Lethal Autonomy

What It Tells Us about Modern Warfare

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By now, most military leaders have heard about the development of autonomy in weapon systems and are aware of the vocal opposition from outside the DOD.[1] Autonomy in weapon systems has been under development and controversial for many years.[2] Now, however, robotics and autonomous systems have been highlighted by the DOD as a centerpiece of the "third offset" strategy.[3] This strategy seeks to ensure continued asymmetric combat advantage for the United States, with a particular focus on the incorporation of future technologies not easily replicated by competitor states or nonstate entities.[4] The upcoming years are therefore a critical time in the research, development, and deployment of lethal autonomous weapon systems (LAWS) in the United States and throughout the world.[5]

The DOD's push, along with recent technological developments, have triggered a broad and public discussion of concerns with LAWS, including direct opposition to their development. These concerns are of three general types: (1) the belief that risks associated with such new weapons outweigh benefits, (2) concerns about whether lethal autonomy violates the international law of war, and (3) doubts regarding the moral propriety of machines apparently making "discretionary" decisions to take a human life.[6]
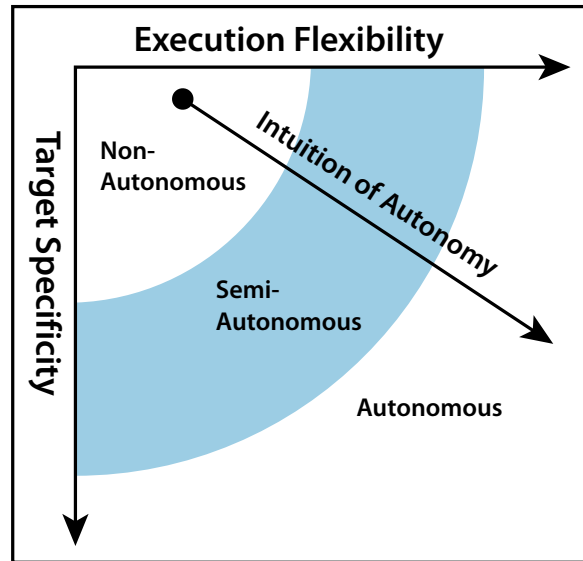

Figure. Continuum of Autonomy

Defining Autonomy

There are various ways to discuss *autonomy* in weapon systems. Outside of the technical literature, the term is less descriptive and more evocative—that is, terming a weapon system autonomous does less to describe how it operates than it does to invoke ideas and concerns about its decision making and predictability.[7] The definitions of the terms, and even the taxonomy of existing systems, are not always consistent among authors on the subject.[8] Although precise definitions are critical for design and engineering purposes, understanding the debate about autonomy requires an acknowledgement of these differing uses of the term, typically centered on ethically relevant subprocesses of the system as a whole; targeting, goal-seeking, and the initiation of lethality.

The perception of policy-relevant autonomy has two underlying elements. On the one hand, it references the target specificity given to the system in geographic, temporal, or descriptive characteristics. Thus, systems that are given a highly specific target designation by a person (that is, air-to-air missiles that attempt to identify

a specifically selected target by location, or the presence of jamming signals, or most defensive systems) are not considered autonomous.

On the other hand is execution flexibility, where systems that have tight constraints on available actions are considered nonautonomous. Examples include a land mine, trip-wire explosive, or defensive gun emplacement, as opposed to a robotic tank ordered simply to "guard a perimeter," which most would consider autonomous. Devices with limited targeting but broad execution flexibility, such as a robot programmed to hunt down a particular individual in a geographic region, seem to encounter the same risk/benefit analysis and ethical intuitions as the notional "fully autonomous system" or "robot soldier."

Therefore, broad targeting specificity and expansive execution flexibility both tend to result in the characterization of a system's behavior as autonomous. Both characteristics raise real or perceived concerns about the locus of decision making and predictability of the system.

Key Issues

There is a wide variety of topics related to the development and employment of lethal autonomous weapon systems. The numerous issues of this debate can be usefully divided into ones regarding (1) risks and potential benefits, (2) legal issues, and (3) moral/ethical concerns (see table). Positions vary in terms of nuance, but much of the primary discussion centers on whether a ban (international or unilateral to the United States) on the research, development, and deployment of LAWS is appropriate.

