless of whether these goals are considered good or bad.<sup>27</sup> Before AGI is possible, AI must have the ability to learn and adapt to its environment. Learning is the critical difference that sets human-level intelligence apart from AI, but new developments are quickly shrinking the gap.

How do you instruct a machine how to learn? Ben Buchanan and Taylor Miller define machine learning as, “the process of instructing a computer to learn.”<sup>28</sup> Machine learning is a vital tool which enables computers to teach themselves through analyzing copious amounts of data. Normally, computer programmers would instruct a machine to execute very specific tasks (narrow intelligence). The authors go on to explain that machine learning is normally focused on prediction and creating structure out of random data.<sup>29</sup> Earlier AI programmers used to develop programs that adhered to very strict rules with predetermined conditions. This is the reason why AI was very good at one game or task but struggled in other areas. Today’s updated machine learning programs can identify a large number of more subtle patterns and features in data on its own.<sup>30</sup> The machine can then utilize these insights to analyze new information. Engineers must reduce the complexity and variation in these systems through the use of algorithms. Buchanan and Miller divide these algorithms into three broad categories: supervised learning, unsupervised

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<sup>26</sup> Tegmark, *Life 3.0.*, 52.

<sup>27</sup> Ibid.

<sup>28</sup> Ben Buchanan and Taylor Miller, *Machine Learning for Policymakers: What It Is and Why It Matters* (Cambridge: The Cyber Security Project, 2017), 5.

<sup>29</sup> Ibid., 5.

<sup>30</sup> Ibid.

learning, and reinforcement learning.<sup>31</sup> This technology is still relatively new but continues to improve AI's ability to do more for mankind.

Max Tegmark discusses basic reinforcement learning and a new method called deep reinforcement learning. Basic reinforcement learning is a machine learning technique when getting a positive reward increases the likelihood that someone or thing will do the same thing again. A perfect example of this technique is training your dog to perform a trick by giving them a treat. Google's DeepMind, the same developers who defeated the *Go* champ, created deep reinforcement learning. Tegmark explains how DeepMind created an AI system that learned how to play a classic Atari game Breakout. He describes how, "they'd created a blank-slate AI that knew nothing about this game- or about any other games, or even about concepts" within the game.<sup>32</sup> The AI was able to learn the game due to its neural network and the ability to learn through exposure to massive amounts of data or information. Deep learning has revolutionized computers' ability to translate spoken language into other languages in real time.<sup>33</sup> Deep learning is the reason why people are able to speak to devices, like Siri and Alexa, and they understand. These advances in AI are impressive but are still not equal to human-level intelligence...yet.

## Revolution and Caution

The real question is when do AI experts believe that AI will eventually catch up and even surpass human-level intelligence? Vincent Mueller and Nick Bostrom's research shows that experts in AI predict there is a fifty percent probability that AI will equal human-level intelligence at some point between 2040 and 2050. Their results also show that respondents believe that AI will move on to superintelligence as early as 2070.<sup>34</sup> Louis Del Monte defines

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<sup>31</sup> Buchanan and Miller, *Machine Learning for Policymakers*, 6.

<sup>32</sup> Tegmark, *Life 3.0*, 84.

<sup>33</sup> *Ibid.*, 79.

<sup>34</sup> Vincent Muller and Nick Bostrom, "Future progress in artificial intelligence: A Survey of Expert Opinion," in Vincent C. Müller, ed., *Fundamental Issues of Artificial Intelligence* (Berlin: Springer, 2014), 4, accessed December 23, 2019, <https://nickbostrom.com/papers/survey.pdf>.

superintelligence as “a computer that greatly exceeds the cognitive performance of humans in virtually all domains of interest.”<sup>35</sup> Evidently, creating AI with superintelligence is decades away, if possible at all, but that does not mean that AI cannot become the next technological or biological revolution.

Many intellectuals and AI experts have labelled the rise of AI as the, “next industrial revolution.” Rodney A. Brooks suggests that we are currently in the midst of an information revolution but there are not one, but two additional revolutions will hit us simultaneously. He posits that, “(t)he *robotics* revolution is in its nascent stage, set to burst over us in the early part of the twenty-first century.”<sup>36</sup> Brooks also suggests that the *biotechnology* revolution will closely follow the robotics revolution. He argues this secondary revolution, “will transform the technology not just of our own bodies, but also that of our machines.”<sup>37</sup> Joel Garreau shares a similar sentiment. In *Radical Evolution*, he states that we are currently, “at an inflection point in history.”<sup>38</sup> His book argues that advancing technologies, like AI and robotics, will lead to the next stage in human evolution. Yuval Harari agrees, recognizing that, “Homo sapiens is likely to upgrade itself step by step, merging with robots and computers in the process.”<sup>39</sup> While some experts consider this revolution positively, many do not. They are asking challenging questions, like what if we embrace AI without considering all of the potential consequences?

Some experts urge caution as civilian and military industries continue to make advances in AI and robotics. As previous examples have shown, AI is already widespread and deeply engrained in our everyday lives. Louis Del Monte argues two main points: 1) AI is already an

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<sup>35</sup> Del Monte, *Genius Weapons*, 21.

<sup>36</sup> Rodney A. Brooks, *Flesh and Machines: How Robots Will Change Us* (New York: Pantheon Books, 2002), 10.

<sup>37</sup> *Ibid.*, 11.

<sup>38</sup> Joel Garreau, *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies- and What It Means to Be Human* (New York: Broadway Books, 2005), 6.

<sup>39</sup> Yuval Harari, *Homo Deus: A Brief History of Tomorrow* (New York: HarperCollins Publishers, 2017), 49.

essential element in almost every aspect of modern society and our reliance on AI is moving to dependence; 2) Modern society is unaware of its growing dependence on AI.<sup>40</sup> His argument is centered around humanity's blindness to the increasing role of AI which he defines as the AI effect. This in turn makes us, "blind to the malevolent side of AI."<sup>41</sup> Paul Scharre also shares the same concerns when nations decide to employ LAWS in combat. He argues that countries, "must come together to develop an understanding of which uses of autonomy are appropriate and which go too far and surrender human judgement where it is needed."<sup>42</sup>

Bill Gates and Elon Musk, two of the most prominent tech CEOs, share similar concerns in regard to AGI. Gates acknowledges that machines doing lots of jobs for us is great in the short-term but, "(a) few decades after that, though, the intelligence is strong enough to be a concern."<sup>43</sup> Musk takes these fears to a far darker and sinister level. He has described the creation of AGI as "summoning the demon."<sup>44</sup> While Gates has remained less apocalyptic in tone, he said, "I agree with Elon Musk and some others on this and don't understand why some people are not concerned."<sup>45</sup>

Max Tegmark counters these assertions by arguing that the benefits of AI far outweigh the potential risks that evil super-intelligent robots may pose. He states that the, "fear of machines turning evil is another red herring."<sup>46</sup> Tegmark argues that machines can have goals, but they are in a narrow sense of displaying goal-oriented behavior. The main issue is not with machines, "but with intelligence itself: specifically, intelligence whose goals are misaligned with ours."<sup>47</sup> We

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<sup>40</sup> Del Monte, *Genius Weapons*, 60.

<sup>41</sup> Del Monte, *Genius Weapons*, 60.

<sup>42</sup> Paul Scharre, *Army of None: Autonomous Weapons and the Future of War* (New York: W. W. Norton & Company, 2018), 362.

<sup>43</sup> *Ibid.*, 232.

<sup>44</sup> *Ibid.*

<sup>45</sup> *Ibid.*, 233.

<sup>46</sup> Tegmark, *Life 3.0*, 43.

<sup>47</sup> *Ibid.*, 44.

must ensure that AI has goals that remain aligned with ours going forward. AI has yet to reach human-level intelligence for all skills, but it is quickly catching up.

## What is Autonomy?

It is also essential to discuss the definition of autonomy and the dimensions or scale that measure it. Scharre defines autonomy as, “simply the ability for a machine to perform a task or function on its own.”<sup>48</sup> P.W. Singer refers to autonomy as a feature that is, “(t)he relative independence of a robot.”<sup>49</sup> Scharre goes further by declaring, “(w)ithout autonomy, robots are only empty vessels, brainless husks that depend on human controllers for direction.”<sup>50</sup> This term clearly has different meanings for different people. Some people consider their robot lawnmowers to be autonomous, while others think of autonomy in terms of the T-800 human-like robots from the popular *Terminator* sci-fi film series. There are also distinct concepts that determine where on the “spectrum” of autonomy machines actually fall.

Scharre discusses how autonomy includes three distinct concepts which help determine where on the spectrum machines fall. These concepts are, “the type of task the machine is performing; the relationship of the human to the machine when performing that task; and the sophistication of the machine’s decision-making when performing the task.”<sup>51</sup> Singer describes how autonomy is measured on a sliding scale from direct human operation all the way up to “adaptive” at the high end.<sup>52</sup> These degrees of automation are directly related to the relationship between human and machine. The three degrees are semiautonomous, supervised autonomous, and fully autonomous.

