REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
04-05-2012

2. REPORT TYPE
FINAL

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
No One At the Controls: The Legal Implications of Fully Autonomous Targeting

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Major Jeffrey S. Thurnher, U.S. Army

Paper Advisors: Paul Povlock and Captain John T. Kondratowicz, U.S. Coast Guard

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Joint Military Operations Department
Naval War College
686 Cushing Road
Newport, RI 02841-1207

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

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

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution Statement A: Approved for public release; Distribution is unlimited.

13. SUPPLEMENTARY NOTES A paper submitted to the Naval War College faculty in partial satisfaction of the requirements of the Joint Military Operations Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Army.

14. ABSTRACT
The United States has increasingly relied on unmanned systems to help fight its wars, and these systems have steadily become more sophisticated. Science is now on the verge of many breakthroughs, particularly in artificial intelligence, which might well lead to the creation of fully autonomous unmanned systems. Autonomous systems could potentially attack enemies with lethal force without a human being in the loop. The possible deployment of lethal, autonomous robots raises significant legal and ethical concerns. These profound concerns, including whether such systems would even comport with the Law of Armed Conflict, have not yet been definitively resolved. The technology, however, continues to race forward, and many nations of the world are actively pursuing autonomous programs. To prevent being surpassed by rivals, the U.S. will likely exploit the potential of fully autonomous targeting. Therefore, operational commanders should begin examining the legal and the command and control implications of using such lethal, autonomous robots as they help steer the future development and doctrine of unmanned systems. While the use of such systems will arguably be deemed permissible under the Law of Armed Conflict, prudent operational commanders should still implement additional control measures to increase accountability over these new systems.

15. SUBJECT TERMS
International Law, Law of Armed Conflict, Unmanned Vehicles, Drones, Robots, Autonomous Targeting.

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Chairman, JMO Dept
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		29	**19b. TELEPHONE NUMBER** *(include area code)* 985-276-9533

NAVAL WAR COLLEGE
Newport, R.I.

<u>No One At the Controls:</u>
<u>The Legal Implications of Fully Autonomous Targeting</u>

by

Jeffrey S. Thurnher

Major, U.S. Army

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Army.

Signature: _____JST_____________

4 May 2012

Contents

Abstract

The United States has increasingly relied on unmanned systems to help fight its wars, and these systems have steadily become more sophisticated. Science is now on the verge of many breakthroughs, particularly in artificial intelligence, which might well lead to the creation of fully autonomous unmanned systems. Autonomous systems could potentially attack enemies with lethal force without a human being in the loop. The possible deployment of lethal, autonomous robots raises significant legal and ethical concerns. These profound concerns, including whether such systems would even comport with the Law of Armed Conflict, have not yet been definitively resolved. The technology, however, continues to race forward, and many nations of the world are actively pursuing autonomous programs. To prevent being surpassed by rivals, the U.S. will likely exploit the potential of fully autonomous targeting. Therefore, operational commanders should begin examining the legal and the command and control implications of using such lethal, autonomous robots as they help steer the future development and doctrine of unmanned systems. While the use of such systems will arguably be deemed permissible under the Law of Armed Conflict, prudent operational commanders should still implement additional control measures to increase accountability over these new systems.

Autonomous robots on the battlefield will be the norm within twenty years.[1]

I. Introduction/Thesis.

Robots and unmanned systems have proven to be incredibly valuable on the battlefield during the Global War on Terror and are likely to play a larger and more sophisticated role for militaries in the future. From 2000 through 2010, the number of U.S. unmanned aerial vehicles (UAVs) proliferated from fewer than fifty to over seven thousand, with similarly astounding increases among land and sea-based unmanned systems.[2] Despite overall reductions in upcoming U.S. defense budgets, expenditures for unmanned systems are projected to grow.[3] All branches of the U.S. military are poised to rely more heavily on unmanned systems in the future.[4] Not only are the numbers of these systems increasing but so are their capabilities. Technology has advanced so remarkably in the past few years, particularly with respect to artificial intelligence, that the creation of fully autonomous systems appears to be a distinct possibility in coming years. The potential deployment of fully autonomous, lethal systems raises significant legal and ethical concerns. These profound concerns, including whether such systems would even comport with the Law of Armed Conflict (LOAC), have not yet been definitively resolved. The technology, however, continues to race forward regardless. Therefore, operational commanders should begin examining the legal and the command and control implications of using such lethal, autonomous robots (LARs) as they help steer the future development and doctrine of unmanned systems.[5] While the use of LARs will arguably be deemed permissible under LOAC in most circumstances, prudent operational commanders should still implement additional control measures to increase accountability over such systems.

II. Technological Advances May Make Lethal, Autonomous Robots Possible.

Operational commanders need to be aware of recent technological advances and the extent to which the military is poised to incorporate these advances into future unmanned systems. While LARs may seem incredibly futuristic at first blush, the technological gap is quickly narrowing. In fact, the former Chief Scientist for the U.S. Air Force even contends that technology currently exists to facilitate "fully autonomous military strikes."[6] Several recent technological breakthroughs, particularly those involving artificial intelligence, highlight how attainable these systems are becoming.

A. Recent Artificial Intelligence Breakthroughs Are Creating Vast Opportunities.

The past few years have witnessed tremendous technological breakthroughs in artificial intelligence. Two highly publicized examples showcase the extraordinary potential of artificial intelligence. The first involves the IBM supercomputer system known as "Watson." The Watson supercomputer is best known for competing and winning against human competitors on the *Jeopardy* television quiz show during several special episodes which aired in February 2011. The uniqueness of Watson stemmed from the way it learned to identify the answers to the trivia questions. To attempt to replicate the complex human thought process, Watson was designed with more than one-hundred statistical algorithms. The algorithms helped Watson rapidly sort through multiple databases of stored information. The algorithms essentially helped Watson learn, statistically speaking, which words were most likely associated with which answers.[7] Watson marked a revolutionary advance in artificial intelligence both in the number of algorithms embedded into it and in the statistical methods it utilized in problem solving. The extraordinary technology showcased in Watson will likely begin appearing in other computer systems and could be adapted to assist LARs in the future.[8] Watson, however, is but one recent breakthrough in artificial intelligence.

