Strategy Research Project

The Complex Problem of Lethal Autonomous Weapons

by

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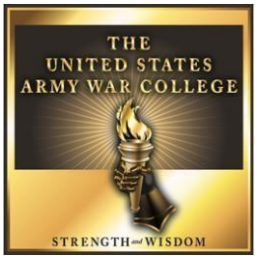

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The Complex Problem of Lethal Autonomous Weapons

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Abstract

The collaboration of technology and weapons development occasionally yields strategic advantages, dramatically changing the way war is waged and significantly shifting power projection and great power alignment. Many believe lethal autonomous weapons (LAWs) to be in that category. Others, however, contend that removing human oversight from the offensive targeting process violates the Law of Armed Conflict (LOAC), specifically the principles of discrimination and proportionality. In order to stop their development, numerous organizations are calling for an international ban on the development of LAWs, claiming their use violates the basic human code of morality derived from Just War Theory. Conversely, developers are pursuing programmable, human-like intelligence, capable of the autonomous application of International Humanitarian Law and the LOAC. Regardless of the opposition, technology continues to advance. The author addresses both sides of this issue for consideration and offers recommendations on a possible compromise for the way ahead.

The Complex Problem of Lethal Autonomous Weapons

> Someday, perhaps soon, we will build a machine that will be able to perform the functions of a human mind, a thinking machine.
>
> —Daniel W. Hillis[1]

Throughout history, technological developments precipitated significant change in the character of war. From siege weapons and gunpowder to tanks and machineguns, new technologies changed the face of conflict and raised questions concerning the 'fairness' of new capabilities. The digital age is no exception. From the inception of automated computation, observers asked the question of limits: Can technology attain a level of intelligence on par with humans? Is programmable, human-like reasoning possible? If so, what are its potential uses and implications? How far should we go in this pursuit? Ever looming in the background is a second echelon question of almost all-emerging technology: How can it be used in warfare?

Although the pursuit of superior technology to yield a tactical advantage is as old as war itself, occasionally the collaboration of technology and weapons development produces strategic advantages, dramatically changing how war is waged and significantly shifting power projection and great power alignment. Nuclear technology serves as the most prominent contemporary example. However, many believe lethal autonomous weapons (LAWs) may be the next game-changing development.[2] LAWs are weapons, through the advancement of computer programming and processing, designed to identify targets and engage them with lethal force without approval or consent from a human controller.[3] Along with advocates for the advancement of autonomy and the pursuit to combine its potential with weapons, opponents increasingly question the ethics of their use. If not addressed soon, an alarming possibility could

develop—the emergence of lethal autonomous weapons regardless of their ethical implications and without consideration or agreement for the potential boundaries of their use. An informed response to these questions requires an understanding of the current state of development of autonomous weapons. Considering the evolution of this technology helps us understand the opposing views on this divisive issue and provides insight into where it could go. Secondly, for us to develop an informed opinion, the ethical implications of LAWs must be considered in light of the law of armed conflict, while the moral implications of their use must be viewed through the lens of Just War Theory. Next, regardless of the legal, ethical, and moral implications, the decision of whether or not to pursue lethal autonomous weapons ultimately will be based upon an evaluation of risks versus rewards. Strategic leaders, in calculating and weighing the perceived advantages these systems offer, must consider their use in light of the potential hazards they present and contemplate the many variables involved. Finally, recommendations are provided on the way ahead. Although some are calling for an outright ban on lethal autonomous weapons, others are extolling the advantages the systems offer. Ultimately, both sides of the issue must be considered in order to understand how our decisions today affect the direction this pursuit may take, and what happens on the day autonomous weapons emerge.

The Current State of Artificially Intelligent Technology

From the outset of World War II, the American industrial machine pursued scientific and technological development to counter or exceed that of the nation's adversaries, sometimes surprising the world with the introduction of capabilities only imagined as science fiction.[4] This pursuit continued with renewed effort during the ensuing Cold War. In an effort to provide exceptional capability to counter an adversary

outnumbering the U.S. in men and machines, the U.S. responded by pursuing superior technology to counter the threat, a principle of preparedness explained by Collins' benchmarks of quantitative sufficiency versus qualitative superiority.[5] An arms race ensued, lasting for several decades. Although time and changes in world politics and economies ended the Cold War, the U.S. pursuit of superior technological capability continued unabated. Now, many contend that the world stands at the edge of another major shift in technological capability that could reshape everything: LAWs.[6] The possibility of using lethal force, even in a communications denied environment, by removing the need for human decision-makers from the targeting process, presents a possibility all too tempting to weapons developers and nations hungry to find a technological advantage over their adversaries.[7] Conversely, recognizing the impact of this change, numerous groups are voicing concern over where the technology is going and what should be done to prevent its rampant rise without boundaries.[8] The message in all of this is quite clear—the growing influence of autonomy in the development of weapons cannot be ignored.

Where Did This Idea Come From? The Historical Development of Autonomy

The rise of autonomous machines parallels the rise of computers. The tremendous potential of electronic or digital computation and the emergence of computers began during World War II with Alan Turing's efforts to break the German Enigma cipher and turn the tide of the war.[9] After World War II, numerous labs continued this development for other uses, incrementally increasing the capabilities of these systems.[10] Along with the development of increased processing power, the idea of using robotics in combination with this new capability also advanced.[11] From the beginning, the possibilities seemed endless. Whether remotely operated vehicles

developed by NASA or household devices that promised to perform the work of humans, the prospect of using computerized robotics to accomplish mundane tasks or to function in environments too harsh for humans steadily captivated the American imagination.[12]

Concurrent with these developments, the recurring question of artificially intelligent design arose, and the possibility of programmable, human-like intelligence and reasoning. In 1950, on the heels of his tremendous success breaking the Enigma Code, Alan Turing postulated the idea that intelligence is in the eye of the beholder and arises primarily out of the ability to communicate.[13] As an evaluation of intelligence, Turing developed a test requiring participants to evaluate anonymous responses to questions, and then decide if the response came from a human or machine based upon the perceived intelligence of the response.[14] Historically, questions requiring reason exposed the limitations in machine technology. Of late, however, this dynamic has changed; giving rise to the notion that advanced programmable artificial intelligence is not only possible, but also probable.[15]