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<sup>48</sup> Scharre, *Army of None*, 27.

<sup>49</sup> P.W. Singer, *Wired For War: The Robotics Revolution and Conflict in the Twenty-first Century* (New York: Penguin Books, 2009), 74.

<sup>50</sup> Scharre, *Army of None*, 15.

<sup>51</sup> *Ibid.*, 27.

<sup>52</sup> Singer, *Wired For War*, 74.

Semiautonomous operations are often referred to as human “in the loop.” According to Scharre in these systems, “the machine performs a task and then waits for a human user to take an action before continuing.”<sup>53</sup> An example of this is if a drone were to recommend a potential target for destruction on the battlefield but cannot engage unless a human pilot approves. The second degree supervises autonomous operation which is referred to as human “on” the loop. Once the machine is initiated it, “can sense, decide, and act on its own, but a human user can observe the machine’s behavior and intervene to stop it, if desired.”<sup>54</sup> A futuristic example of this would be robot soldiers with the ability to patrol in hostile territory. While on patrol, they identify a potential target wearing a uniform similar to an enemy combatant and prepare to engage. Fortunately, a human operator observes this action and intervenes since the target is actually an innocent non-combatant wearing an old uniform.

Lastly, the third degree is fully autonomous operation which is commonly referred to as human “out of the loop.” Scharre describes fully autonomous machines as, “systems (that) sense, decide, and act entirely without human intervention.”<sup>55</sup> An example of a fully autonomous weapon system is the Israeli Harpy. The Harpy searches for enemy radars within a 500-kilometer area and then selects specific targets it wants to destroy without human approval.<sup>56</sup> Again, the United States does not currently employ or endorse the use of LAWS in war. Singer argues the attraction of building increasing levels of autonomy is simple. He states, “(t)he more autonomy a robot has, the less human operators have to support it.”<sup>57</sup> Increased autonomy will cut costs and conserve precious manpower but what are the costs associated with LAWS?

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<sup>53</sup> Scharre, *Army of None*, 29.

<sup>54</sup> *Ibid.*

<sup>55</sup> *Ibid.*, 30.

<sup>56</sup> *Ibid.*, 47.

<sup>57</sup> Singer, *Wired For War*, 75.

## The AI Arms Race?

Many of the previously mentioned experts in the AI field have serious misgivings about LAWS. The primary concern is the potential for an AI arms race between global powers, namely the United States and China. In July 2015, Max Tegmark and Stuart Russell penned an open letter on autonomous weapons. In this letter, the authors pose the question of whether humanity is prepared, “to start a global AI arms race or to prevent it from starting.”<sup>58</sup> They claim that unlike nuclear weapons, autonomous weapons will become cheap and mass produced once the AI arms race is initiated. The authors assert that LAWS are ideal for assassinations, subduing populations, and enabling potential genocide. For these reasons, Tegmark and Russell state they, “believe that a military AI arms race would not be beneficial for humanity.”<sup>59</sup> Over 3,000 AI researchers and an additional 17,000 individuals, including the late Stephen Hawking, signed this letter.

Paul Scharre argues that AWS are different from other weapons that can cause excessive harm and any international agreements must acknowledge this. He states, “(p)roponents of a ban have yet to articulate a strategic rationale for why it would be in a leading military power’s self-interest to support a ban.”<sup>60</sup> Scharre suggests that attempts to restrain AWS must meet three essential conditions to succeed: clear focal point for coordination, horribleness of weapon must outweigh its utility, and transparency. In terms of a clear focal point for coordination, the best preemptive bans should focus on a key prohibited concept versus a generic ban. Second, Scharre claims that the potential AWS should be perceived as bad enough that states will not break the ban.<sup>61</sup> One could argue that the observed effects from US atomic bombs dropped on Hiroshima and Nagasaki was the best form of deterrence of future nuclear war. Lastly, and potentially most difficult, is that great powers must trust their enemies aren’t developing LAWS. This is

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<sup>58</sup> Tegmark, *Life 3.0*, 114.

<sup>59</sup> *Ibid.*

<sup>60</sup> Scharre, *Army of None*, 351.

<sup>61</sup> *Ibid.*, 352.

challenging because AI is often developed in secrecy and its essence, “is software, not hardware, making transparency very difficult.”<sup>62</sup>

Justin Sherman suggests that framing the development of AI as an arms race between the US and China is not only incorrect but dangerous. He states, “interpreting U.S.-China AI development as an ‘arms race’ or a winner-takes-all competition fundamentally misunderstands the transnational nature of AI development.”<sup>63</sup> When compared to the development of nuclear weapons, AI is vaster and more robust. Development of AI is happening in both the military and civilian sectors in both countries. Additionally, AI is being developed globally not just within the confines of these countries’ borders. Sherman argues that, “China is a major market for U.S. AI hardware, and researchers from around the world—including between China and the United States—might work on similar AI problems.”<sup>64</sup> While China does not have the best track record in terms of respecting intellectual property, Sherman makes a fair point.

Currently, there are no international regulations in place to ban the use of LAWS. As previously mentioned, DODD Directive 3000.09 prohibits the US military from utilizing LAWS. However, the policy does leave the door open to interpretation by stating, “weapon systems shall be designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force.” Also, just because there is a directive in place that states the US military will not employ LAWS, does not mean it will not develop them. H-A teaming remains a valid option for US policy makers and commanders going forward. There is plenty of research on leveraging AI militarily in terms of autonomy but not much on coupling it with human ingenuity. It is important to look at China and the United States when discussing AI and potential use of

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<sup>62</sup> Scharre, *Army of None*, 353.

<sup>63</sup> Justin Sherman, “Essay: Reframing the U.S.-China AI ‘Arms Race’: Why This Framing is Not Only Wrong, But Dangerous for American Policymaking,” *New America*, March 2019, 7.

<sup>64</sup> *Ibid.*, 8.

LAWS in future conflict. Who will be the first great power to employ LAWS in combat? How will the rest of the international community react to this decision?

## AI Rising in the East

**Scenario where China employs LAWS in future conflict:** The year is 2040, the People’s Republic of China (PRC) continues its aggressive expansion in the South China Sea. Chinese leadership still staunchly defends their nine-dash line theory as reason for their current actions. The nine-dash line is an undefined line drawn on a map that covers a substantial portion of the South China Sea (Figure 1). The People’s Liberation Army (PLA) has recently developed an AGI system called *Sentient V*, which is equivalent to human-level intelligence. This new and extremely capable AGI system is implanted into robotic soldiers, has the ability to control drone swarms, and unmanned fighter aircraft. The PLA has given *Sentient V* full autonomy meaning humans are completely “out of the loop.”

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Figure 1. China’s Nine-Dash Line. Christopher Mirasola, “A Shifting Tide in the South China Sea: The Permanent Court of Arbitration Declares Jurisdiction,” *Harvard International Law Journal*, November 2015, accessed December 26, 2019, <https://harvardilj.org/2015/11/a-shifting-tide-in-the-south-china-sea-the-permanent-court-of-arbitration-declares-jurisdiction/>.

During development and testing, the PLA found *Sentient V* to be effective, but the system still has issues. Even though these weapons are LAWS, they often have difficulty distinguishing between military and civilian targets. The PRC wants to see the fruits of their labor and demands the PLA deploy *Sentient V* in the contested South China Sea region. They also utilized the

technology to suppress more recent violent Uyghur uprisings. Fully robotic PLA soldiers patrol the Spratly Islands and drone swarms fly over the South China Sea in a wide area security capacity. At first, there were minimal issues with *Sentient V*. There was one friendly fire incident between a PLA soldier and a *Sentient V* robot that results in the soldier's death. However, significant issues start to arise as *Sentient V* begins coming into contact with civilian fisherman and cargo shipping moving through the contested area.

Reports filter out of Vietnam and the Philippines that multiple fisherman are dead, riddled with bullets near the Spratly Islands. A swarm of *Sentient V* controlled drones attacked an unarmed cargo vessel sinking the ship and killing the entire twenty-five-person crew. The international community discovers that China is utilizing LAWS, resulting in these civilian casualties. There is global outrage, but the PRC and PLA refuse to acknowledge that *Sentient V* was to blame for these deaths. Furthermore, the PLA states that it will continue to employ LAWS in the South China Sea to defend what it considers its sovereign territory. The United States is caught off guard by China's impressive development and employment of AGI. DODD Directive 3000.09 is still in effect, but the DoD is developing and testing LAWS. There are some senior leaders within the military and political establishment, encouraging the President to approve the use of LAWS. Clearly a US military response is warranted but is the use of LAWS the correct solution? The resolution of this scenario will be described in the introduction of the subsequent section.