A second technological breakthrough came from Google with its driverless car. Google funded a team of researchers to design vehicles that could drive without human controllers on city streets and public highways. The researchers, most of whom are part of Stanford University's Artificial Intelligence Laboratory, successfully created seven vehicles, which navigated California's freeways and streets accident-free for approximately 140,000 miles with only sporadic human assistance.[9] The sophisticated artificial intelligence in these vehicles was able to "sense anything near the car and mimic the decisions made by a human driver."[10] This cutting-edge technology represented a tremendous leap forward in artificial intelligence. The potential military use of systems capable of navigating themselves is clear. In fact, this Google project was an extension of an earlier Stanford University project which competed in and won the 2005 Defense Advanced Research Projects Agency (DARPA) Grand Challenge competition. That Pentagon-funded competition offered a two-million dollar prize to the team who could develop an autonomous vehicle capable of navigating itself over a one-hundred thirty mile desert course.[11] The Google version of the vehicle represents a marked improvement over the one which won the DARPA prize, and possesses the advanced artificial intelligence capabilities that the military will likely incorporate into future unmanned systems.

The true breakthrough of systems like Watson and the Google car is the way in which they adapt and learn. These systems essentially are able to learn from their own mistakes.[12] The artificial intelligence branch used in these systems is called "machine learning."[13] The computers can recognize patterns in data and learn from the patterns to make decisions or perform a function.[14] It is akin to humans learning through examples.[15] Machine learning is helping computer developers tackle problems "once thought too complex for computers."[16]

Any future development of LARs will rely heavily on such types of artificial intelligence reasoning capabilities. Machine learning computers will likely help future LARs learn the necessary behaviors and make the critical decisions about whether and how to engage and destroy a target. The U.S. military has wisely positioned itself to incorporate these new technological breakthroughs into the next generation of its unmanned systems.

B. U.S. Military is Poised to Capitalize on Technological Breakthroughs.

The Department of Defense (DOD) is at the vanguard of developing new unmanned technologies. DARPA is the "primary player in the world of funding new research in … robotics."[17] It sponsors research on future technologies, and is currently focused heavily on robots and unmanned systems.[18] Other government entities, like the Office of Naval Research (ONR), are funding efforts to develop robots that can act independent of humans.[19] These DOD organizations helped create the vast numbers of unmanned systems that deployed to Afghanistan and Iraq over the past decade of fighting.[20] They are now poised to develop even more sophisticated systems in coming years.

As the technology advances, many newer DOD unmanned systems are taking greater advantage of these artificial intelligence improvements and are being designed with more autonomous features. For instance in the U.S. Navy, close-in weapons systems, like the Phalanx found on Aegis-class cruisers and other ships, can now autonomously find, track, and destroy enemy anti-ship missiles.[21] ONR is developing systems for the U.S. Navy like the Biomimetic Autonomous Undersea Vehicle (BAUV), which is capable of conducting long-term underwater surveillance. BAUV can recognize changes in the environment and make adjustments autonomously to retain its position in the water for many weeks.[22] The U.S. Navy is also developing "mine-hunting," autonomous mini-submarines.[23]

The U.S. Navy is not alone in pursuing unmanned systems with autonomous features. The U.S. Air Force has designed its Global Hawk UAV systems to include autonomous flying options.[24] Rather than directly controlling the aircraft's every move, human operators merely designate the areas the Global Hawk is to observe. The system then flies itself to those areas utilizing GPS satellites.[25] The U.S. Air Force is also researching the use of Proliferated Autonomous Weapons or PRAWNs, which are systems of small robots that could potentially be flown autonomously to attack targets as a swarm.[26]

The U.S. Army has been developing a series of unmanned vehicles capable of autonomous operations. Some future U.S. Army counter battery systems may be able to autonomously destroy incoming artillery and missile barrages at speeds faster than humans could possibly perform.[27] Other U.S. Army unmanned ground systems are being designed to move around the battlefield autonomously, such as the Crusher Unmanned Ground Combat Vehicle. The Crusher possesses advanced artificial intelligence capabilities and represents a potential prototype of the next generation autonomous robotic ground fighting vehicle.[28]

In anticipation of these autonomous features becoming more widely available, DOD is already developing doctrine and tactics for incorporating autonomous systems into the overall force. Military organizations, such as DARPA, ONR, and the U.S. Army Research Laboratory have been working diligently on the so-called "warfighters' associate" concept, which will partner humans and robots together to work as "synergistic teams."[29] The expectation is that robots on the battlefield in the future will form the bulk of detachments, such as infantry units that would be comprised of 150 human soldiers working alongside 2,000 robots.[30]

Operational commanders need to be aware not only that these technological breakthroughs will make autonomous features more readily available but also that there likely will be a growing need for unmanned systems to become more autonomous in the future. Several key reasons explain the growing need. First, requiring a man-in-the-loop for all unmanned systems is prohibitive personnel-wise. It takes scores of people, from pilots to technicians to intelligence analysts, to operate a single tethered UAV.[31] Particularly as the overall size of the force shrinks in coming years, more sophisticated unmanned systems will be expected to fill the capability gaps.[32] Second, future battles will likely occur at such a fast tempo that human controllers may not be able to supervise drone forces quickly enough to counter what the enemy may be doing.[33] Essentially, a force in the future that does not have fully autonomous systems may not be able to compete with an enemy who does. Many nations around the world, including China, are already developing advanced systems with autonomous features.[34] Third, adversaries are improving satellite communications jamming and cyber-attack capabilities, and, as a result, systems tethered to a human controller may be incredibly vulnerable.[35] Without a constant connection to a human operator, tethered systems are incapable of completing their missions.[36] Thus, in general, future weapons systems will be "too fast, too small, too numerous, and will create an environment too complex for humans to direct."[37] One likely solution will be unmanned systems that are much more autonomous than those that presently exist.