Beyond the idea of machine intelligence, however, is the potential for machines to learn—to adapt beyond their initial programming, observe the environment and its reactions, and then process these observations to influence future outputs. The possibility of applying processing power combined with discovery learning was first demonstrated in early computerized chess programs.[16] Although these programs easily mastered the rules of chess, later technological advances demonstrated that machines could not only apply the rules but also learn and adapt their play as the game progressed.[17] This possibility presented a monumental step in the potential

development of artificial intelligence: outputs based upon the appearance of logically learned, reasoned choices in reaction to the environment. The result was a transformation in the way programmers assessed and designed intelligence into programmable language, using a multi-disciplined approach to include not only technologists and engineers but also experts in psychology, sociology, and philosophy.[18] Since then, "Considerable progress has been achieved in understanding common modes of reasoning that are not strictly deductive, such as case-based reasoning, analogy, induction, reasoning under uncertainty, and default reasoning."[19]

Doesn't This Capability, At Least Partially, Already Exist? Levels of Autonomy

Although discussion of lethal autonomous weapons has gained momentum only recently, varying levels of autonomy have existed for years. In 1953, the U.S. Navy began testing the RIM-2 Terrier computer-guided missile, the predecessor to the TALOS missile system that provided computer-aided target homing for in-flight corrections to increase accuracy.[20] Laser-guided munitions technology emerged in the 1970s, yielding the first "smart bombs," and in 1978, the first launch of a satellite within the Global Positioning System constellation occurred, marking a turning point in the technological possibilities of future weapon systems.[21] With all the incredible possibilities this new technology held, there also were moments when the world witnessed its terrifying potential. The events of July 1988 opened the eyes of the world to this reality, when an Aegis air-defense system aboard the USS Vincennes targeted an Iranian commercial jet, assessing the aircraft as a potential threat and then, under the supervision of human operators, engaged it, killing all 290 passengers.[22]

Much of the discussion today on autonomy centers on the level or amount of autonomous decision-making that systems have or should have. Numerous weapon

systems already include elements of autonomy designed to assist the operator. For instance, automation can easily perform the tedious functions of weapon system employment, such as providing a firing solution to the targeting process.[23] Performing these more calculative functions increases the effectiveness of the weapon system, reduces the burden on human operators, lessens the likelihood of human error, reduces the amount of time required to employ the weapon, and allows commanders on scene more flexibility.[24] However, these functions are far from the level of full lethal autonomy discussed here. Rather, the interest in this study is more in the subjective element of lethal autonomy—in its ability to distinguish combatants from noncombatants and apply the "rules" of combat, and then decide, absent a human controller, to use lethal force.

To further our understanding, a review of the vernacular used in describing autonomy provides clarity. Primarily, the categorization of autonomy falls into one of three specific categories. According to Michael Schmitt and Jeffrey Thurnher, the key element in determining the appropriate category is the level of autonomy versus human involvement.[25] "Human-in-the-loop" weapons are able to identify and track targets, but can only engage targets when permitted by a human operator with oversight of the system. "Human-on-the-loop" weapons can identify, track, and engage targets independent of a human operator, but the human operator can overrule the system at any point in the process. Finally, "human-out-of-the-loop" weapons are capable of identifying, tracking, and engaging targets without human operator input—a fully autonomous system.

Until now, full autonomy has only been part of the discussion in a limited number of weapons, most of which are defensive by design. For instance, the U.S. Phalanx

system automatically detects and engages threats to U.S. ships such as anti-ship missiles and aircraft.[26] However, unlike defensive weapons that process preprogrammed data to engage a limited number of possible threats, most of which are other weapons, advancements in computing power and programmable intelligence make some autonomous offensive weapons possible. For instance, the Israeli Aerospace Industry's Harpy Unmanned Combat Aerial Vehicle patrols the skies searching for and engaging enemy radar sites without human involvement.[27] Before the advent of autonomy, the underlying premise for the use of any weapon system, regardless of its complexity, was that determination of the legitimacy of the target rested upon human judgment. However, with the initiation of artificially intelligent human reasoning in computer programming, the necessity of this dynamic could change. If a computer-aided weapon can accurately identify an enemy combatant, as distinguished from a noncombatant, and accurately assess and apply the Law of Armed Conflict within the established Rules of Engagement, then should the system be allowed to apply lethal force without human oversight? The deontologist might disagree, but if developers and military professionals can demonstrate that LAWs are more capable than human-controlled systems, it would be hard to propose a rational argument for their exclusion—even if we find the idea of automated lethal force reprehensible.

What Makes a Machine Autonomous? Current Capabilities and Efforts

With the amount of investment in our nation's defense and the growth in the capability and complexity of modern weapons, America has developed an expectation that its military forces will possess technological overmatch on the field of battle.[28] Concurrently, Americans have developed an expectation of quick victories and fewer casualties.[29] The promise of autonomy feeds both of these perceptions, promising the

projection of technological might through an algorithm of death while risking only a machine. Investment in research and development in autonomous weapons reflects this valuation. For example, the Army has invested heavily in the development of the C-RAM (Counter Rocket, Artillery and Mortar) system, which detects and then autonomously fires at incoming indirect rounds.[30] Similarly, the Navy's AGM-158C Long-Range Anti-Ship Missile provides autonomous protection against enemy threats.[31] Predictably, the U.S. is not the only state pursuing increasingly autonomous weapons. For instance, South Korea recently deployed the Samsung SGR-1 unmanned sentry along the demilitarized zone, combining the ever-vigilant readiness of an automated system with the lethality of automatic weapons.[32]

Interestingly, much of the discussion about autonomous weapons centers on drones, which are primarily semi-autonomous systems. First utilized by the military over Bosnia, the utility of these platforms gained increasing prominence over the last two decades after developers found a way to arm them.[33] As an indication of the possible way ahead with this technology, in 2009 the USAF released its "Unmanned Aircraft Systems Flight Plan" looking forward to 2047 where, with fully autonomous systems developed, aircraft could swarm adversaries and conduct automatic target engagement. According to the document, "The end result would be a revolution in the roles of humans in air warfare."[34] The smaller, faster, "swarm" idea is not just an ambition. The U.S. Defense Advanced Research Projects Agency is developing two programs that may achieve this reality. The first program, known as Fast Lightweight Autonomy (FLA), utilizes highly maneuverable, lightweight, autonomous rotorcraft to maneuver in urban environments, even inside buildings.[35] The second program, Collaborative Operations in