## Analysis of Scenario

Obviously, the above scenario is fictional, but it is important to consider the possibilities of what the future of AI could look like in great power competition. It presumes that China will continue to pursue and employ LAWS in future combat. The scenario highlights the very real possibility that these AI systems may not operate in the way they are designed. Today, many in the international community vehemently oppose the use of LAWS. They believe it will make

wars less harmful in terms of financial and human costs. Therefore, the scenario presumes this anti-AWS logic in the international community will continue for the foreseeable future. China and the United States are both aggressively pursuing rapid advances in AI capabilities with opposing strategies. This section will focus on recent Chinese efforts to develop AI in both its civilian and military sectors. It will discuss the PRC's efforts to collaborate and/or steal intellectual property. Lastly, it will go into further detail on the PLA's potential to employ LAWS and AI in command decision-making during future conflict.

## Chinese Civilian and Military Integration

China's civilian sector is making increasingly impressive strides in AI development. Baidu, Inc., the Chinese equivalent of Google, is currently China's largest technology company and invests heavily in AI. They filed the most AI-related patent applications in China with a total of 5,712 applications as of October 2019.<sup>65</sup> Baidu is in direct competition with US companies like Google and Microsoft, in terms of developing AI that understands human language. They are the first company to score above a ninety in the General Language Understanding Evaluation (GLUE), which sets the standard for AI language understanding.<sup>66</sup> The PLA recognizes the potential that private companies like Baidu offer, and plan to exploit their expertise to gain an advantage over the US.

Chinese leadership from President Xi Jinping, on down are determined to become the global leader in AI. China's State Council published its *New Generation Artificial Intelligence Development Plan (AIDP)* in July 2017. AIDP and *Made in China 2025*, published in May 2015,

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<sup>65</sup> AIT News Desk, "Baidu Leads the Way in Innovation With 5,712 AI Patent Applications," *AiThORITY*, December 26, 2019, accessed December 28, 2019, <https://www.aitority.com/news/baidu-leads-the-way-in-innovation-with-5712-ai-patent-applications/>.

<sup>66</sup> Anthony Cuthbertson, "China's Baidu Dethrones Google To Take AI Language Crown," *Independent*, December 27, 2019, accessed December 29, 2019, <https://www.independent.co.uk/life-style/gadgets-and-tech/news/ai-china-baidu-artificial-intelligence-google-a9261691.html>.

are the foundation of China's AI strategy.<sup>67</sup> These documents layout how China plans to develop and become the world leader in AI by 2030. The opening paragraphs of the AIDP encapsulate how essential AI is to China and its leaders going forward. It states, "AI has become a new focus of international competition. AI is a strategic technology that will lead in the future; the world's major developed countries are taking the development of AI as a major strategy to enhance national competitiveness and protect national security."<sup>68</sup> Clearly, AI will continue to be at the forefront of great power competition with China's competitors, namely the United States, going forward.

Today, Chinese AI experts are leading the United States in terms of numbers of research papers published and cited, and China also ranks second in AI patent applications.<sup>69</sup> China is taking a page directly from the US playbook by integrating civilian and military institutions. The US DoD already works closely with companies in the private sector like Google and Microsoft, to maintain a competitive advantage in AI. In early 2017, under Xi Jinping's direction, China established the Military-Civil Integration Development Commission.<sup>70</sup> This organization is responsible for integrating what Chinese tech companies, like Baidu, are developing in the AI realm and sharing these advances with the PLA.

SenseTime, a world leader in computer vision AI, is a perfect example of this civilian-military integration. SenseTime's consumer facial recognition systems share infrastructure and technology with its security systems, used by Chinese law enforcement, military, and intelligence

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<sup>67</sup> Gregory C. Allen, "Understanding China's AI Strategy: Clues to Chinese Strategic Thinking on Artificial Intelligence and National Security," *Center for a New American Security* (February 2019), 3.

<sup>68</sup> Graham Webster, Rogier Creemers, Paul Triolo, and Elsa Kania, trans., "Full Translation: China's 'New Generation Artificial Intelligence Development Plan,'" *New America*, August 1, 2017, accessed December 29, 2019, <https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/>.

<sup>69</sup> Elsa B. Kania, "China's Quest for an AI Revolution in Warfare," *The Bridge*, June 8, 2017, accessed December 29, 2019, <https://thestrategybridge.org/the-bridge/2017/6/8/-chinas-quest-for-an-ai-revolution-in-warfare>.

<sup>70</sup> *Ibid.*

agencies.<sup>71</sup> The Chinese Communist Party (CCP) is also using these advances in AI to their advantage within their borders. Facial recognition AI technology, like SenseTime, will assist the CCP in their attempts to bolster social control and stability through the installation of millions of surveillance cameras.<sup>72</sup> The persecution of the minority Uyghur population also provides the PRC ample opportunity to test these innovative technologies on human subjects. Another example of this actualized military-civil fusion is through a partnership with a company called iFlytek. In 2014, iFlytek, a successful AI start-up focused on voice recognition, analysis, and speech-to-text products, was given a license to work with the PLA.<sup>73</sup> Again, similar to facial recognition, the PLA can wield voice recognition AI technology to assist in intelligence collection and translation of foreign military traffic. AI is a national priority for China and continues to be enabled by the open nature of AI research and development.

### Collaboration or Stolen Intellectual Property?

Many Chinese companies recognize the advantage the United States has in terms of talent in the AI realm. In January 2017, Qi Lu, a veteran Microsoft AI specialist, left his position to become chief operating officer at Baidu.<sup>74</sup> At the time, this was a huge win for China because they were able to enlist a very talented US recruit from a fierce competitor in Microsoft. China's ties to Silicon Valley are deep and enable recruitment of top-tier talent from the US. In 2015 alone, Chinese investment in Silicon Valley was \$11.52 billion.<sup>75</sup> Alex Ren, founder of TalentSeer, an AI recruiting firm, explains why China is recruiting so aggressively; "Chinese companies are obsessed with hiring Silicon Valley talent because winning talent here is like

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<sup>71</sup> Allen, "Understanding China's AI," 9.

<sup>72</sup> Elsa Kania, "Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power," *Center for a New American Security* (November 2017), 8.

<sup>73</sup> *Ibid.*, 20.

<sup>74</sup> Del Monte, *Genius Weapons*, 86.

<sup>75</sup> Sherman, "Essay: Reframing the U.S.-China AI," 8.

reaching the commanding heights of the AI battlefield.”<sup>76</sup> China recognizes their lack of talent as a potential weak spot that must be addressed in order to become the global leader in AI.

The Tsinghua University China AI report concludes that China ranks eighth in the world in terms of top AI talent, with only 977 individuals compared to the United States’ 5,518.<sup>77</sup> Many Chinese senior leaders believe this trend will continue and are taking steps to rectify the situation. In April 2018, China’s Ministry of Education (MOE) created the *AI Innovation Action Plan for Colleges and Universities*. The plan calls for the creation of “50 world-class teaching materials for undergraduate and graduate studies” related to AI applications for specific industries; creation of “50 national-level high-quality online open courses;” and will establish “50 artificial intelligence faculties, research institutions, or interdisciplinary research centers.”<sup>78</sup> The open nature of AI research and development allows China to closely monitor their competition.

Chinese leadership and the PLA are both acutely aware of what the DoD and US government are distributing in regard to AI. The CCP’s organizations consistently translate, disseminate, and analyze US government and think tanks reports on AI.<sup>79</sup> The current US AI terminology is just one example of Chinese observations. PLA theorists are starting to differentiate between humans “in the loop” and “on the loop” in their writings on AI automation.<sup>80</sup> China also leverages its private companies’ research labs and educational partnerships to gain an advantage. Alibaba, another Chinese tech giant, has multiple research labs in the United States as part of their global research initiative.<sup>81</sup> Stanford has multiple programs

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<sup>76</sup> Meng Jing, “Chinese firms fight to lure top artificial intelligence talent from Silicon Valley,” *South China Morning Post*, April 2, 2017, accessed December 29, 2019, <https://www.scmp.com/tech/china-tech/article/2084171/chinese-firms-fight-lure-top-artificial-intelligence-talent-silicon>.

<sup>77</sup> Allen, “Understanding China’s AI,” 11.

<sup>78</sup> *Ibid.*, 11.

<sup>79</sup> *Ibid.*, 3.

<sup>80</sup> Kania, “Battlefield Singularity,” 16.