Although the U.S. is developing a variety of autonomous features for many of its unmanned systems as discussed above, the U.S. remains committed, at the moment, to having a human remain in the loop for most lethal targeting decisions.[38] One of the main reasons the U.S. has not yet fully embraced lethal, autonomous targeting is the legal uncertainty associated with robots making those life and death decisions.[39] As will be explored fully below, deciding whether LARs are permissible under LOAC remains an unresolved and hotly contested issue.

III. LOAC Would Permit Fully Autonomous Targeting Under Most Circumstances.

LOAC has proven to be flexible and has evolved and adapted over time to advances in both weapons technology and military tactics.[40] Many weapons systems were initially outlawed only to be accommodated later, once the technology proliferated to other nations and international norms conformed.[41] LOAC is essentially derived from customary international practices and international treaties, but thus far there is neither international consensus nor an international treaty about autonomous targeting.[42] Internationally, the debate over whether LARs should be lawful is highly contentious.[43] Any examination of the lawfulness of LARs must begin with the aspect of LOAC known as *jus in bello* (or justice in war), which focuses on determining the practices allowed and the practices prohibited in war.[44] The *jus in bello* is comprised of four bedrock principles: military necessity, distinction, proportionality, and unnecessary suffering.[45] As will be discussed below, with a careful analysis of these and other foundational LOAC principles, the use of LARs will likely be deemed permissible in the vast majority of circumstances.

A. Military Necessity.

LOAC is not designed to hinder the waging of war but is instead intended to ensure combatants properly direct violence toward the "enemy's war efforts."[46] The principle of military necessity helps to achieve that goal. Military necessity requires combatants to focus their military efforts and attacks on those items with a military objective or those offering a "definite military advantage."[47] Thus, force may only be used when it will help the belligerent win the war.[48] Belligerents are expected to examine whether an "object of attack is a valid military objective" before engaging a particular target.[49] One normally looks to an object's nature, location, use, or purpose to determine if it is indeed a valid military target.

Given those parameters, LARs would need to be able to make the determination that a potential target meets the criteria as a valid military objective. While this decision making process might be complex, forces utilizing the unmanned systems would be able to greatly influence this process and likely ensure compliance with the LOAC principle. Even though a system is designed to operate autonomously, it would presumably be given specific orders from its headquarters about what types of missions it would be expected to accomplish. Leadership would most likely program LARs to only engage specific targets or at least specific types of targets. In essence, the systems would be told who its enemy is and what objects belong to that enemy. As long as the types of targets and missions assigned to LARs are valid military objectives, then the LARs would be in compliance with the principle of necessity when engaging those targets.

The issue becomes more complicated if the target is not on a preset list of targets. Such a situation might arise when a target is a "target of opportunity" or is in response to some kind of emergency situation. The most likely emergency situation is one in which fellow troops are being attacked and LARs are dispatched to provide the troops assistance. In those situations, the military necessity prong would be relatively easy to meet as part of a unit self-defense argument. Nevertheless, as will be discussed in Section IV below, operational commanders may still want to limit LARs from engaging targets in some such emergency situations.

B. Distinction.

The *jus in bello* principle of distinction requires belligerents to distinguish between combatants and civilians.[50] It applies to both real persons and tangible objects.[51] The intent is to minimize the harm to civilians and their property.[52] Commanders have the affirmative duty to distinguish between these before ordering an attack.[53] This principle is intended to prohibit indiscriminate attacks.

LARs have the same requirements to distinguish as any other member of the force. They need to be able to identify between civilian and military objects and personnel. To make this distinction, LARs should be able to rely upon uniforms and other distinctive signs. Given the advanced image recognition technology expected to be incorporated into LARs, the systems will likely be capable of recognizing this distinction consistently.[54]

As the U.S. has learned during the past decade of fighting, however, enemies do not always wear uniforms or use distinctive marks. In such uncertain cases, civilians are safeguarded "unless and for such time as they take a direct part in hostilities."[55] Determining if and when a civilian is taking direct part in hostilities can often be a most difficult decision to make. Similar to humans, LARs would have a difficult time making this distinction.[56] However, LARs possess one advantage over humans in this regard. They are not constrained by the notion of self-preservation. Thus, LARs could be programmed to sacrifice themselves to "reveal the presence of a combatant."[57] LARs could easily be ordered to hold their fire until after being fired upon by the enemy. In so doing, the use of LARs could greatly help a belligerent distinguish combatants from non-combatants on a complex battlefield.

Belligerents would still need to satisfy the other foundational principles, including proportionality.

C. Proportionality.

Proportionality requires belligerents to weigh the military advantage of their attack against the unavoidable collateral damage that will result.[58] An attack is lawful as long as it is not expected to cause collateral damage that would be "excessive" in relation to the military advantage.[59] Thus, collateral damage is permitted but only in an amount that would not be deemed excessive. It is vital to recognize that the balancing decision is made in anticipation of the attack rather than with the actual amount of collateral damage caused after the fact.[60]

This proportionality determination equates to a judgment call. The judgment call has always belonged to a human. Traditionally, the call has been compared against what a "reasonable person" or a "reasonable commander" would do in such a situation. As long as a similarly situated person would be expected to make a comparable determination of what is excessive under the circumstances, then the decision to strike would be deemed lawful.[61] Advances in artificial intelligence notwithstanding, it remains unclear whether a robot's determination of excessiveness could be considered sufficient given such a standard.[62]

Even if the proportionality standard represented an obstacle, many workarounds might still enable commanders to lawfully employ LARs on the battlefield. Operational commanders could use LARs in situations where a higher amount of collateral damage might be acceptable. Normally, attacks directed against high value targets or against a declared hostile force in a high-intensity conflict might fall into this category.[63] Similarly, a commander could designate a bright-line rule for the amount of expected collateral damage that is permissible during a specific mission. Thus, if LARs determine that the expected number of civilian casualties exceeds the predetermined acceptable limit, they would not be permitted to engage the target without supplementary human approval. These and other additional control measures will be more fully addressed in Section IV below. Beyond proportionality, the U.S. must also ensure LARs do not cause unnecessary suffering.