Denied Environment (CODE), utilizes, “collaborative autonomy, CODE-enabled unmanned aircraft [to] find targets and engage them.”[36] Likewise, the recently developed UK Taranis prototype combines autonomy with stealth technology to make the aircraft virtually invisible to radar and capable of complete independent functionality.[37] Although a human operator is included in its current configuration, it is not required.[38]

The challenge in developing fully autonomous weapons is both conceptual and technological. The conceptual challenge centers on the question, “Are ethics programmable?” The answer lies in the limitations of programming language capable of mirroring ethical, human decision-making. In order to fully replicate the complex scenarios simulating combat and the nebulous determination of whether or not to use lethal force, computer programming in LAWs requires an enormous ability to replicate human decision-making scenarios—all in an environment producing less-than-perfect information. The process, in other words, is much more than simply selecting between well-defined choices. Computer programming for LAWs must interpret complex sensory data in the midst of the fog of war and apply the rules of combat while continually learning in the most difficult environment known to man—combat.[39] The second part of the challenge in the development of LAWs concerns the physical boundaries of modern processing power capable of tackling robust algorithmic computations.[40] Nevertheless, the solution to this barrier may be achieved with developing advances in capability. The limitations of computer processing power are about to meet quantum computing. According to researchers, the miniaturization of computer technology is working its way toward quantum bits, or qubits, that use atomic particles as processors.[41] These

particles replace the typical “on” or “off” switches in binary transistors utilized in computers today, in exchange for quantum-size particles that are far from binary. Instead, they deliver an increase in computational capability that is several orders of magnitude greater than current processing capacity.[42] With ultra-complex programming language designed to mimic human reasoning combined with the computational capacity to process that language almost instantaneously, the possibility of a functioning, artificially intelligent agent moves from the realm of science fiction to science fact.

Legal, Ethical, and Moral Implications

Every technology resulting in a new weapon must be considered in light of its compliance with the norms of International Humanitarian Law. These laws, developed out of the theory of just war, provide the groundwork for an international understanding of what it acceptable, or unacceptable, in warfare.[43] Intended to prevent violations of the basic rights of humanity and to prevent unnecessary suffering, the conventions laid out in these agreements (developed over time) include a fundamental set of principles concerning justice and humanitarian thinking in war. Although known today as International Humanitarian Law (IHL), these principles are rooted in centuries-old understandings on the topic.[44] However, their most recent codification and international acceptance is traced to several conventions held in Geneva beginning in 1863 and expanded in the wake of World War II during the conventions of 1949.[45] Since then, the continued development and re-ratification of these principles provides a foundation for understanding the legal impact of lethal autonomous weapons on International Humanitarian Law.

According to the International Committee of the Red Cross, an autonomous weapon is one that has the ability to “learn or adapt” in response to its environment, and then search for, identify, and apply lethal force to the target “including a human target (enemy combatants), without any human intervention or control.”[46] Similarly, the U.S. Department of Defense defines a weapon as autonomous based upon its ability to select and engage targets independently without further human intervention, and includes semi-autonomous weapons with human oversight within the definition.[47] Differences in the two definitions are intriguing, but so are the similarities. Both identify the prospect of autonomous target selection as a key function of autonomy. The targeting process, which includes detection, assessment, and engagement, is a function already performed autonomously by some weapons that are defensive in nature and designed for force protection.[48] In addition, the ability to track and then process a firing solution is rather mechanical in nature and is primarily an automated feature of many complex weapon systems. The real difference is in the assessment of the threat and the decision to engage with lethal force. Can LAWs be trusted to make these judgments for offensive vice defensive engagements? Is it possible for an autonomous weapon to distinguish an insurgent (combatant) from a farmer (non-combatant) when both are intermixed within the populace? Can an autonomous system accurately assess hostile intent? Can an autonomous system choose not to engage, based on other factors like the desire to track a target and collect additional intelligence, even when all the necessary criteria to engage with lethal force exist? Understanding the possible answers to these questions requires a deeper understanding of the law.

The Law of Armed Conflict and International Humanitarian Law

The Law of Armed Conflict (LOAC) evolved out of customary international law and treaty law, and is based upon the experience of armed conflict through history and the agreements between nations concerning principles of conduct in war.[49] The Law of Armed Conflict centers on four basic principles:

1. Necessity: reasonable force against an adversary is allowable only so far as to achieve his submission or accomplish the mission, as long as the other principles are followed;
2. Distinction: only combatants are legitimate targets. Always distinguish between combatants and noncombatants, as well as between military objectives and civilian objects;
3. Proportionality: in the application of force, civilians and civilian objects are protected; the anticipated loss of life or collateral damage to property must not be excessive in relation to the military advantage expected to be gained;
4. Humanity: minimize unnecessary suffering and do not employ weapons that may cause such.[50]

Focusing primarily on the second and third principles with regard to LAWs, several issues arise. Although LAWs may be able to accurately detect an inbound enemy missile (based upon factors like projectile speed, trajectory, point of origin, or caliber), the likelihood that LAWs can accurately assess and distinguish an enemy combatant intermixed with noncombatants presents an infinitely more complex problem. The complexity of the problem deepens as conflicts move toward population centers, an arena that provides weaker adversaries a level playing field utilizing unconventional or hybrid warfare as opposed to conventional battlefields.[51] Unlike states with large

organized armies in uniform, many conflicts involve insurgencies and non-state actors that are indistinguishable from the civilian population. These complexities, combined with the requirements of the LOAC, make the possibility of fulfilling the principle of distinction formidable even for trained soldiers. In order to comply, LAWs must comprehend the context of the operational environment and the ever-changing tactics of the modern battlefield.[52]

The ability of LAWs to apply the LOAC principle of proportionality is another aspect that concerns many in the international community.[53] The basic requirement of proportionality concerns the potential for harm to civilians and civilian objects, which implies the use of judgment and the application of discretion—attributes found in humans and not in machines. As circumstances in combat continually change, the assessment of the value of a military objective in relation to the damage that an attack on it may cause is difficult to assess, even for professional soldiers. Adding to the complexity of the problem is the inability to apply a metric to assist in answering it—every problem is different and the circumstances surrounding it are in a state of constant change. Accordingly, proportionality, more than any other principle of the LOAC, requires judgment: the weighing of military gain against human suffering. Even humans, in making this determination, are occasionally wrong. It has yet to be determined, however, whether or not the world is ready to accept the same from a machine.