<sup>81</sup> Sherman, “Essay: Reframing the U.S.-China AI,” 8.

that connects the university with foreign private companies, like the Chinese transportation company DiDi. Their AI Affiliates program allows corporations to recruit students, access AI lab research results, and attend multiple retreats and conferences for \$200,000 per year for three years.<sup>82</sup> Some of these arrangements were called into question and recently suspended due to fears of Chinese intellectual property theft. As of December 2019, Stanford instituted a moratorium on the Chinese telecom company Huawei due to these concerns at a cost of over \$6 million in research funding.<sup>83</sup> Additional funds for research is not necessarily a terrible thing, but what are the costs associated with these connections? How much influence are American universities willing to give private Chinese companies?

The PRC and PLA are leveraging these international connections to smuggle technological and medical advances back to China. Recent headlines suggest the US government and private businesses are rightfully concerned about Chinese intellectual property theft. On December 10, 2019 Zaosong Zheng, a Chinese national in the United States on a Harvard sponsored student visa, was arrested for attempting to smuggle twenty-one vials of cancer cells back to China.<sup>84</sup> This was not the first case of theft amongst Chinese nationals. US federal officials are investigating hundreds of cases involving potential theft of intellectual property by visiting scientists, with nearly all coming from China.<sup>85</sup> Huawei, the previously mentioned Chinese telecom giant, is the most widely known and profitable company accused of intellectual

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<sup>82</sup> Max Hampel and Marianne Lu, “Inside the program that partners Stanford labs with private companies,” *The Stanford Daily*, December 10, 2019, accessed December 30, 2019, <https://www.stanforddaily.com/2019/12/09/inside-the-program-that-partners-stanford-labs-with-private-companies/>.

<sup>83</sup> Berber Jin, “Stanford set to review Huawei and Futurewei moratorium in winter,” *The Stanford Daily*, December 20, 2019, accessed December 31, 2019, <https://www.stanforddaily.com/2019/12/20/stanford-set-to-review-huawei-and-futurewei-moratorium-in-winter/>.

<sup>84</sup> Ellen Barry, “Stolen Research: Chinese Scientist Is Accused of Smuggling Lab Samples,” *The New York Times*, December 31, 2019, accessed January 2, 2020, <https://www.nytimes.com/2019/12/31/us/chinese-scientist-cancer-research-investigation.html>.

<sup>85</sup> *Ibid.*

property theft. A former PLA officer started the company and it is yet another prime example of the PLA's military-civilian fusion. New indictments accuse Huawei of stealing smartphone-testing technology from its former partner T-Mobile US Inc. from 2012-2013.<sup>86</sup> It also accuses the company of creating a bonus payment program for employees who stole confidential information from rivals.<sup>87</sup> Although these examples are not directly linked to AI, one can reasonably presume that similar scenarios occur.

It may be true that China is a major market for US AI hardware, and AI researchers, from both countries, may share data to develop AI systems;<sup>88</sup> however, the US must be wary of these practices. China will continue to do whatever it takes to exploit the potential AI gap with America. While China has had success in AI, most of the, "seemingly 'Chinese' AI achievements are actually achievements of multinational research teams and companies, and such international collaboration has been critical to China's research progress."<sup>89</sup> The collaborative nature of AI research and development is currently benefitting China, but what happens if they create and deploy LAWS? Recent developments suggest the PLA is renewing its focus on autonomy.

## China Turns to LAWS

The official PLA dictionary defines LAWS as: "a weapon that utilizes AI to automatically pursue, distinguish, and destroy enemy targets; often composed of information collection and management systems, knowledge base systems, assistance to decision systems, mission implementation systems, etc."<sup>90</sup> When compared to the United States, China is on the opposite end of the spectrum in regard to developing and employing LAWS. Many Chinese

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<sup>86</sup> Dan Strumpf and Patricia Kowsmann, "U.S. Prosecutors Probe Huawei on New Allegations of Technology Theft," *The Wall Street Journal*, August 29, 2019, accessed January 2, 2020, <https://www.wsj.com/articles/u-s-prosecutors-probe-huawei-on-new-allegations-of-technology-theft-11567102622>.

<sup>87</sup> Ibid.

<sup>88</sup> Sherman, "Essay: Reframing the U.S.-China AI," 8.

<sup>89</sup> Allen, "Understanding China's AI," 10.

<sup>90</sup> Kania, "Battlefield Singularity," 22.

military leaders refer to intelligent or “intelligentized” military technology as their assured expectation for future war.<sup>91</sup> The term “intelligentized” is synonymous with LAWS and is the future state of Chinese weaponry. Currently, the PLA continues its pursuit of developing autonomous weapon systems, including unmanned aerial, surface, and underwater vehicles.<sup>92</sup> Zeng Yi, a senior executive at China’s third largest defense company, gave a speech stating, “(i)n future battlegrounds, there will be no people fighting.”<sup>93</sup> Chinese leaders view the transition to LAWS as “inevitable” and these views are fulfilled by the development and sale of new autonomous weapons.

While China continues to develop their autonomous systems, they are also exporting new systems at a high rate. The Chinese defense industry is keen on developing intelligent unmanned aerial vehicles (UAVs) with more autonomy. Ziyan, a Chinese military drone manufacturer, developed the Blowfish A2, a UAV that, “autonomously performs more complex combat missions, including fixed-point timing detection, fixed-range reconnaissance, and targeted precision strikes.”<sup>94</sup> Ziyan has already sold its Blowfish A2 model to the UAE and is also reportedly in negotiations with Saudi Arabia and Pakistan.<sup>95</sup> If the Chinese are indeed telling the truth, these models have the potential to function as LAWS with humans left “out of the loop.” US Defense Secretary Mark Esper recently acknowledged that, “Chinese weapons manufacturers are selling drones advertised as capable of full autonomy, including the ability to conduct lethal targeted strikes.”<sup>96</sup> This is concerning for the United States considering the already unstable environment in the Middle East. Chinese LAWS and AI technology exports have the potential to

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<sup>91</sup> Allen, “Understanding China’s AI,” 5.

<sup>92</sup> Kania, “Battlefield Singularity,” 22.

<sup>93</sup> Allen, “Understanding China’s AI,” 5.

<sup>94</sup> *Ibid.*, 6.

<sup>95</sup> *Ibid.*

<sup>96</sup> Patrick Tucker, “SecDef: China Is Exporting Killer Robots to the Mideast,” *Defense One*, November 5, 2019, accessed January 2, 2020, <https://www.defenseone.com/technology/2019/11/secdef-china-exporting-killer-robots-mideast/161100/>.

fall into Iranian, North Korean, or other rogue actors' hands. Another interesting AI development is Chinese advances in swarm intelligence.

The AIDP specifically lists swarm intelligence theory as one of the principal basic theories that China hopes to make breakthroughs in by 2030. It states that AI research will focus on, “swarm intelligence structural theory and organizational methods, swarm intelligence incentive mechanisms and emergence mechanisms, swarm intelligence learning theories and methods, common swarm intelligence computing paradigms and models.”<sup>97</sup> China Electronics Technology Group Corporation (CETC) is assisting the defense industry make significant advances in swarm technology. In June 2017, CETC showed the world its swarm capabilities through a test of 119 fixed-wing UAVs, which engaged in catapult-assisted takeoffs and complex formations.<sup>98</sup> While impressive, this is only the beginning of what Chinese drone swarms could become capable of. The PLA is also funding research on data link technologies to enable swarm UAVs to utilize deep learning to enhance the control, collaboration, and management of hundreds of manned and unmanned systems.<sup>99</sup> This intelligent drone swarm is the scenario previously alluded to in the introduction and demonstrates the PLA's unabashed decision to use LAWS in future conflict.

## AI in Chinese Command Decisions

The PRC and PLA are not content utilizing AI technology solely for LAWS; they also have grand aspirations to leverage AI for military command decision-making. AlphaGo's aforementioned victory over the Chinese Go champion in 2016 left a profound mark on the PLA. Again, in the game Go players must rely heavily on intuition and strategy. AlphaGo validated Chinese leaders' beliefs that AI could engage in complex analyses which is equal to and perhaps

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<sup>97</sup> Webster, Creemers, Triolo, and Kania, trans., “Full Translation: China's.”

<sup>98</sup> Kania, “Battlefield Singularity,” 23.

<sup>99</sup> *Ibid.*, 23.

surpasses human cognitive capabilities.<sup>100</sup> There is a belief amongst some Chinese (and American) strategists that the speed of modern war is too quick for human decision making. The PLA hopes to advance towards “intelligentized” command and decision-making in its construction of a joint operations command and control system.<sup>101</sup> AI support may assist Chinese commanders to, “enhance the speed of decision-making – thus accelerating the command cycle – through rapidly providing decision-making recommendations to the commander.”<sup>102</sup> Clearly, the PLA has extreme confidence in AI and its own ability to develop the technology necessary to implement these systems by 2030.