D. Unnecessary Suffering.

The last *jus in bello* principle is unnecessary suffering or humanity. When examining the lawfulness of LARs, this principle should not prevent their use as long as standard munitions and tactics are used in these robots.[64] LOAC requires belligerents to prevent unnecessary suffering when conducting attacks. To comply, belligerents cannot use any weapon or ammunition that is calculated to cause such harm.[65] Instead, they must only use lawfully designed weapons and ammunition and employ them in a lawful method of warfare. All U.S. military weapons and ammunition have been designed with these considerations in mind. As a result, the U.S. does not field per se unlawful munitions, such as hollow-point rounds or warheads filled with glass.[66] In this case, LARs equipped with standard weapons and ammunition and used in accordance with U.S. doctrine would likely be deemed to comply with the principle of unnecessary suffering.

Overall, as explained in the preceding paragraphs, LARs would arguably be in compliance with all four foundational *jus in bello* principles in the vast majority of circumstances.[67] Commanders should, therefore, be confident in their ability to utilize LARs, especially given some of the additional control measures that will be discussed in Section IV below. This opinion on the lawfulness of LARs is by no means universal, however. Many legal commentators argue that LARs should be banned under international law. Some of the key criticisms are discussed below.

E. Counterarguments: Lawfulness of LARs is Disputed.

There are several strong counterarguments for why LARs might not be permissible under LOAC. First, many critics argue that LOAC assumes a human is ultimately making the weighty life and death decisions. It would, therefore, be morally wrong to completely remove humans from these targeting decisions. As such, LARs operate outside the bounds of the applicable international laws and norms.[68] Second, other critics contend that the systems should be deemed as illegal because their use could lead to a total lack of accountability for attacks on civilians. They assert that there is no human who can be held accountable for a breach committed by an autonomous system.[69] Those critics contend that there is a "visceral human desire to find an individual accountable."[70] Third, other critics argue that the fact that a system is technologically possible does not automatically mean it is lawful. They contend that some weapons systems are simply too dangerous and thus risk causing too much unnecessary suffering. They argue that other systems, such as lasers with the ability to blind soldiers on a battlefield, are technologically possible but have been banned from war for being too abhorrent.[71] They contend that LARs should suffer a similar fate. Fourth, still other critics contend that LARs fail the proportionality test, for some of the reasons that were discussed above. In particular, they argue that robots will not be able to "holistically weigh" the proportionality test.[72] While LARs may be able to determine if the number of expected civilian casualties exceeds some predetermined limit, the proportionality test requires a greater sense of what is excessive.

While those critics provide compelling reasons to doubt the lawfulness of LARs, their counterarguments can be rebutted with a deeper examination of the many prevailing theories on the law. The first counterargument questioned whether LOAC is designed to handle life and death decisions made by robots vice humans. LOAC is indeed a flexible and robust body of law. It has adapted to numerous technological changes, such as the development of submarines and helicopters and nuclear weapons.[73] Although the development of LARs represents a significant advancement in war fighting, it is not so drastic a change as to warrant throwing out the existing body of international laws. LOAC can evolve to encompass LARs and can provide necessary and sound guidance to their use. The second counterargument focused on the lack of accountability. Contrary to the opinions of those critics, LOAC does not require that a human be held personally accountable for any mistakes or violations that may occur on the battlefield. While the need to hold someone accountable might be "visceral," it is not definitively required by law. Instead, international law demands that states not absolve themselves of liability with respect to a grave breach of the laws of war.[74] Therefore, the state would likely be responsible for any breach related to LARs.[75] Such a framework essentially exists today if, for instance, a sophisticated mine exploded incorrectly and injured a civilian or some civilian property. The lack of a human to hold accountable does not undermine the lawfulness of the weapon system.[76]

With respect to the third counterargument regarding abhorrent weapons, LARs can easily be distinguished from blinding lasers and other banned weapons. As opposed to those weapons where the weapon itself was at issue, the unique feature of LARs is the autonomous controls.[77] LARs are expected to use the same types of conventional munitions found on manned military systems, and the lethality of LARs would not differ substantially from that of other weapons systems. Thus, LARs would not cause the same type of unnecessary suffering that blinding lasers create. As such, it seems less likely that LARs would be deemed abhorrent under international law.

The fourth counterargument dealt with proportionality and the requirement for a holistic approach. As was discussed above, the proportionality judgment call is normally assumed to be a human's decision. While it is not clear whether a robot's judgment will be deemed holistic enough for the critics, the commander's orders and guidance to LARs about acceptable levels of collateral damage may be sufficient to encompass that holistic examination. Furthermore, there is actually no specific LOAC requirement for the judgment call to be holistic. International law merely requires belligerents to balance the military advantage against the expected collateral damage. Thus, critics are expanding the notion of proportionality beyond what is legally required.

In general, such strong counterarguments highlight just how complicated and unresolved these legal issues remain. Given this complexity, prudent operational commanders will enact additional control measures when utilizing LARs.

IV. Prudent, Additional Control Measures For Commanders of LARs.

Even though LARs will likely be technologically possible and permitted under LOAC in the future, operational commanders would be wise to plan carefully for how and when to utilize such systems. There may be situations in which using LARs might actually prove disadvantageous and unnecessarily risky. If an operational commander ever doubts the effectiveness or lawfulness of using LARs in a particular situation, then the commander should not deploy them or instead implement additional control measures to further protect the unit from LOAC violations. The following additional control measures will assist operational commanders in their employment of LARs systems.