Some critics of the capability point to the existing clarification given by the Geneva Convention to make their point, because the convention, at least tangentially, provides applicable guidance. According to Article 36 of the 1977 Additional Protocol I

of the Geneva Conventions, states are obligated to ensure that newly developed weapons do not violate any of the protocols of the convention.[54] Although Article 36 raises the stakes on weapons development, it does not specifically forbid the development of LAWs. However, in compliance with this protocol and in dealing specifically with the increasing development of autonomy in weapons, in 2012 the U.S. Department of Defense released a directive providing further guidance. Specifically, it states:

> Autonomous and semi-autonomous weapon systems shall be designed to allow…human judgment over the use of force… [any] weapon systems intended to be used in a manner that falls outside the policies [must be approved] before formal development and again before fielding.[55]

Although this directive provides guidance that complies with the Geneva Conventions Article, it leaves the door open to the development of weapons that are fully autonomous.

Morality and Just War Theory

Aside from the legal implications and the application of the Law of Armed Conflict, LAWs directly challenge our idea of morality in war. To fight in ways that are outside what is permissible (Jus in Bello), even if fighting for the right reasons (Jus Ad Bellum), is to undermine the justness of the cause itself.[56] Just War Theory even goes so far as to propose that states on the side of right cannot resort to means that are immoral in order to win, even if it means losing.[57] Violation of this standard, however, is not unprecedented.[58]

Granting full autonomy to weapons to decide through automation how war is waged will undoubtedly change both the character of war and the way it is perceived. Using LAWs instead of humans to conduct warfare eliminates, for the side possessing

them, one of the largest inhibitors to war: the human cost. The horrible price of war, in soldiers and destruction, serves to constrain, especially in democratic societies, the urge to declare war.[59] However, the advent of LAWs may serve as a direct challenge to these aspects of Just War Theory. First, one of the hallmarks of the tradition of Just War Theory is the understanding that military force always must be considered as an undertaking of last resort.[60] Secondly, for the use of military force to be just, the decision to use it must be based upon an inherently ethical reason—the cause must be sufficiently grave.[61] Finally, a commander making the decision to put his own forces at risk should do so only when he believes there is no other alternative.[62] However, some observers fear that the advent of LAWs could create a risk-free version of warfare that reduces all of these natural barriers to declaring war—ultimately serving as a virtual death sentence for democracies.[63] When the inhibitions to conflict are removed (that is, the political pressures that traditionally make democracies reluctant to declare war or pressures democracies to minimize its length), then democratic principles are eroded, creating a clear path for more, potentially unnecessary, warfare.[64] Ultimately, what emerges is a world more dangerous than ever, both for combatants and civilians. Weaker states, unable to contend with those able to develop and employ LAWs, are left at the mercy of technologically advanced states. The historical precedence of what typically occurs in this situation rings loud and clear: “The strong do what they can, and the weak suffer what they must.”[65]

In light of Just War Theory and the employment of LAWs in combat, another question we must answer is the morality of killing by automation. Should the decision to take life be left to a machine? Is killing without meaningful human intervention inherently

repugnant? The idea that LAWs shift the risk in warfare away from soldiers is appealing to some.[66] Others, however, argue that risk to the parties involved in a conflict is a requirement that must exist; else, it becomes immoral.[67] As one political scientist puts it, “An action so serious in its consequences should not be left to mindless machines.”[68]

In part, the moral objections to LAWs stem from the belief that life and death decisions in war must include intuition and compassion, qualities only humans possess. According to the U.N. special rapporteur on extrajudicial, summary, or arbitrary executions, Christof Heyns, “Humans – while they are fallible – at least might possess these qualities, whereas robots definitely do not.”[69] Likewise, the Martens Clause in IHL requires that the means (i.e., weapons) of warfare be evaluated according to the “principles of humanity” and the “dictates of public conscience” even in cases not covered by specific international agreements.[70] This would indicate that the LOAC not only serves as a legal code but also as a moral code. If a method or means of war does not meet the approval of society, according to the Martens Clause it would be a violation of international law to pursue it.

To Pursue or Not Pursue: Risk versus Reward

For all the momentum developed by technological breakthroughs surrounding artificial intelligence, some scientists and concerned citizens are alarmed at how quickly, even recklessly, the pursuit of full autonomy is moving. Numerous international organizations have formed battle lines on the issue, bringing the topic to various forums to raise awareness, voice opposition, and force elected officials and international organizations to stop development before it becomes a reality.[71] In 2014, at the behest of several non-governmental organizations, the United Nations Convention on Certain Conventional Weapons met to begin dialogue on the topic of LAWs.[72] A similar

convention occurred in 2015, with another scheduled for April 2016. Although no formal position on the topic has surfaced, one thing is certain: states with the ability to develop LAWs appear to be firmly in favor of leaving the possibility of their development open. In the words of Michael Meier, the U.S. delegate to the convention in April 2015, the "U.S. position on the potential future development of lethal autonomous weapon systems…neither encourages nor prohibits [their] development.[73]

The moral dilemma presented by lethal autonomy, combined with the complexity of developing LAWs capable of processing decisions within the bounds of the Law of Armed Conflict, raises the question of why we would pursue them at all. There are several potential responses. One is the belief that the first state to develop LAWs will gain an extraordinary strategic advantage in the world, and that everyone else will be scrambling to catch up.[74] With the rise of anti-access and area denial (A2/AD) capabilities around the globe, the development of LAWs may provide the perfect counter to maintain U.S. advantage. In keeping with the U.S. doctrine of striking an adversary's A2/AD "in-depth" using a synergistic approach across domains, LAWs could provide a unique opportunity to gain initial access to denied areas.[75] Assuming an adversary would use any means, including cyber-attacks, to disrupt our operations, the use of LAWs that can target enemy assets independently while requiring no human oversight or vulnerable data links represents a unique advantage in today's operating environment.