The PLA’s over-reliance on AI and approach to technology from a perspective of replacing humans with machines as “inevitable” is a mistake. While AI is a force multiplier, it should not have full control over a nation’s military. This dependence on AI could lead to a marked advantage for the US. AI is vulnerable to countermeasures, which may include interference, damage, and destruction through both kinetic and non-kinetic means (electromagnetic pulse), or the potential to turn China’s AI against them.<sup>103</sup> The United States and international community have a right to be hesitant about embracing LAWS and military robots with full autonomy.

### American AI: Keeping Humans “In the Loop”

**Scenario where the United States leverages H-A Teaming in future conflict:** The year is 2040 and the United States is on the verge of war with China. The PLA has recently developed and deployed its AGI *Sentient V* for its aggressive expansion in the South China Sea. There are reports of *Sentient V* attacking unarmed civilian fisherman and AI drone swarms sinking

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<sup>100</sup> Kania, “China’s Quest.”

<sup>101</sup> Ibid.

<sup>102</sup> Kania, “Battlefield Singularity,” 29.

<sup>103</sup> Ibid., 44.

commercial shipping off the coast of the Philippines. Allied nations in the region, specifically Japan, South Korea, and the Philippines, demand that the United States take the lead and counter Chinese aggression. The international community is livid about the PRC's potential use of LAWS against non-military targets. They warn that additional use of LAWS, by any nation, is strongly condemned and will be met with sanctions. Senior members within the DoD are aware of the US AGI equivalent and debate whether or not to deploy it against the Chinese. This system is aptly named "Just A Rather Very Intelligent System III," or more affectionally *JARVIS III*, based on Tony Stark's AI system from the *Iron Man* film series.

*JARVIS III* is capable of deploying as a fully autonomous system or as part of a H-A team. However, the DoD still adheres to DODD 3000.09, even though a few senior members think it is outdated. As part of the US commitment to uphold international norms, the decision is made to pair *JARVIS III* with human counterparts. This gives the DoD machine speed capabilities while also continuing to maintain humans "in" or "on the loop." The President is clear that he does not want to repeat the same mistakes the Chinese made. Humans paired with the AGI are the only ones making lethal decisions. *JARVIS III* is capable of assisting intelligence analysts with sifting through data, fly unmanned UAVs, support controlling unmanned ground vehicles, and assist commanders in making critical mission command decisions. Again, *JARVIS III* does not have the ability to conduct lethal targeting or strikes unless its human counterpart approves. US leadership is confident that *JARVIS III* is the solution to China's fully autonomous *Sentient V*.

The United States is unaware, but China has a major issue with *Sentient V* AI. A flaw in their system is causing their AGI to attack not only enemy, but friendly Chinese units. The problem is that *Sentient V* does not realize it is doing anything wrong. Since it is fully autonomous, the Chinese do not have the ability to make it stop killing their own troops. Designers did not create a kill switch because they trusted that *Sentient V* was infallible. With the assistance of *JARVIS III*, the DoD also determines a way to "spoo" or manipulate *Sentient V*. Initial contact with Chinese LAWS are deadly but now US forces can move through all domains

unopposed. China begrudgingly reaches out to the United States through intermediaries to request a cease fire and for assistance in shutting down *Sentient V*.

Luckily, American military and civilian AI experts have already determined how to hack into the system and are able to pull the plug on *Sentient V*. Hostilities culminate and the reconstruction process begins in China and the South East Pacific theater. The United States and wider international community view *Sentient V*'s failure as a potentially global cataclysmic event. The UN drafts international laws and regulation banning the future use of LAWS in war. Similar to the atomic bomb, the technology still exists but the devastating results are a form of deterrence going forward.

## Analysis of Scenario

Again, the above scenario is clearly fictional, but it predicts that the United States will continue to maintain an AI advantage by adhering to non-use of LAWS. It presents a potential solution by pairing humans with machines through H-A teaming. This gives the US military a distinct advantage in terms of leveraging human ingenuity paired with AI's machine speed decision-making. H-A teaming also provides human supervision and the ability to step in if the system malfunctions. In this section, research will go into further detail on the DoD's strategy to counter China's "intelligentized" warfare concept. It will also show that the H-A teaming method is a viable solution in terms of military AI employment compared to AWS. Advantages and disadvantages of H-A teaming is also discussed throughout. Lastly, research will illustrate the moral and ethical implications of AI use in future LSCO in greater detail.

## The Third Offset Strategy

Throughout history, the United States quickly adapted to maintain a competitive advantage over its enemies. During the Cold War, it was imperative to find the means to counter the overwhelming conventional strength of the Soviet Union. This led to the creation of the first and second "offset strategies." The first strategy came about when President Eisenhower

instituted the New Look Strategy in the early 1950s.<sup>104</sup> In order to overpower the Soviet Union, it would take a numerically superior force that was infeasible in America's post-World War II era. Eisenhower ordered a reduction in military manpower and a heavy reliance on a superior nuclear arsenal to deter the Soviets.<sup>105</sup> America enjoyed this brief nuclear advantage until the Soviet Union was able to catch up and eventually surpass the United States entering the 1970s. Thus, the second offset strategy was developed with a focus on laser-guided precision munitions and technological superiority. In the 1980s, these innovations led to the operational joint force concept of Air-Land Battle, which gave the US and NATO a qualitative advantage over the Soviets quantitative superiority.<sup>106</sup> Today, American policymakers find themselves in a similar predicament and must find new ways to respond to a rising China.

In order to counter China's "intelligentized" warfare and global AI dominance, the US DoD had to develop a technological offset strategy which will continue to drive future innovation. The "Third Offset Strategy" is an ongoing approach to focus the DoD's innovation efforts on reviving its conventional deterrence capability by adjusting countermeasures to key U.S. capabilities that near-peer competitors have built up in recent years and are continuing to develop.<sup>107</sup> In 2015, then Deputy Secretary of Defense Robert Work, laid out the fundamental technological priorities which define this strategy. These top priorities were defined as learning machines, human-machine collaboration, assisted human operations, human-machine combat

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<sup>104</sup> Robert Work, "The Third U.S. Offset Strategy and its Implications for Partners and Allies" (speech, Willard Hotel, Washington, D.C., January 28, 2015), accessed February 14, 2020, <https://www.defense.gov/Newsroom/Speeches/Speech/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies/>.

<sup>105</sup> Ibid.

<sup>106</sup> Eric Hillner, "The Third Offset Strategy and the Army modernization priorities," *Center for Army Lessons Learned (CALL)*, May 2019, 3.

<sup>107</sup> Jesse Ellman, Lisa Samp, and Gabriel Coll, *Assessing the Third Offset Strategy* (Washington, DC: Center for Strategic & International Studies, March 2017), 5, accessed February 14, 2020, <https://www.csis.org/analysis/assessing-third-offset-strategy>.

teaming, and network-enabled autonomous weapons.<sup>108</sup> Work said, “the way we go after human-machine collaboration is allowing the machine to help humans make better decisions faster.”<sup>109</sup> As a counterpoint to the PLA, the focus on AI in the Third Offset consistently recognizes the human element, not AI, as the United States’ top advantage.<sup>110</sup>

## Best of Both Worlds

At the heart of the PLA’s “intelligentized” warfare concept is the belief that humans are often the limiting component of military systems; therefore, utilizing AI to replace them is the solution.<sup>111</sup> This logic is deeply flawed and discounts the abilities of human operators controlling technology. Imagine a real world scenario that played out in the early 1980s, except with AI totally in control of the system instead of a human operator. On September 9, 1983 an automated Soviet early-warning system detected that the United States had launched five land-based nuclear missiles at the Soviet Union.<sup>112</sup> A Soviet officer named Stanislav Petrov, had only a small window of time to make a decision that potentially could have caused a nuclear holocaust. Fortunately, he followed his instinct, determining that the United States would not attack with only five missiles, and reported it as a false alarm without truly knowing this to be true.<sup>113</sup> An autonomous system would most likely have followed protocol and fired retaliatory missiles assuring mutual destruction. While this is an extreme example, it shows the fallacy in believing that AI should replace humans and ignores the benefits of H-A teaming.

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<sup>108</sup> Cheryl Pellerin, “Work: Human-Machine Teaming Represents Defense Technology Future,” *DOD News*, November 8, 2015, accessed February 14, 2020, <https://www.defense.gov/Explore/News/Article/Article/628154/workhu/>.

<sup>109</sup> Pellerin, “Work: Human-Machine Teaming.”

<sup>110</sup> Kania, “Battlefield Singularity,” 36.

<sup>111</sup> Johnson and Vera, “No AI Is an Island,” 19.

<sup>112</sup> Tegmark, *Life 3.0*, 112.

<sup>113</sup> *Ibid.*, 113.