First, operational commanders need to ensure that all LARs have the proper rules of engagement (ROE), tactical directives, and other national caveats embedded into their algorithms. Moreover, commanders must ensure any revisions to the ROE or directives are immediately inputted into and incorporated by the LARs. Unmanned underwater systems, particularly those without regular communications with the headquarters, may prove most challenging in this arena. For LARs that cannot make such adjustments while deployed, commanders need to ensure those systems can be recalled and then reprogrammed quickly in the event of such a change.

Second, commanders should limit when and where LARs are employed to avoid potential proportionality issues. Geographically, LARs are best suited to engage targets in areas where the likelihood of collateral damage is reduced, such as underwater or in an area like the demilitarized zone in Korea. Regardless of geography, LARs might be appropriate when the target is one of particularly high value. In such situations, a commander may have fewer proportionality concerns or might at least be able to quantify the amount of acceptable collateral damage. Utilizing LARs only in "kill box" type environments or when pursuing high value targets would alleviate many of the critics' proportionality concerns and best protect operational commanders.[78]

Third, operational commanders should carefully examine the type of conflicts in which they deploy LARs. Commanders would be wise to use LARs predominantly during high-intensity conflict situations where the ROE is status-based, meaning there is a declared hostile force to attack. Those declared hostile forces would then be easily recognizable, eligible targets for LARs. LARs are less appropriate in counterinsurgency or irregular warfare situations, where "the blurring of the lines between civilian and military is a commonplace occurrence."[79] Similarly, commanders may also want to restrict LARs in emergency type situations where the proposed target is not already on a preset list of targets. In such irregular fights and in emergency situations, the legal authority to engage with lethal force is more often conduct-based and thus contingent upon an enemy demonstrating a hostile intent or engaging in a hostile act. Given the higher degree of difficulty in identifying targets and the greater distinction concerns, the best approach may be to avoid using LARs under these circumstances.[80] Prudent commanders should only use these systems in appropriate situations and recognize when it might be best to resort instead to systems with increased human oversight.

Lastly, LARs should be required to have some version of a human override, sometimes referred to as software or ethical "brakes."[81] The systems should be able to be shut down or recalled immediately upon a commander's order.[82] Commanders should also establish triggers for when LARs must seek human guidance before engaging a target. For instance, when a LARs system identifies expected collateral damage greater than a predetermined acceptable limit, it could be forced to seek guidance from the command before engaging that target. Commanders would need to establish protocols and support structures to facilitate quick decision making on these potential targets. In these circumstances, human decision makers need a high degree of clarity about what situation the LARs is facing. This oversight would not be effective if the human operator were merely a rubber stamp to approve an engagement. With prudent additional control measures such as these, commanders can more safely use LARs on the battlefield and better protect themselves and their commands.

V. Conclusion.

The U.S. will likely face asymmetric threats in military campaigns of the future. Whether the threat is the substantial jamming and cyber-attacks capabilities of the People's Republic of China or the legions of swarming Iranian patrol boats, LARs may provide the perfect solution to countering these threats.[83] LARs have the unique potential to operate at a tempo faster than humans can possibly achieve and to lethally strike even when communications links have been severed. Autonomous targeting technology will likely proliferate to nations and groups around the world. To prevent being surpassed by rivals, the U.S. should fully commit itself to harnessing the potential of fully autonomous targeting. The feared legal concerns do not appear to be an impediment to the development or deployment of LARs. Thus, operational commanders should take the lead to steer this emerging technology into becoming a true force multiplier for the joint force. Operational commanders who establish appropriate control measures over these unmanned systems will ensure their LARs are effective, safe, and legal weapons on the battlefield.

END NOTES

1. P.W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century* (New York: Penguin Press, 2009), 128. In the quotation, Mr. Singer is paraphrasing a Joint Forces Command Study published in 2005 called "Unmanned Effects: Taking the Human Out of the Loop." Thus, the target date for this prediction is actually closer to 2025.
2. Raul A. Pedrozo, "Use of Unmanned Systems to Combat Terrorism," in *U.S. Naval War College International Law Studies*, vol. 87, Raul A. Pedrozo and Daria P. Wollschlaeger, eds., (Newport: U.S. Naval War College, 2011), 217.
3. Jack Browne, "UAV Markets Robust Despite Declining Spending," *Defense Electronics.com*, 15 February 2012, accessed 25 April 2012, http://rfdesign.com/military_defense_electronics/uav-markets-robust-despite-declining-spending-0215/.
4. W.J. Hennigan, "New Drone is Pilotless, So Who's Accountable?" *Los Angeles Times*, 26 January 2012, accessed 7 March 2012, http://articles.latimes.com/2012/ jan/26/business/la-fi-auto-drone-20120126.
5. There is no universally accepted nomenclature for unmanned systems that are both armed and fully autonomous. One common label for such systems is "lethal, autonomous robots" (LARs). For consistency, this paper will refer to them as LARs. Unless otherwise indicated, the LARs label is intended to encompass land-based, aerial, and surface and subsurface unmanned systems.
6. Werner J.A. Dahm, "Killer Drones Are Science Fiction," *Wall Street Journal*, 15 February 2012, 11.
7. Clive Thompson, "What is I.B.M.'s Watson?," *New York Times*, 16 June 2010, accessed 3 May 2012, http://www.nytimes.com/2010/06/20/magazine/20Computer-t.html?fta=y.
8. Since appearing on *Jeopardy*, the Watson technology was refined further and began operating in the health care industry to help diagnose health care problems for major cancer centers and to authorize appropriate treatments for insurance companies. Jim Fitzgerald, "IBM's Supercomputer Watson Hired to Handle Health Insurance Claims," *The Star-Ledger* (Newark, NJ), 13 September 2011, sec. 1. Similar technology is now also appearing in the newest iPhone's personal assistant application, known as Siri. Edward Larkin, "Siri, Watson, and Artificial Intelligence's Big Year," *London School of Economics Beaver Newspaper*, 11 October 2011, accessed 3 May 2012, http://edwardandlarkin.com/2011/10/11/siri-watson-and-artificial-intelligences-big-year/.
9. John Markoff, "Google Cars Drive Themselves, in Traffic," *New York Times*, 9 October 2010, accessed 3 May 2012, http://www.nytimes.com/2010/10/10/science/10google.html.
10. Ibid.
11. Ibid.
12. Public Broadcasting Service, "Smartest Machines on Earth," *NOVA*, 14 September 2011, transcript, http://www.pbs.org/wgbh/nova/tech/smartest-machine-on-earth.html.
13. Victoria Nicks, "Machine Learning Types – Unsupervised Learning," *Suite101.com,* 26 March 2010, accessed 3 May 2012, http://victoria-nicks.suite101.com/machine-learning-types---unsupervised-learning-a218298.
14. Ibid.
15. Public Broadcasting Service, "Smartest Machines on Earth," transcript.