As states strive to achieve this capability, it is interesting to consider how the technology development may unfold. Knowing the high level of scrutiny these systems will be under both before and during their initial fielding, some researchers contend the

first LAWs developed for offensive action will likely be extremely capable. However, as states scramble to close the technology gap, follow-on systems may be less capable and therefore more dangerous.[76] Other researchers believe that, rather than some great moment of revelation, the development of LAWs will be incremental, utilizing semi-autonomous systems already in use, slowly increasing their capability as technology improves.[77] Nevertheless, even low-end autonomy has the potential to wreak havoc on the contemporary battlefield.[78]

A second reason proponents offer for pursuing LAWs centers on the proposition that the technology, once fully developed and tested, may prove to be as good or better than humans at applying the principles of the LOAC.[79] Ronald Arkin, director of the Mobile Robot Lab at the Georgia Institute of Technology, believes ethical programming language is possible, and is developing software called the Ethical Governor to do just that.[80] According to Arkin, the programmable restraint required to ensure compliance with the Laws of Armed Conflict and International Humanitarian Law is possible, and LAWs can be designed to comply with these standards.[81] Some suggest the key is in the ability in passing a “Moral Turing Test” for machines that demonstrates their ability to apply human moral decision-making when given complex, often contradictory information—and to do it as well and as consistently as humans.[82] This possibility begs the question of tolerance, or how good is good enough. For instance, if humans, in the application of lethal force, correctly apply the principles of the LOAC 96% of the time, then it could be argued that LAWs demonstrating the ability to do as well or better (albeit not perfectly) prevent some degree of human suffering and civilian deaths; therefore, LAWs should be allowed to perform lethal targeting. As one researcher

details, “Contrary to the claims of some advocates, autonomous weapon systems are not inherently illegal or unethical. The technologies involved potentially hold promise for making armed conflict more discriminating and causing less harm on the battlefield.”[83]

Recommendations

Will the pursuit of LAWs become the next arms race? Some believe it may already be underway and are calling for immediate action before it is too late.[84] Are these systems truly a catastrophe waiting to happen—will their autonomy ultimately lead to a calamitous “black swan” incident?[85] On the other hand, is this simply the next step in the natural progression of arms development, which Colin Gray notes will eventually be “triumphed” by an “antidote?”[86] Alternatively, could a decision not to pursue LAWs result in a strategic disadvantage to the U.S.? As Douhet noted, “Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur."[87]

As with any new powerful military technology, LAWs bring the promise of an immediate capability advantage or the promise to counter a fundamental weakness. Currently, the rise of A2/AD represents that weakness for the U.S. and highlights a growing threat to U.S. ability to project power abroad. In response, the U.S. has turned to technology to find an effective counter that provides a decisive advantage and allows the U.S. to maintain its conventional deterrence approach—the “Third Offset strategy.”[88] As Deputy Secretary of Defense Bob Work recently revealed, the “[U.S. Third Offset strategy] is about developing the means to offset advantages or advances in anti-access area denial weapons and other advanced technologies that we see proliferating around the world.”[89] Named among the initiatives that are part of this offset strategy are advanced autonomous systems.[90]

To move forward with any recommendations on LAWs, it is important to establish some fundamental truths. First, an effective ban on all autonomous weapons is unlikely. If the United Nations is the forum where such a ban must be approved, and the permanent members of the Security Council are the primary states pursuing this technology, then developing a consensus that unilaterally bans autonomous weapons is virtually dead on arrival. Not only would a ban be unenforceable, unlike nuclear development programs, the development of LAWs would be relatively easy to conceal, because their distinguishing feature is in their programming. Second, the international community needs to stop and consider the topic before reacting. The development of LAWs, like most emerging technologies, will likely be incremental and measured. Any call for an across-the-board ban at this point is imprudent, since the development of LAWs capable of conducting offensive targeting is still years away. However, the U.S. should take the lead in developing a common understanding of autonomy and LAWs using the same forum. The purpose would be two-fold. First, the opportunity could be used to gain consensus on a common definition of the varying levels of autonomy, to distinguish a semi-autonomous weapon from a fully autonomous one. Second, states could define the characteristics that make an autonomous weapon offensive versus defensive in nature, since, in part it is the application of the LOAC that makes LAWs so contentious. These efforts will provide a baseline for all future dialogue and development.

Next, the U.S. should take a lead role in building an international understanding and interpretation of the legal aspects in the development of LAWs. Rather than resisting the skeptics at every turn and shrouding the program in secrecy, the U.S. can

act as a leader in guiding the development process and establishing international standards and agreements to reduce distrust and miscalculations between nations Examples could include:

1. Establishing agreement on the limited types of missions in which LAWs would be utilized. Due to the complexity of offensive targeting, LAWs should not be utilized to conduct offensive targeting against humans in any capacity, but rather only against machines. LAWs should be limited to targeting only manmade platforms and structures that are easily distinguishable as legitimate targets.
2. Establishing agreement on proximity limitations where LAWs may be utilized. The ability to satisfy the principles of the LOAC becomes increasingly difficult the more densely populated the area. By establishing proximity limits near population centers, overseers of LAWs can provide parameters to protect civilians.
3. Proposing standards of reliability and safety to gain consensus on the bounds of LAWs. One step for which the U.S. could provide leadership is in establishing acceptable minimum design standards for deployment and agreed upon reliability standards for states pursuing the technology. Likewise, fail-safe security designs should be established so that states can “pull the plug” in the event a LAW malfunctions.
4. Demonstrate, through transparency and openness, a desire to comply with IHL and the LOAC. Establish lessons learned forums for developers and review developer practices while including legal reviews at every stage of

development from concept to testing to ensure compliance with international law.