Potential Benefits

Military Capabilities

The potential value of LAWS in armed conflict is uncontroversial.[9] With nonlethal military systems, traditional automation provides an immediate force multiplier by taking repetitive or analytically arduous tasks and removing the need to hire, train, and support personnel to perform them. Autonomous action is even more valuable as complex systems, incorporating learning algorithms and contextual awareness, allow for the automation of much more numerous and difficult tasks requiring judgment and situational awareness, such as automated flight control.[10] Additionally, autonomous systems will likely be capable of reacting substantially faster than humans. The initial reaction advantage of autonomous systems could snowball through cycles of reaction, creating a potentially insurmountable advantage in warfare.[11]

Leverage Civilian Technology

The focus on LAWS is also potentially beneficial for the United States because it capitalizes on current advances in civilian autonomous technology. The United States is a global leader in this area, and one of the imperatives of military technology is to maximize areas where an asymmetric advantage is available that is difficult for opponents to replicate. Investment in these areas of research and development (R&D)

may drive the development of industrial capacity and commercial innovation in a virtuous cycle. Military and civilian developments in autonomous capability therefore have a positive symbiotic relationship.[12]

Table. Taxonomy of the debate

Category of Concern		Specific Issue	Critical of LAWS	Supportive of LAWS
Benefits and Risks	Benefits	Military capabilities	Risk related to error and adversary action may outweigh benefits	Provides significant, and perhaps decisive, military advantage
		Leverage civilian technology	Arms race with competitors not able to master technical side of militarization of civilian technology	Takes advantage of areas of US technology leadership; strengthens persistence of advantage
		Ethical improvements	Will not be capable of ethical decision making	May improve on precision weaponry in protecting civilians
	Risks	Likelihood of war/ Jus ad bellum	Lack of casualties will encourage leaders to engage in unlawful war	Generic objection that applies to development of any substantial military advantage
		Arms race	Triggers a wider arms race	Peer development and civilian technology will result in LAWS
		Asymmetric warfare	Increases likelihood of strikes on civilians	Excessively generic objection; seems to blame victims for illegal attacks
		Hacking/subversion	Allows for hacking/ subversion	Allows continued operations without communications
		Loss of command and control	Runaway escalation due to fast LAWS on both sides	LAWS likely restrictive rules of engagement; free-ranging persistent LAWS improbable
		Judgment errors	Decision making of the system is unpredictable	Reliability and predictability will reach human levels; no more required
Legal Issues	Weapons Law	Per se	Because inherently indiscriminate, per se illegal	High-intensity conflicts make even unreliable LAWS conditionally legal
		Distinction	Unable to distinguish civilians	No negative emotions, human-level decisions
		Proportionality	Cannot balance military advantage and collateral damage	Commander who sets into motion makes judgment, as current practice
	Accountability		No one held responsible for commission of war crimes	Excessive focus on criminal; same as other weapon malfunctions
Moral / Ethical Issues			Demeaning to humanity for LAWS to determine death	LAWS don't make decision; commander who sets in motion does

Source: Multiple sources.

Potential Improvements in Ethical Warfare

Both opponents and supporters of a ban on LAWS highlight the potential for autonomous technology to facilitate compliance with the law of armed conflict—at least in some areas. LAWS are not susceptible to emotional effects such as shock or anger that may result in abuses by human soldiers. The presence of LAWS in mixed teams with human soldiers, particularly if LAWS have independent capacity to judge ethical conduct, may also temper the willingness and ability of those soldiers to engage in inappropriate or unlawful conduct.[13]

The use of autonomous weapon systems under circumstances where all or almost all of the potential targets are lawful, or have already been vetted, may arguably also provide humanitarian benefits. For example, if the alternative is between using a bomb and a robot soldier, the LAWS might be legally and ethically desirable, even if the autonomous system's ability to distinguish noncombatants is unreliable. In this sense, autonomous decision making at the moment of lethal action may be an improvement on the precision of weapon systems, eliminating some of the error created by imperfect intelligence and distance in time between the initiator and target.[14]

Potential Risks

Likelihood of War/Moral Hazard

A common concern is that the existence of LAWS encourages inappropriate aggression. Although sometimes couched in terms of jus ad bellum, or the legal theory of just war, this concern does not actually question the propriety of war initiation.[15] Rather, the argument is that LAWS would create a moral hazard for national leadership. If you suppose that current or future leaders are willing and desire to engage in unlawful war-making but are inhibited by the likelihood that it will result in military casualties, either for moral reasons or because of spin-off effects of those casualties, then LAWS might minimize these casualties and thus result in unlawful aggression.[16] A counterargument, however, is that this objection is excessively generic. Any weapon system that minimizes casualties, or gives a substantial advantage to one side in armed conflict, would seem to trigger this same moral hazard.[17]

Uncontrolled Arms Race

LAWS may also trigger wider arms races. This argument takes two forms. First, because of the tremendous tactical advantage associated with the development of LAWS, peer and near-peer competitors will be forced to develop increasingly sophisticated autonomous capabilities for their own weapon systems. Second, asymmetric competitors, such as international terrorist organizations, who would otherwise lack organic R&D to develop such systems, will gain access to the technology once it becomes widely used in warfare. In addition to the inherent instability associated with arms race dynamics, competitors in both cases may have less incentive or less capacity to control the behavior of LAWS.[18] Therefore, even the most ethical

development of LAWS by the United States may result in the development and fielding of indiscriminate LAWS.[19]