16. Ibid.
17. Singer, *Wired for War*, 140.
18. Ibid.
19. Ibid., 143.
20. In fact, by some estimates there is nearly one robot for every fifty Soldiers deployed to Afghanistan. David Axe, "One in 50 Troops in Afghanistan Is a Robot," *Wired.com*, 7 February 2011, accessed 26 April 2012, http://www.wired.com/dangerroom/2011/02/1-in-50-troops-robots/.
21. Ronald C. Arkin, *Governing Lethal Behavior In Autonomous Robots* (Boca Raton, FL: Chapman & Hall, 2009), 7.
22. Singer, *Wired for War*, 144.
23. Ibid., 225. Such mini-submarine capabilities are particularly useful in the littorals where it might be too dangerous to risk a nuclear powered submarine in an area patrolled by enemy diesel powered submarines.
24. Global Hawk Block 30 and Block 40 variants have autonomous features embedded into their design. It should be noted that the U.S. Air Force is currently considering retiring the Global Hawk Block 30 vehicles, but the newer Global Hawk Block 40 vehicles have not yet been affected. Dave Majumdar, "Source: AF to kill Block 30 Global Hawks," *Military Times.com*, 25 January 2012, accessed on 28 April 2012, http://www.militarytimes.com/news/2012/01/dn-af-to-delete-global-hawk-012512w/; Sydney J. Freedberg, Jr., "HASC Orders DoD To Fly Block 30 Global Hawks," *AOL Defense.com*, 25 April 2012, accessed on 28 April 2012, http://defense.aol.com/2012/04/25/hasc-orders-air-force-to-fly-its-block-30-global-hawks-260-mil/.
25. Singer, *Wired for War*, 36.
26. Ibid., 232.
27. Ibid., photo section.
28. Defense Advanced Research Projects Agency, "News Release: Crusher Unmanned Ground Combat Vehicle Unveiled," 28 April 2006, accessed 3 May 2012, http://www.rec.ri.cmu.edu/projects/crusher/Crusher_Press_Release_DARPA.pdf.
29. Singer, *Wired for War*, 132; Michael J. Barnes and A. William Evans III, "Soldier-Robot Teams in Future Battlefields," in *Human-Robot Interactions in Future Military Operations*, eds. Michael Barnes and Florian Jentsch (Burlington, VT: Ashgate Publishing Company, 2010), 9.
30. Singer, *Wired for War*, 133.
31. Some estimates are that it takes at least fifty-five personnel to operate a Predator. Defense Update Online Defense Magazine, "RQ-1A/MQ-1 Predator UAV," accessed 3 May 2012, http://defense-update.com/products/p/predator.htm.
32. Armin Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons* (Burlington, VT: Ashgate Publishing Company, 2009), 2.
33. Darren Stewart, "New Technology and the Law of Armed Conflict: Technological Meteorites and Legal Dinosaurs?," in *U.S. Naval War College International Law Studies*, vol. 87, Raul A. Pedrozo and Daria P. Wollschlaeger, eds., (Newport: U.S. Naval War College, 2011), 275.
34. Ibid., 276-77. One example is the South Koreans who have even begun developing fully autonomous lethal unmanned ground systems to patrol the demilitarized zone. Arkin,

Governing Lethal Behavior*, 10. The Israelis have similarly developed and deployed an autonomous unmanned ground vehicle to patrol its borders. Brendan Gogarty and Meredith Hagger, "The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air," *Journal of Law, Information and Science*, vol. 19 (2008): 90-91. Perhaps even more disconcerting is how this technology might be easily obtainable by terrorist or other dangerous organizations. For example, Hezbollah reportedly used make-shift, armed UAVs against Israel in 2006. Arkin, *Governing Lethal Behavior*, 44.

35. Krishnan, *Killer Robots*, 38-39.

36. Jan Van Tol et al., "AirSea Battle: A Point-of-Departure Operational Concept," Center for Strategic and Budgetary Assessments, 33-34, accessed 3 May 2012, http://www.csbaonline.org/wp-content/uploads/2010/05/2010.05.18-AirSea-Battle.pdf.

37. Thomas Adams, colonel, U.S. Army, quoted in Singer, *Wired for War*, 128. Viewed from a slightly different perspective, one could contend that the future introduction of LARs will dramatically alter the time, space, and force factors of operational art. That shift could well be so significant that a nation without LARs would be ineffective against one with such advanced weapons.

38. DOD is committed to increased autonomy for unmanned systems in the coming years. In a 2009 planning guidance covering unmanned systems in the future, the DOD states that "[T]he level of autonomy should continue to progress from today's fairly high level of human control/intervention to a high level of autonomous tactical behavior … ." U.S. Department of Defense, *FY2009–2034 Unmanned Systems Integrated Roadmap* (Washington, DC: Government Printing Office, 6 April 2009), 27.

39. The DOD further explained in its 2009 unmanned systems planning guidance the following: "For a significant period into the future, the decision to pull the trigger or launch a missile from an unmanned system will not be fully automated, but it will remain under the full control of a human operator. Many aspects of the firing sequence will be fully automated but the decision to fire will not likely be fully automated until legal, rules of engagement, and safety concerns have all been thoroughly examined and resolved." U.S. Department of Defense, *FY2009–2034 Roadmap*, 24. It should be noted that others, such as the former Chief Scientist of the U.S. Air Force, Werner Dahm, contend that the U.S. is keeping humans in the loop because there is no strategic need to do otherwise. He argues that the time it takes a human to authorize the strike is relatively short and does not hinder the success of these unmanned systems. Werner Dahm, "Killer Drones Are Science Fiction," 11.