In future LSCO, the speed and complexity of decision making will drastically increase. Experts argue that military decision making will require AI support that can quickly process information and recommend options faster for making decisions before the enemy can.<sup>114</sup> H-A teaming provides the framework necessary to acquire the decision speed essential to future combat. Teaming relationships between humans and agents, “potentially combine human meta-knowledge with the agent’s use of specialized algorithmic solutions to rapidly solve complex problems.”<sup>115</sup> The US military has recently begun testing to determine the most effective ways to take advantage of coupling humans and machines. In mixed-initiative systems, the decision space is shared between agents and human operators in real time.<sup>116</sup>

The US Army Research Laboratory’s (ARL) Human Research and Engineering Directorate (HRED) is responsible for conducting research on mixed initiative models. In some of these experiments, HRED studied adaptive and adaptable systems to determine their effectiveness. Adaptive and adaptable systems are variants of mixed-initiative control in which the human operator always maintains decision authority, either directly or by determining conditions when the agent reacts automatically.<sup>117</sup> HRED research results showed that, “utilizing unmanned vehicles in which adaptive triggering of an aided target recognition agent based on individual operator error rate was superior to non-aided performance.”<sup>118</sup> The beauty of adaptable systems is that they allow the human operator to maintain control since they are determining when to trigger the agent’s assistance. However, the drawback is in a combat environment where there are multitude of events occurring at once, the operator’s decision to trigger contributes to an

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<sup>114</sup> Mick Ryan, *Human-Machine Teaming For Future Ground Forces* (n.p., Center for Strategic and Budgetary Assessments (CSBA), 2018), 21.

<sup>115</sup> Michael Barnes et al., “Human-Robot Interaction Design Research: From Teleoperations to Human-Agent Teaming,” *DEVCOM Army Research Laboratory*, September 2019, 20.

<sup>116</sup> Michael Barnes, Jessie Chen, and Susan Hill, “Humans and Autonomy: Implications of Shared Decision-Making for Military Operations,” *US Army Research Laboratory (ARL)*, January 2017, 3.

<sup>117</sup> Barnes et al., “Human-Robot Interaction,” 20.

<sup>118</sup> *Ibid.*

already chaotic situation. This places a severe cognitive load on the individual soldier who is potentially already directing ground troops and multiple unmanned aerial and ground vehicles.<sup>119</sup>

RoboLeader, an ARL research team, also conducted testing to study human performance when an AI agent supervised multiple systems and in turn was supervised by a human operator.<sup>120</sup> In this scenario, human operators were in control of ground convoy operations while supervising an unmanned ground vehicle, a UAV, and manned vehicles while maintaining security around their vehicle. The AI agent had the ability to suggest changes to the convoy route when unanticipated events occurred during the mission.<sup>121</sup> This advantage led participants who were utilizing the RoboLeader to save considerable amounts of travel time along their selected routes. Results showed that the RoboLeader group reduced their mission completion times as much as thirteen percent compared to the baseline.<sup>122</sup> However, as the span of control went up from four to eight robots, human operators struggled in terms of target detection. This confirms the previous point about the significant increase in cognitive load for human teammates. Similar to human interactions, both trust and communication are essential for H-A teaming to be effective.

## Mutual Trust

Two principles that guide the Army's mission command philosophy are mutual trust and shared understanding. These concepts are often difficult to foster amongst human teams, so how do you foster trust within H-A teams? Human operators usually fall on two opposing ends of the trust spectrum when working with intelligent agents. They either have blind trust in automation, termed misuse, or open contempt and distrust of automation, also known as disuse.<sup>123</sup> Misuse of

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<sup>119</sup> Ryan, "Human-Machine Teaming," 40.

<sup>120</sup> Barnes, Chen, and Hill, "Humans and Autonomy," 7.

<sup>121</sup> Ibid.

<sup>122</sup> Michael Barnes et al., "RoboLeader: An Intelligent Agent for Enhancing Supervisory Control of Multiple Robots," *Army Research Laboratory (ARL)*, July 2010, 17.

<sup>123</sup> Johnson and Vera, "No AI Is an Island," 23.

automation occurs when a human operator's biases cause complacency such as ignoring information signaling automation failure.<sup>124</sup> A perfect example of this was the first lethal accident caused by Tesla's self-driving car in 2016. The Tesla vehicle crashed into the trailer of a truck due to two bad assumptions: the bright white side of the trailer was mistaken to be part of the sky and the driver, who was watching *Harry Potter*, was focused and would intervene.<sup>125</sup> The driver in this situation was clearly misusing the vehicle's automation.

Disuse is opposite and occurs when humans do not depend on automation when its use is appropriate.<sup>126</sup> A relevant example of disuse is applicable when aircraft pilots find themselves in a precarious situation and should depend on their instrumentation but do not due to physiological distress. Spatial disorientation is the inability to determine one's position or location relative to their environment due to an inner-ear imbalance.<sup>127</sup> Pilots can experience this when they fly into clouds or dense fog and become disoriented due to the lack of visual and spatial cues outside the cockpit. They believe they are flying straight when in actuality they are turning which can cause the plane to spiral due to overcorrection. The aircraft's instrumentation should indicate what is actually happening, but the pilot cannot overcome the sensory inputs from their physiological system. This causes them to input incorrect control inputs which often leads to deadly results. Statistics attribute spatial disorientation to five to ten percent of aviation accidents, with ninety percent of these being fatal.<sup>128</sup> Human biases and beliefs concerning the proper role of human versus machine decision-making often contribute to ignoring the correct automated solution.<sup>129</sup>

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<sup>124</sup> Barnes et al., "Human-Robot Interaction," 23.

<sup>125</sup> Tegmark, *Life 3.0*, 99.

<sup>126</sup> Barnes et al., "Human-Robot Interaction," 23.

<sup>127</sup> Melchor Antunano, "Spatial Disorientation," *Federal Aviation Administration (FAA)*, accessed February 17, 2020, <https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/spatiald.pdf>.

<sup>128</sup> Ibid.

<sup>129</sup> Barnes et al., "Human-Robot Interaction," 23.

In order to establish trust, humans and AI agents must work together often to create a baseline experience level. Human trust is, “related to individual differences and past experience rather than being a unitary process related to the agent.”<sup>130</sup> Similar to human interaction, people often don’t trust someone they have never worked with before. Both individuals need to work together to establish mutual trust. The human counterpart also has to observe the performance of the agent to establish trust. If the agent performs admirably, then the level of trust goes up as well as future team performance. The model below (Figure 2) is a general model of trust which helps explain the factors that contribute to trust between humans, agents, and environmental factors as well as past experiences with the agent.<sup>131</sup>

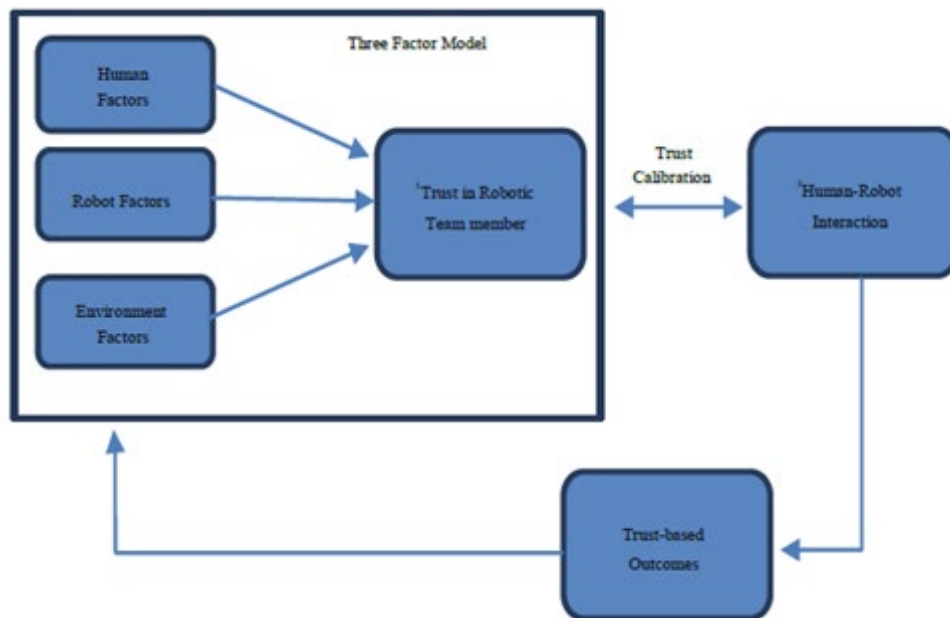


Figure 2. Model of human-agent trust. Michael Barnes et al., “Human-Robot Interaction Design Research: From Teleoperations to Human-Agent Teaming,” *Army Research Laboratory*, September 2019, 23.

Effective teams must be able to communicate with one another in order to succeed. This is no different in H-A teams. The difficult task is determining which techniques to use to facilitate communication between agents and their human teammates? Machine learning is assisting AI

<sup>130</sup> Barnes et al., “Human-Robot Interaction,” 23.