As an incremental approach, the progress of these ideas should begin now, while the technology is still in its early stages of development. With open dialogue and U.S. leadership, these topics can be improved as the capability increases while avoiding the rush to develop international standards based on impulses after the technology is fully mature. For all its tremendous promise, the question of whether or not to pursue the development of lethal autonomous weapons leaves us with much to consider and many unanswered questions. Nevertheless, research and technology development is not waiting for a response.[91] Ultimately, the decision for or against the pursuit of LAWs will not be decided by either the opponents or advocates, but by strategic leaders who must carefully weigh the tremendous potential of the technology against its inherent risks.

Endnotes

[1] Daniel W. Hillis, *The Connection Machine* (Cambridge, MA: MIT Press, 1989), 1.

[2] Stuart Russell, "Ban Lethal Autonomous Weapons," *Boston Globe Online*, September 8, 2015, https://www.bostonglobe.com/opinion/2015/09/07/ban-lethal-autonomous-weapons/2yI2wF0wWRjHLmNQkPiCpI/story.html (accessed March 19, 2016); Peter Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (London: Penguin Publishing, 2009), 12-13.

[3] Russell, "Ban Lethal Autonomous Weapons."

[4] Tim Urban, "The AI Revolution: The Road to Superintelligence," *Wait but Why*, blog entry posted January 22, 2015, http://waitbutwhy.com/2015/01/artificial-intelligence-revolution-1.html (accessed March 19, 2016).

[5] John M. Collins, *Military Preparedness: Principles Compared with U.S. Practices* (Washington, DC: U.S. Library of Congress, Congressional Research Service, January 21, 1994), 27-30.

[6] John Reed, “Beyond Drones: The Next-Generation of Autonomous Weapons Cannot Be Developed in Secrecy,” March 9, 2015, linked from *Just Security Home Page*, https://www.justsecurity.org/20825/autonomous-weapons-developed-secrecy/ (accessed March 19, 2016).

[7] Singer, *Wired for War,* 205-236.

[8] Stephen Goose, “The Case for Banning Killer Robots,” *Human Rights Watch,* November 24, 2015, https://www.hrw.org/news/2015/11/24/case-banning-killer-robots (accessed February 27, 2016).

[9] Kate Clements, “How Alan Turing Cracked the Enigma Code,” linked from *IWM Imperial War Museums Home Page*, http://www.iwm.org.uk/history/how-alan-turing-cracked-the-enigma-code (accessed March 19, 2016).

[10] Martin Davis, "Mathematical Logic and the Origin of Modern Computers," in *The Universal Turing Machine*, 2nd ed., ed. Rolf Herken (New York: Springer-Verlag, 1995),135-158.

[11] Alan M. Turing, "Computing Machinery and Intelligence," in *Parsing the Turing Test*, *Philosophical and Methodological Issues in the Quest for the Thinking Computer*, ed. Robert Epstein, Gary Roberts, and Grace Beber (New York: Springer Science, 2009), 23-65.

[12] Brian H. Wilcox et al., "Robotic Vehicles for Planetary Exploration," *Applied Intellgience* 2, no. 2 (August 1992): 181-193, http://link.springer.com/article/10.1007/BF00058762?no-access=true (accessed March 19, 2016).

[13] Alan Turing et al., “Can Automatic Calculating Machines Be Said to Think?” in *The Essential Turing Seminal Writings in Computing, Logic, Philosophy, Artificial Intelligence, and Artificial Life: Plus the Secrets of Enigma*, ed. Jack Copeland (Oxford, UK: Clarendon Press, 2004), 487-506.

[14] Ibid.

[15] Ayse Pinar Saygin, Ilyas Cicekli, and Varol Akman, "Turing Test: 50 Years Later," in *The Turing Test: The Elusive Standard of Artificial Intelligence*, ed. James H. Moor (New York: Springer, 2003), 23-78.

[16] Murray A. Campbell, Joseph Hoane, and Feng-Hsiung Hsu, "Deep Blue," *Artificial Intelligence* 134, no. 1 (2002): 57-83.

[17] Michelle McPhee, K.C. Baker, and Corky Siemaszko, “Deep Blue, IBM's Supercomputer, Defeats Chess Champion Garry Kasparov in 1997,” *New York Daily News Online*, May 10, 2015, http://www.nydailynews.com/news/world/kasparov-deep-blues-losingchess-champ-rooke-article-1.762264 (accessed February 29, 2016).

[18] Bruce G. Buchanan. "A (Very) Brief History of Artificial Intelligence," *AI Magazine* 26, no. 4 (Winter 2005): 53.

[19] Ibid.

[20] George Galdorisi, “U.S. Navy Missile Defense: Getting Surface-to-Air Missile Development Started,” October 18, 2012, linked from *Defense Media Network Home Page*, http://www.defensemedianetwork.com/stories/u-s-navy-missile-defense-getting-surface-to-air-missile-development-started/ (accessed March 8, 2016).

[21] Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospect* (Washington, DC: Center for Strategic and Budgetary Assessments, 2007), 57; Thuy Mai, “Global Positioning System History,” linked from *NASA Home Page*, October 22, 2012, http://www.nasa.gov/directorates/heo/scan/communications/policy/GPS_History.html (accessed March 8, 2016).

[22] Gene I. Rochlin, "Iran Air Flight 655 and the USS Vincennes," in *Social Responses to Large Technical Systems*, ed. Todd R. La Porte (Dordrecht, Netherlands: Springer, 1991), 99-125.

[23] John Becker et al., *Submarine Combat Systems Engineering Project Capstone Project*, Master Thesis (Monterey, CA: Naval Postgraduate School, 2011), 16.

[24] Ibid.

[25] Michael N. Schmitt and Jeffrey S. Thurnher, "Out of the Loop: Autonomous Weapon Systems and the Law of Armed Conflict," *Harvard National Security Journal* 4, no. 2 (2013): 231.

[26] “Phalanx Close-In Weapon System: Last Line of Defense for Air, Land and Sea,” linked from *Raytheon Home Page*, http://www.raytheon.com/capabilities/products/phalanx/ (accessed March 19, 2016).

[27] “Harpy Air Defense Suppression System,” April 3, 2006, linked from *Defense Update Home Page*, http://defense-update.com/directory/harpy.htm (accessed March 19, 2016).

[28] Bob Work, Deputy Secretary of Defense, “CNAS Defense Forum,” Public Speech, JW Marriott, Washington, DC, December 14, 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/634214/cnas-defense-forum (accessed March 18, 2016).