40. Stewart, "New Technology," 272.

41. Examples of such initially banned weapons systems include "feathered arrows, catapults, balloons firing projectiles, helicopters [and] submarines." Krishnan, *Killer Robots*, 90.

42. Ibid.

43. Ibid., 89. Some leading military analysts have proclaimed that autonomous systems, such as LARs, would be unlawful under LOAC. Some activists have even organized themselves into a group called the International Committee for Robot Arms Control (ICRAC). ICRAC has demanded an international treaty banning LARs. Peter Finn, "A Future for Drones: Automated Killing," *Washington Post*, 19 September 2011, accessed 1 March 2012, http://www.washingtonpost.com/national/national-security/a-future-for-drones-automated-killing/2011/09/15/gIQAVy9mgK_story.html.

44. Krishnan, *Killer Robots*, 90.

45. Stewart, "New Technology," 272.
46. U.S. Navy, Marine Corps & Coast Guard, *The Commander's Handbook on the Law of Naval Operations,* Naval Warfare Publication (NWP) 1-14M / Marine Corps Warfighting Publication (MCWP) 5-12.1/ Commandant Publication (COMDTPUB) P5800.7A (Washington, DC: July 2007), 5-2 [hereinafter Commander's Handbook].
47. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts, 8 June 1977, 1125 U.N.T.S. 3, art. 52 [hereinafter AP I]. *See also* Ryan J. Vogel, **"**Drone Warfare And The Law Of Armed Conflict," *Denver Journal of International Law and Policy*, vol. 39, no. 1 (Winter 2010): 115.
48. Krishnan, *Killer Robots*, 91.
49. Commander's Handbook, 5-2.
50. Ibid., 5-3; AP I, art. 48.
51. Pedrozo, "Use of Unmanned Systems to Combat Terrorism," 249.
52. Chris Jenks, "Law From Above: Unmanned Aerial Systems, Use of Force, and The Law of Armed Conflict," *North Dakota Law Review*, no. 85 (2009): 665.
53. Commander's Handbook, 5-3.
54. Some experts even expect LARs to be able to "improve on current indiscriminate military practices" as a result of their "pinpoint accuracy." Krishnan, *Killer Robots*, 95.
55. AP I, art. 51(3).
56. As Mr. Singer described it: "A robot can't easily tell a good human from a bad human." Singer, *Wired for War*, 402.
57. Arkin, *Governing Lethal Behavior*, 46.
58. Commander's Handbook, 5-3.
59. AP I, art. 51(5)(b).
60. Pedrozo, "Use of Unmanned Systems to Combat Terrorism," 248.
61. David E. Graham, "The Law of Armed Conflict in Asymmetric Urban Armed Conflict," in *U.S. Naval War College International Law Studies*, vol. 87, Raul A. Pedrozo and Daria P. Wollschlaeger, eds., (Newport: U.S. Naval War College, 2011), 304.
62. Some experts disregard this concern altogether and instead contend that robots can actually make sounder proportionality decisions than humans can. They argue that in the heat of a battle, a machine may be better able to determine the blast radius or other factors that cause collateral damage. Humans would find such calculations too difficult to make in real time. Therefore, robots might reduce the overall probability of collateral damage and be able "use force more proportionately than humans." Krishnan, *Killer Robots*, 92.
63. Author's notes, U.S. Naval War College Center for Naval Warfare Studies Conference, subject: Unmanned Maritime System Legal Workshop, 20 March 2012.
64. It should be noted that this principle is often difficult to apply directly. Instead, decisions about these issues are normally resolved through international treaties or conventions. Furthermore, DOD requires that every new weapon or weapon system receive a legal review to determine the lawfulness of the system. That review is outside the scope of this paper, but it should be presupposed that a legal review would be completed on any LARs system before it is used operationally. Commander's Handbook, 5-3.
65. Ibid.
66. Graham, "Law in Asymmetric Urban Armed Conflict," 305.

67. LOAC is certainly broader and more encompassing than simply four principles. While those principles comprise the core of LOAC and are most relevant to this analysis, operational commanders would want to ensure the systems comply fully with all applicable legal standards. For instance, the first Additional Protocol to the Geneva Convention requires belligerents to do “everything feasible” to ensure a target is a proper military one and to protect against collateral damage. AP I, art. 57. High technology countries, such as the U.S., generally have a higher standard than others to meet these so-called “precautions in the attack” requirements. Stewart, “New Technology,” 287. The U.S. could fulfill this requirement with respect to LARs, however, in a variety of manners, to include by performing sufficient intelligence gathering and by sufficiently evaluating collateral damage estimate models prior to attacks. Jenks, “Law From Above,” 668.

68. Kenneth Anderson and Matthew Waxman, “Law and Ethics for Robot Soldiers,” *Policy Review*, (Forthcoming, 2012): 11, accessed 1 May 2012, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2046375.

69. Stewart, “New Technology,” 290.

70. Ibid., 291.

71. Singer, *Wired for War*, 408.

72. Stewart, “New Technology,” 283 and note 38.

73. Krishnan, *Killer Robots*, 90.

74. The Geneva Conventions described grave breaches to be “willful killing, torture or inhuman treatment, … willfully causing great suffering or serious injury to body or health, … extensive destruction and appropriation of property, not justified by military necessity and carried out unlawfully and wantonly.” Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field, Aug. 12, 1949, 6 U.S.T. 3114, 75 U.N.T.S. 31, art. 147.