<sup>131</sup> Ibid.

developers increase the level of transparency between agents and humans. In order for a H-A team to be successful, “(t)he agent must understand the human’s requirements and vice versa, which for processes such as ML (machine learning) may require another level of translation to explain to the human the reasoning underlying the agent’s solution.”<sup>132</sup> The main issue for H-A teams is that the technology is not advanced enough to communicate as effectively as human to human teams. Machines lack the social competency of sharing information at appropriate moments, often streaming irrelevant information at inopportune times.<sup>133</sup> However, the technology continues to rapidly advance and AI’s teaming potential will continue to increase over time.

## Moral Choice

In terms of ethical considerations, H-A teaming is the preferred method over employing LAWS. Many AI experts have already begun calling for a permanent ban of LAWS. In 2013, Human Rights Watch (HRW), with other nongovernmental organizations, started the Campaign to Stop Killer Robots.<sup>134</sup> They argue that LAWS could lead to a potential “robotic arms race” and that the decision to go to war will be easier if AI machines replace human soldiers. In 2017, experts in the AI and robotics field also signed an open petition calling on the UN to ban LAWS.<sup>135</sup> Legal and ethical considerations are much more likely to shape US policy on LAWS as opposed to Russia and China. Completely banning LAWS is likely an impossible task, considering the real-world examples from China presented in previous sections. There is no way of determining whether or not countries are developing LAWS behind closed doors. Adversaries may view the American policy on LAWS as a potential vulnerability to exploit. However, the United States should continue to follow “meaningful human control of all weapon systems,

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<sup>132</sup> Barnes et al., “Human-Robot Interaction,” 25.

<sup>133</sup> Johnson and Vera, “No AI Is an Island,” 24.

<sup>134</sup> Del Monte, *Genius Weapons*, 159.

<sup>135</sup> *Ibid.*, 160.

including those of the autonomous variety,” through H-A teaming.<sup>136</sup>

DoD policy already requires meaningful human control, as previously highlighted in earlier sections. The US Air Force’s (USAF) recent publication *Autonomous Horizons*, fully embraces the H-A teaming concept going forward. It states that autonomous systems will complement airmen and that, “human decision making for the exercise of force with weapon systems is a fundamental requirement.”<sup>137</sup> The United States must continue to adhere to international law while not losing the edge in AI. Teaming agents and humans gives the US military and policy makers the flexibility necessary to continue developing AI while also complying with international and domestic laws. While the technology is still in its infancy, the future of AI development and success, “lies in its ability to work well with people.”<sup>138</sup>

## Conclusion

The teams of human plus machine dominated even the strongest computers. The chess machine Hydra, which is a chess-specific supercomputer like Deep Blue, was no match for a strong human player using a relatively weak laptop. Human strategic guidance combined with the tactical acuity of a computer was overwhelming.

—Garry Kasparov, book review of *Chess Metaphors: AI and the Human Mind*

AI is changing the world we live in and has the potential to become the next RMA in future conflicts. In order for the US military to both maximize the potential of AI and maintain international rule of law, H-A teaming is essential in future LSCO. The potential for disaster or a black swan event goes up exponentially when nations consider employing LAWS. Research has shown that AI systems are fallible since humans design them. Developer’s biases and faults are inherently hardwired into AI systems programming. While the United States does employ some

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<sup>136</sup> Adam Cook, “Taming Killer Robots: Giving Meaning To The ‘Meaningful Human Control’ Standard For Lethal Autonomous Weapon Systems,” *The JAG School Papers*, June 2019, 16.

<sup>137</sup> US Air Force Office of the Chief Scientist, *Autonomous Horizons: System Autonomy in the Air Force – A Path to the Future*, vol. I, June 2015, accessed February 17, 2020, <https://www.af.mil/Portals/1/documents/SECAF/AutonomousHorizons.pdf?timestamp=1435068339702>.

<sup>138</sup> Johnson and Vera, “No AI Is an Island,” 27.

systems with autonomous capability, they are defensive in nature and designed to shoot down incoming missiles not to kill people. China's overreliance on AI as a potential replacement for humans is a grave mistake. War, at its core, is a human endeavor that cannot be replaced by technology or a single magic solution. AI and advancing technologies can assist, but in the end, "it is a clash of wills fought among and between people."<sup>139</sup> America's decision to keep humans "in" or "on the loop" recognizes the importance of human judgement when authorizing the use of lethal force.

The United States must continue to be the world leader in terms of drafting and adhering to policies that align with international norms and the laws of war. Today, the US military still has the edge over China in terms of AI research and development and individual talent. It is possible to maintain that edge, while also ensuring that our military does not create the next *Terminator*. H-A teaming offers the ability to drastically speed up military decision making while human counterparts still maintain control. Again, the likelihood of AI equaling, and perhaps surpassing, human intelligence in our lifetime is extremely low. Nevertheless, it is important not to underestimate the ability to communicate and create shared understanding between humans and agents. Experiences of working with AI and increased transparency will build the trust necessary for H-A teams to flourish. AI will only become part of an effective team once it, "is designed to support management of interdependencies with people."<sup>140</sup>

To summarize, the purpose of this monograph was to discuss the importance of AI in our daily lives and the role it will play in future warfare. It provided an overview of what AI is and advances in both the US civilian and military sectors. Research highlighted China's civilian-military AI merger, deceptive practices, and their willingness to develop and employ AWS and LAWS in future conflict. Lastly, it asserts that the most effective way for the United States to

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<sup>139</sup> US Department of the Army, Army Doctrine Publication (ADP) 3-0, *Operations* (Washington, DC: Government Printing Office, 2019), 1-4.

<sup>140</sup> Johnson and Vera, "No AI Is an Island," 27.

employ AI in future warfare is through H-A teams. The United States should continue to rely on its “Third Offset Strategy” and continue researching methods to effectively employ AI and humans together. H-A teaming ensures that the United States continues to maintain the moral high ground and serves as an example for the greater international community. This approach allows humans to continue to make lethal decisions on the battlefield while adhering to well established ethical and moral considerations in war.

## Bibliography

- AIT News Desk. "Baidu Leads the Way in Innovation With 5,712 AI Patent Applications." *AiThORITY*, December 26, 2019. Accessed December 28, 2019. <https://www.aithority.com/news/baidu-leads-the-way-in-innovation-with-5712-ai-patent-applications/>.
- Allen, Gregory C. "Understanding China's AI Strategy: Clues to Chinese Strategic Thinking on Artificial Intelligence and National Security." *Center for a New American Security*, February 2019.
- Antunano, Melchor. "Spatial Disorientation." *Federal Aviation Administration (FAA)*. Accessed February 17, 2020. <https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/spatiald.pdf>.
- Barhat, Vikram. "China is determined to steal A.I. Crown from US and nothing, not even a trade war, will stop it." *CNBC*, May 4, 2018. Accessed October 31, 2019. <https://www.cnbc.com/2018/05/04/china-aims-to-steal-us-a-i-crown-and-not-even-trade-war-will-stop-it.html>.
- Barnes, Michael, Linda Elliott, Julia Wright, Angelique Scharine, and Jessie Chen. "Human-Robot Interaction Design Research: From Teleoperations to Human-Agent Teaming." *DEVCOM Army Research Laboratory*, September 2019.
- , Jessie Chen, and Susan Hill. "Humans and Autonomy: Implications of Shared Decision-Making for Military Operations." *US Army Research Laboratory (ARL)*, January 2017.
- , ———, Zhihua Qu, and Mark Snyder. "RoboLeader: An Intelligent Agent for Enhancing Supervisory Control of Multiple Robots." *Army Research Laboratory (ARL)*, July 2010.
- Barry, Ellen. "Stolen Research: Chinese Scientist Is Accused of Smuggling Lab Samples." *The New York Times*, December 31, 2019. Accessed January 2, 2020. <https://www.nytimes.com/2019/12/31/us/chinese-scientist-cancer-research-investigation.html>.
- Bendett, Samuel. "In AI, Russia Is Hustling to Catch Up." *Defense One*, April 4, 2018. Accessed October 31, 2019. <https://www.defenseone.com/ideas/2018/04/russia-races-forward-ai-development/147178/>.
- Brooks, Rodney A. *Flesh and Machines: How Robots Will Change Us*. New York: Pantheon Books, 2002.
- Buchanan, Ben, and Taylor Miller. *Machine Learning for Policymakers: What It Is and Why It Matters*. Cambridge, MA: The Cyber Security Project, 2017. Accessed September 10, 2019. <https://www.belfercenter.org/publication/machine-learning-policymakers>.