[29] Timothy M. Karcher, "The Victory Disease," *Military Review* 83, no. 4 (2003): 9.

[30] United States Army Acquisition Support Center, “Counter-Rocket, Artillery, Mortar (C-RAM) Intercept Land-Based Phalanx Weapon System (LPWS),” http://asc.army.mil/web/portfolio-item/ms-c-ram_lpws/ (accessed March 19, 2016).

[31] “LRASM Missiles: Reaching for a Long-Range Punch,” *Defense Industry Daily,* February 25, 2016, https://www.defenseindustrydaily.com/lrasm-missiles-reaching-for-a-long-reach-punch-06752/ (accessed February 27, 2016).

[32] Tim Hornyak, “Korean Machine-Gun Robots Start DMZ Duty,” *CNET,* July 14, 2010, http://www.cnet.com/news/korean-machine-gun-robots-start-dmz-duty/ (accessed March 19, 2016).

[33] Katharine Hall Kindervater, *Lethal Surveillance: Drones and the Geo-History of Modern War,* PhD Dissertation (Minneapolis, MN: University of Minnesota, 2015), 55.

[34] U.S. Department of the Air Force, *United States Air Force Unmanned Aircraft Systems Flight Plan 2009-2047* (Washington, DC: U.S. Department of the Air Force, May 18, 2009), 50.

[35] Jean-Charles Ledé, "Fast Lightweight Autonomy (FLA)," linked from *Defense Advanced Research Projects Agency Home Page*, http://www.darpa.mil/program/fast-lightweight-autonomy (accessed March 19, 2016).

[36] Jean-Charles Ledé, "Collaborative Operations in Denied Environment (CODE)," linked from *Defense Advanced Research Projects Agency Home Page*, http://www.darpa.mil/program/collaborative-operations-in-denied-environment (accessed March 19, 2016).

[37] Chris Cole, *Drone Wars Briefing* (Oxford, UK: Drone Wars UK, January 2012), 10-12, https://dronewarsuk.files.wordpress.com/2012/01/drone-wars-briefing-final2.pdf (accessed March 16, 2016).

[38] Ibid.

[39] Colin Allen, Iva Smit, and Wendell Wallach, "Artificial Morality: Top-down, Bottom-up, and Hybrid Approaches," *Ethics and Information Technology* 7, no. 3 (2005): 152.

[40] Ibid.

[41] George Johnson, *A Shortcut through Time: The Path to the Quantum Computer* (New York: Vintage Books, 2007), 49, 63-71.

[42] Patrick Tucker, "The Subatomic Race to Harness Quantum Science," *DefenseOne,* September 3, 2015, http://www.defenseone.com/technology/2015/09/subatomic-race-harness-quantum-science/120260/?oref=search_quantum (accessed March 12, 2016).

[43] Alexander Moseley, "Just War Theory," in *The Encyclopedia of Peace Psychology*, ed. Daniel J. Christie (Malden, MA: Blackwell Publishing, 2009), 583-585.

[44] Hans-Peter Gasser, *International Humanitarian Law: An Introduction* (Berne: Paul Haupt Publishers, 1993), 88-92.

[45] Robert Kolb, "The Relationship between International Humanitarian Law and Human Rights Law: A Brief History of the 1948 Universal Declaration of Human Rights and the 1949 Geneva Conventions," *International Review of the Red Cross* 38, no. 324 (September 30, 1998): 409-419.

[46] Kathleen Lewand, "Fully Autonomous Weapon Systems," November 25, 2013, linked from *International Committee of the Red Cross Home Page,* https://www.icrc.org/eng/resources/documents/statement/2013/09-03-autonomous-weapons.htm (accessed February 27, 2016).

[47] Deputy Secretary of Defense, *Autonomy in Weapon Systems*, DOD Directive 3000.09 (Washington, DC: U.S. Department of Defense, November 21, 2012), 13.

[48] United States Army Acquisition Support Center, “Counter-Rocket, Artillery, Mortar (C-RAM).”

[49] GenevaCall, “Introduction to the Law of Armed Conflict (LOAC),” http://www.genevacall.org/wp-content/uploads/dlm_uploads/2013/11/The-Law-of-Armed-Conflict.pdf (accessed March 19, 2016).

[50] Gary D. Solis, *The Law of Armed Conflict: International Humanitarian Law in War* (New York: Cambridge University Press, 2010), 250-285.

[51] Frederic Megret, "War and the Vanishing Battlefield," *Loyola University of Chicago International Law Review* 9, no. 1 (2011): 131.

[52] Marcello Guarini and Paul Bello, "Robotic Warfare: Some Challenges in Moving from Noncivilian to Civilian Theaters," in *Robot Ethics: The Ethical and Social Implications of Robotics,* ed. Patrick Lin, Keith Abney, and George Bekey (Cambridge, MA: MIT Press, 2012), 136.

[53] Peter Asaro, "On Banning Autonomous Weapon Systems: Human Rights, Automation, and the Dehumanization of Lethal Decision-making," *International Review of the Red Cross* 94, no. 886 (2012): 687-709.

[54] International Committee of the Red Cross (ICRC), *Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I)* (Geneva, Switzerland: ICRC, June 8, 1977), http://www.refworld.org/docid/3ae6b36b4.html (accessed March 13, 2016).

[55] Deputy Secretary of Defense, *Autonomy in Weapon Systems*, 13.

[56] Moseley, "Just War Theory,” 583-585.

[57] Stanley Hoffmann, "States and the Morality of War," *Political Theory* 9, no. 2 (1981): 149-172.

[58] Stephen A. Garrett, "Terror Bombing of German Cities in World War II," in *Terrorism: The Philosophical Issues*, ed. Igor Primoratz (London: Palgrave Macmillan, 2004), 141-160.

[59] Michael R. Contratto, “The Decline of the Military Ethos and Profession of Arms: An Argument against Autonomous Lethal Engagements,” *Air and Space Power Journal* 30, no. 1, (Spring 2016): 4.

[60] James F. Childress. "Just-War Theories: The Bases, Interrelations, Priorities, and Functions of Their Criteria," *Theological Studies* 39, no. 3 (1978): 427-445.