75. Some commentators envision that states could hold either the manufacturer of LARs or the military commander liable for errors: “If the robot does not operate within the boundaries of its specified parameters, it is the manufacturer’s fault. If the robot is used in circumstances that make it use illegal, then it is the commander’s fault.” However, such a “regulatory framework” has not yet been designed. Krishnan, *Killer Robots*, 105.

76. Some commentators even argue that relying on criminal liability as the primary means for establishing accountability may inadvertently stymie the production of advanced weapon systems that could reduce dangers for civilians. Anderson and Waxman, “Law and Ethics for Robot Soldiers,” 12.

77. Krishnan, *Killer Robots*, 97.

78. Ibid., 162.

79. Stewart, “New Technology,” 286.

80. There may be other significant concerns about using LARs in a counterinsurgency fight. For instance, it may be more difficult for a robot to help a force gain the trust of a local population. Given that the population is often the center of gravity in such conflicts, the use of LARs should be weighed carefully. Another alternative may be to limit LARs to the use of non-lethal weapons in such complex situations.

81. Barnes and Evans, “Soldier-Robot Teams in Future Battlefields,” 23.

82. Krishnan, *Killer Robots*, 163.

83. The U.S. Central Command is upgrade the technology on many of its systems to counter a possible Iranian threat. Tony Capaccio, "Pentagon's Iran Buildup Calls For Lasers, Spy-Plane, Sensors" *Bloomberg News*, 19 March 2012, accessed 3 May 2012, http://www.bloomberg.com/news/2012-03-19/pentagon-s-iran-buildup-call-for-adding-laser-weapons.html.

BIBLIOGRAPHY

Anderson, Kenneth and Matthew Waxman. “Law and Ethics for Robot Soldiers.” *Policy Review*, (Forthcoming, 2012): 1-19. Accessed 1 May 2012. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2046375.

Arkin, Ronald C. *Governing Lethal Behavior In Autonomous Robots*. Boca Raton, FL: Chapman & Hall, 2009.

Bar-Cohen, Yoseph, and David Hanson. *The Coming Robot Revolution: Expectations and Fears About Emerging Intelligent, Humanlike Machines*. Pasadena, CA: Springer Science+Business Media, 2009.

Barnes, Michael and Florian Jentsch, eds. *Human-Robot Interactions in Future Military Operations*. Burlington, VT: Ashgate Publishing Company, 2010.

Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field, Aug. 12, 1949, 6 U.S.T. 3114, 75 U.N.T.S. 31.

Gogarty, Brendan and Merridth Hagger. “The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air.” *Journal of Law, Information and Science*, vol. 19 (2008): 73-145.

Graham, David E. “The Law of Armed Conflict in Asymmetric Urban Armed Conflict.” In *U.S. Naval War College International Law Studies*, vol. 87, edited by Raul A. Pedrozo and Daria P. Wollschlaeger. Newport, RI: U.S. Naval War College, 2011.

Jenks, Chris. “Law From Above: Unmanned Aerial Systems, Use of Force, and The Law of Armed Conflict.” *North Dakota Law Review*, no. 85 (2009): 650-671.

Krishnan, Armin. *Killer Robots: Legality and Ethicality of Autonomous Weapons*. Burlington, VT: Ashgate Publishing Company, 2009.

Pedrozo, Raul A. “Use of Unmanned Systems to Combat Terrorism.” In *U.S. Naval War College International Law Studies*, vol. 87, edited by Raul A. Pedrozo and Daria P. Wollschlaeger. Newport, RI: U.S. Naval War College, 2011.

Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts, June 8, 1977, 1125 U.N.T.S. 3.

Public Broadcasting Service. “Smartest Machines on Earth.” *NOVA*, 14 September 2011. Transcript. http://www.pbs.org/wgbh/nova/tech/smartest-machine-on-earth.html.

Singer, P.W. *Wired for War: The Robotics Revolution and Conflict in the Twenty-first Century*. New York: Penguin Press, 2009.

Stewart, Darren M. "New Technology and the Law of Armed Conflict: Technological Meteorites and Legal Dinosaurs?." In *U.S. Naval War College International Law Studies*, vol. 87, edited by Raul A. Pedrozo and Daria P. Wollschlaeger. Newport, RI: U.S. Naval War College, 2011.

United Nations. *Interim Report of the Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions*, UN General Assembly report A/65/321 (New York: 23 August 2010).

U.S. Air Force, *Unmanned Aircraft Systems Flight Plan 2009-2047* (Washington DC, Headquarters Department of the Air Force, 18 May 2009).

U.S. Army. *The Law of Land Warfare*, Field Manual 27-10 (Washington, DC: Headquarters Department of the Army, 18 July 1956).

U.S. Department of Defense. *FY2009–2034 Unmanned Systems Integrated Roadmap*. Government Printing Office. Washington, DC: 6 April 2009.

U.S. Joint Forces Command. *Rapid Assessment Process (RAP) Report # 03 – 10, Unmanned Effects (UFX): Taking the Human Out of the Loop*. (Virginia: Headquarters Joint Forces Command, September 2003).

U.S. Navy, Marine Corps & Coast Guard. *The Commander's Handbook on the Law of Naval Operations*, Naval Warfare Publication (NWP) 1-14M / Marine Corps Warfighting Publication (MCWP) 5-12.1/ Commandant Publication (COMDTPUB) P5800.7A (Washington, DC: July 2007).

Van Tol, Jan, Mark Gunzinger, Andrew Krepinevich, and Jim Thomas. "AirSea Battle: A Point-of-Departure Operational Concept." Center for Strategic and Budgetary Assessments. Accessed 3 May 2012. http://www.csbaonline.org/wp-content/uploads/2010/05/2010.05.18-AirSea-Battle.pdf.

Vogel, Ryan J. "Drone Warfare And The Law Of Armed Conflict." *Denver Journal of International Law and Policy*, vol. 39, no. 1 (Winter 2010): 101-138.

Wagner, Marcus. "Taking Humans Out of the Loop: Implications for International Humanitarian Law." *Journal of Law, Information and Science*, vol. 21 (2011): 1-11.