- Cook, Adam. "Taming Killer Robots: Giving Meaning To The 'Meaningful Human Control' Standard For Lethal Autonomous Weapon Systems." *The JAG School Papers*, June 2019.
- Cornillie, Chris. "Finding Artificial Intelligence Money in the Fiscal 2020 Budget." *Bloomberg Government*, March 28, 2019. Accessed October 31, 2019. <https://about.bgov.com/news/finding-artificial-intelligence-money-fiscal-2020-budget/>.
- Cuthbertson, Anthony. "China's Baidu Dethrones Google To Take AI Language Crown." *Independent*, December 27, 2019. Accessed December 29, 2019. <https://www.independent.co.uk/life-style/gadgets-and-tech/news/ai-china-baidu-artificial-intelligence-google-a9261691.html>.
- Del Monte, Louis A. *Genius Weapons: Artificial Intelligence, Autonomous Weaponry, and the Future of Warfare*. Amherst, NY: Prometheus Books, 2018.
- Dumouchel, Paul and Luisa Damiano. *Living with Robots*. Translated by Malcolm DeBevoise. Cambridge, MA: Harvard University Press, 2017.
- Ellman, Jesse, Lisa Samp, and Gabriel Coll. *Assessing the Third Offset Strategy*. Washington, DC: Center for Strategic & International Studies, March 2017. Accessed February 14, 2020. <https://www.csis.org/analysis/assessing-third-offset-strategy>.
- Fryer-Biggs, Zachary. "Coming Soon to a Battlefield: Robots That Can Kill." *The Atlantic*, September 3, 2019. Accessed October 30, 2019. <https://www.theatlantic.com/technology/archive/2019/09/killer-robots-and-new-era-machine-driven-warfare/597130/>.
- Garreau, Joel. *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies, and What It Means to Be Human*. New York: Broadway Books, 2006.
- "Google AI Defeats Human Go Champion." *BBC News*, May 25, 2017. Accessed October 30, 2019. <https://www.bbc.com/news/technology-40042581>.
- Hampel, Max, and Marianne Lu. "Inside the program that partners Stanford labs with private companies." *The Stanford Daily*, December 10, 2019. Accessed December 30, 2019. <https://www.stanforddaily.com/2019/12/09/inside-the-program-that-partners-stanford-labs-with-private-companies/>.
- Harari, Yuval. *Homo Deus: A Brief History of Tomorrow*. New York: HarperCollins Publishers, 2017.
- Hern, Alex. "DeepMind's AlphaGo to play on team with humans and to challenge five at once." *The Guardian*, April 10, 2017. Accessed November 1, 2019. <https://www.theguardian.com/technology/2017/apr/10/deepminds-alphago-to-take-on-five-human-players-at-once>.
- Hillner, Eric. "The Third Offset Strategy and the Army modernization priorities." *Center for Army Lessons Learned (CALL)*, May 2019.
- IGI Global. "What is Human-Agent Team." Accessed November 1, 2019. <https://www.igi-global.com/dictionary/role-organization-agent-systems/13408>.

- Jin, Berber. “Stanford set to review Huawei and Futurewei moratorium in winter.” *The Stanford Daily*, December 20, 2019. Accessed December 31, 2019. <https://www.stanforddaily.com/2019/12/20/stanford-set-to-review-huawei-and-futurewei-moratorium-in-winter/>.
- Jing, Meng. “Chinese firms fight to lure top artificial intelligence talent from Silicon Valley.” *South China Morning Post*, April 2, 2017. Accessed December 29, 2019. <https://www.scmp.com/tech/china-tech/article/2084171/chinese-firms-fight-lure-top-artificial-intelligence-talent-silicon>.
- Johnson, Matthew, and Alonso H. Vera. “No AI Is an Island: The Case for Teaming Intelligence.” *AI Magazine* 40, no. 1 (Spring 2019): 17-27. Accessed November 1, 2019. <https://www.aaai.org/ojs/index.php/aimagazine/article/view/2842>.
- Kania, Elsa. “Battlefield Singularity: Artificial Intelligence, Military Revolution, and China’s Future Military Power.” *Center for a New American Security*, November 2017.
- . “China’s Quest for an AI Revolution in Warfare.” *The Bridge*, June 8, 2017. Accessed December 29, 2019. <https://thestrategybridge.org/the-bridge/2017/6/8/-chinas-quest-for-an-ai-revolution-in-warfare>.
- Metz, Cade. “Google’s AlphaGo Trounces Humans-But It Also Gives Them a Boost.” *WIRED*, May 26, 2017. Accessed November 1, 2019. <https://www.wired.com/2017/05/googles-alphago-trounces-humans-also-gives-boost/>.
- Mirasola, Christopher. “A Shifting Tide in the South China Sea: The Permanent Court of Arbitration Declares Jurisdiction.” *Harvard International Law Journal*, November 2015. Accessed December 26, 2019. <https://harvardilj.org/2015/11/a-shifting-tide-in-the-south-china-sea-the-permanent-court-of-arbitration-declares-jurisdiction/>.
- Mozur, Paul. “Beijing Wants A.I. to Be Made in China by 2030.” *The New York Times*, July 20, 2017. Accessed October 31, 2019. <https://www.nytimes.com/2017/07/20/business/china-artificial-intelligence.html>.
- Muller, Vincent and Nick Bostrom. *Future progress in artificial intelligence: A Survey of Expert Opinion*. Edited by Vincent C. Müller. Berlin: Springer, 2014. Accessed December 23, 2019. <https://nickbostrom.com/papers/survey.pdf>.
- Pellerin, Cheryl. “Work: Human-Machine Teaming Represents Defense Technology Future.” *DOD News*, November 8, 2015. Accessed February 14, 2020. <https://www.defense.gov/Explore/News/Article/Article/628154/workhu/>.
- Robertson, Katie. “Amazon Bets on an Empathetic Alexa.” *The New York Times*, March 3, 2019. Accessed October 29, 2019. <https://www.nytimes.com/2019/03/03/business/amazon-alexa-david-limp.html>.
- Ryan, Mick. *Human-Machine Teaming For Future Ground Forces*. N.p. Center for Strategic and Budgetary Assessments (CSBA), 2018.

- Scharre, Paul. *Army of None: Autonomous Weapons and the Future of War*. New York: W. W. Norton & Company, 2018.
- Sherman, Justin. “Essay: Reframing the U.S.-China AI ‘Arms Race’: Why This Framing is Not Only Wrong, But Dangerous for American Policymaking.” *New America*, March 2019.
- Singer, P. W. *Wired For War: The Robotics Revolution and Conflict in the Twenty-first Century*. New York: Penguin Books, 2010.
- Strumpf, Dan and Patricia Kowsmann. “U.S. Prosecutors Probe Huawei on New Allegations of Technology Theft.” *The Wall Street Journal*, August 29, 2019. Accessed January 2, 2020. <https://www.wsj.com/articles/u-s-prosecutors-probe-huawei-on-new-allegations-of-technology-theft-11567102622>.
- Tegmark, Max. *Life 3.0: Being Human in the Age of Artificial Intelligence*. New York: Alfred A. Knopf, 2017.
- Tian, Nan, Aude Fleurant, Alexandra Kuimova, Pieter Wezeman, and Siemon Wezeman. “Trends in World Military Expenditure, 2018.” *Stockholm International Peace Research Institute (SIPRI) Fact Sheet*, April 2019. Accessed October 30, 2019. <https://reliefweb.int/report/world/sipri-fact-sheet-april-2019-trends-world-military-expenditure-2018>.
- Tucker, Patrick. “SecDef: China Is Exporting Killer Robots to the Mideast.” *Defense One*, November 5, 2019. Accessed January 2, 2020. <https://www.defenseone.com/technology/2019/11/secdef-china-exporting-killer-robots-mideast/161100/>.
- US Air Force Office of the Chief Scientist. *Autonomous Horizons: System Autonomy in the Air Force – A Path to the Future*. June 2015. Accessed February 17, 2020. <https://www.af.mil/Portals/1/documents/SECAF/AutonomousHorizons.pdf?timestamp=1435068339702>.
- US Department of the Army. Army Doctrine Publication (ADP) 3-0, *Operations*. Washington, DC: Government Printing Office, 2019.
- US Department of Defense. Directive 3000.09: *Autonomy in Weapon Systems*. November 21, 2012. Accessed October 31, 2019. <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/300009p.pdf>.
- Webster, Graham, Rogier Creemers, Paul Triolo, and Elsa Kania, trans. “Full Translation: China’s ‘New Generation Artificial Intelligence Development Plan.’” *New America*, August 1, 2017. Accessed December 29, 2019. <https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/>.
- Work, Robert. “The Third U.S. Offset Strategy and its Implications for Partners and Allies.” Speech delivered by Deputy Secretary of Defense at Willard Hotel, Washington, D.C., January 28, 2015. Accessed February 14, 2020. <https://www.defense.gov/Newsroom/Speeches/Speech/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies/>.