[61] Ibid.

[62] Ibid.

[63] Contratto, “The Decline,” 7.

[64] Ibid.

[65] Robert B. Strassler, ed., *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War* (New York: The Free Press, 1996), 352.

[66] Paul W. Kahn, "The Paradox of Riskless Warfare," *Yale Law School Legal Scholarship Repository* 21, no. 3 (Summer 2002): 1-8, http://digitalcommons.law.yale.edu/cgi/viewcontent.cgi?article=1325&context=fss_papers (accessed March 20, 2016).

[67] Michael Walzer, *Just and Unjust Wars: A Moral Argument with Historical Illustrations,* 5th ed. (New York: Basic Books, 2015), ix-xxvi.

[68] Charli Carpenter, "US Public Opinion on Autonomous Weapons," May 2013, http://www.duckofminerva.com/wp-content/uploads/2013/06/UMass-Survey_Public-Opinion-on-Autonomous-Weapons_May2013.pdf (accessed March 13, 2016).

[69] Christof Heyns, United Nations General Assembly Human Rights Council, *Report of the Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions,* 23rd sess., April 9, 2013, 10.

[70] Rupert Ticehurst, "The Martens Clause and the Laws of Armed Conflict," April 30, 1997, linked from *ICRC Resource Center Home Page*, https://www.icrc.org/eng/resources/documents/misc/57jnhy.htm (accessed March 13, 2016).

[71] "Artificial Intelligence Experts Call for Ban," July 28, 2015, linked from *Campaign to Stop Killer Robots Home Page,* https://www.stopkillerrobots.org/2015/07/aicall/ (accessed March 22, 2016).

[72] "2015 Meeting of Experts on Laws," linked from *UNOG: The United Nations Office at Geneva Home Page*, http://www.unog.ch/80256EE600585943/(httpPages)/6CE049BE22EC75A2C1257C8D00513E26?OpenDocument (accessed March 19, 2016).

[73] Michael Meier, "U.S. Delegation Opening Statement to the UN Convention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems," April 13, 2015, linked from *Mission of the United States, Geneva Switzerland Home Page*, https://geneva.usmission.gov/2015/04/15/u-s-opening-statement-at-the-ccw-informal-meeting-of-experts-on-lethal-autonomous-weapons-systems/ (accessed March 20, 2016).

[74] Kenneth Anderson and Matthew C. Waxman, *Law and Ethics for Autonomous Weapon Systems: Why a Ban Won't Work and How the Laws of War Can* (Stanford, CA: Stanford University, 2013), http://media.hoover.org/sites/default/files/documents/Anderson-Waxman_LawAndEthics_r2_FINAL.pdf (accessed March 21, 2016).

[75] U.S. Joint Chiefs of Staff, *Joint Operational Access Concept*, Version 1.0 (Washington, DC: U.S. Joint Chiefs of Staff, January 17, 2012), 34.

[76] David Chalmers, "The Singularity: A Philosophical Analysis," *Journal of Consciousness Studies* 17, no. 9-10 (2010): 7-65.

[77] Anderson and Waxman, *Law and Ethics*.

[78] U.S. Department of Defense Science Board, *Task Force Report: The Role of Autonomy in DoD Systems* (Washington, DC: U.S. Department of Defense, July 2012), 13, http://fas.org/irp/agency/dod/dsb/autonomy.pdf (accessed March 20, 2015).

[79] Ronald Arkin, *Governing Lethal Behavior in Autonomous Robots* (London: Chapman and Hall, 2009), 29.

[80] Ronald C. Arkin, Patrick Ulam, and Brittany Duncan, *An Ethical Governor for Constraining Lethal Action in an Autonomous System* (Atlanta: Georgia Institute of Technology, 2009), http://www.cc.gatech.edu/ai/robot-lab/online-publications/GIT-GVU-09-02.pdf (accessed March 19, 2016).

[81] Ibid.

[82] Colin Allen, Gary Varner, and Jason Zinser, "Prolegomena to Any Future Artificial Moral Agent," *Journal of Experimental & Theoretical Artificial Intelligence* 12, no. 3 (2000): 251-261.

[83] Anderson, Kenneth, Daniel Reisner, and Matthew Waxman, "Adapting the Law of Armed Conflict to Autonomous Weapon Systems," *Stockton Center for the Study of International Law* 90, no. 386 (2014): 1-32, https://www.usnwc.edu/getattachment/a2ce46e7-1c81-4956-a2f3-c8190837afa4/dapting-the-Law-of-Armed-Conflict-to-Autonomous-We.aspx (accessed March 19, 2016).

[84] "Artificial Intelligence Experts Call for Ban."

[85] Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York: Random House, 2007), quoted in Wendell Wallach and Colin Allen, "Framing Robot Arms Control," *Ethics and Information Technology* 15, no. 2 (2013): 125-135.

[86] Colin S. Gray, *Recognizing and Understanding Revolutionary Change in Warfare: The Sovereignty of Context* (Carlisle Barracks, PA: U.S. Army War College, 2006), http://www.strategicstudiesinstitute.army.mil/pdffiles/PUB640.pdf (accessed March 14, 2016).

[87] Giulio Douhet, Joseph Patrick Harahan, and Richard H. Kohn, *The Command of the Air* (Tuscaloosa: University of Alabama Press, 2009), 30.

[88] Mackenzie Eaglen, "What Is the Third Offset Strategy?" *Real Clear Defense,* February 16, 2016, http://www.realcleardefense.com/articles/2016/02/16/what_is_the_third_offset_strategy_109034.html (accessed March 22, 2016).

[89] Bob Work, "The Third U.S. Offset Strategy and its Implications for Partners and Allies," Public Speech, Willard Hotel, Washington, D.C., January 28, 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies (accessed March 19, 2016).

[90] Ibid.

[91] Human Rights Watch and Harvard Law School's International Human Rights Clinic (IHRC), *Fully Autonomous Weapons: Questions and Answers* (New York and Cambridge, MA: Human Rights Watch and IHRC October 2013),

https://www.hrw.org/sites/default/files/supporting_resources/10.2013_killer_robots_qa.pdf (accessed March 14, 2016).