A number of counterpoints have been presented to this risk. First, some argue an arms race is already in progress, with peer and near-peer competitors developing autonomous weapon systems, and US efforts are required simply to remain competitive. These nations will arguably refuse to adopt, or successfully evade enforcement of, any potential multilateral ban. Second, asymmetric competitors may be capable of leveraging technological development in the civilian sector, since some argue weaponization of some civilian technologies will be relatively easy.[20]

Asymmetric Warfare

The replacement of soldiers by LAWS also has the potential to increase attacks on civilian targets, particularly in the United States itself. Enemies of the United States, it is argued, will see no political or strategic benefit in attempting to fight if the United States is not suffering human casualties. These opponents are therefore incentivized to carry out attacks on civilian rather than military targets.[21]

Of course, as critics note, any generic technological advantage that makes US service members less susceptible to enemy attack appears to create the same risk. In the same vein, one DOD analyst notes that this argument essentially "blames the victim" by discouraging the protection of soldiers because of the enemy's presumed willingness to violate the laws of war by assaulting civilians. Finally, considering the history of nuclear strategy as well as terrorist targeting, both of which focus substantially on civilians, both near-peers and asymmetric opponents seem willing to place civilians in jeopardy if it serves strategic ends; therefore, the presence or absence of US casualties on the battlefield is arguably irrelevant.[22]

Hacking/Subversion

The reliance on autonomous systems increases the military's vulnerability to hacking or the subversion of software and hardware. The replication of software, as well as the complexity and interdependence involved with widespread use of autonomous weapon systems could significantly magnify harm if a security vulnerability or exploitable system malfunction were acquired by an adversary. Potential consequences could include mass fratricide, civilian targeting, or unintended escalation.[23]

One response to that argument, however, is that on-board autonomous capability may actually *counter* subversion or hacking of current and future remote systems. For example, an autonomous friend/foe system might refuse to fire on friendlies when receiving a spoofed set of instructions or an autonomous flight system might continue protective flight of a remotely piloted aircraft if the control link is disrupted. Of course, even weapon systems that do not include autonomous capabilities rely heavily on computer hardware and software. This automation does not seem markedly less susceptible to hacking and subversion, and the presence of autonomy may make a system more resilient than an equally computerized but less internally controlled nonautonomous weapon system.[24]

Loss of Command/Control

The literature also identifies a risk that the large-scale adoption of autonomous weapon systems may result in runaway escalation. The very interdependence, complexity, and flexibility of the system that allows it to perform complex mission sets may result in unpredictable and unintended lethality. In addition, the danger of uncontrolled escalation is significantly greater precisely because the speed with which LAWS are capable of decision making and action—one of the primary military advantages—creates a potential time delay between failure and corrective action. Finally, unlike idiosyncratic human decision making, software control systems may be replicated throughout the fleet of LAWS, and so the damage potential of a simultaneous failure by all similar LAWS in the inventory must be considered, not only the consequences of a single system failure. Some analysts of LAWS envision an armed conflict that begins without either party intending it because of an initial error snowballing into a full-scale response, triggering automated response in a vicious cycle.[25]

The counterargument is that there is nothing inherently more destructive about autonomous weaponry; it is simply conventional weaponry directed by an autonomous system. Thus, it is not clear why autonomous systems would be more susceptible to inadvertent escalation than humans under the same circumstances. Some also question the plausibility of a scenario in which numerous free-ranging autonomous weapon systems come into contact with one another while empowered to engage in conflict independent of explicit human tasking or authorization.[26]

Judgment Errors/Accuracy

The final and most frequently cited risk is in the area of reliability and predictability. For various reasons, almost all involved in LAWS analysis recognize the difficulties inherent in ensuring reliable decision making.[27] Proponents of a ban generally take the position that the decision making of an autonomous weapon system is fundamentally or irreducibly unpredictable, thereby foregoing the need for research to determine future reliability. For example, some argue that because no software can include an exhaustive description of all possible circumstances, it is impossible for an autonomous system to behave predictably outside highly controlled circumstances. Others argue that the technology required for flexible autonomous operations will, by needs, be based on learning or self-altering algorithms, which may develop unpredictable behavior patterns invisible to the original designers.[28] Finally, there are concerns that, even if developed, ethical decision making would be a premium system not deployed by potential state and nonstate opponents of the United States in a prospective arms race, even if the United States reliably employed it.[29]

Some experts, however, believe that an autonomous decision-making system may plausibly reach a level of reliability and predictability comparable to a human soldier. The proponents of the technology argue that requiring absolute or logically

certain predictability from LAWS holds it to a higher standard than that applied to humans and risks failing to use a potentially more reliable system because it is not perfectly reliable.[30] The question of decision-making performance is, however, inextricably linked to a large number of disputes regarding the legality of LAWS. The nature and performance of the autonomous system in making critical decisions about the propriety of the use of lethal force are the central issues addressed next.

Legal Issues

There are two areas of legal contention regarding autonomous weapon systems. The first area is the weapon system's ability to comply with US obligations under international humanitarian law and rules of engagement (ROE).[31] This is essentially an operational concern: Will the functioning of the weapon systems comply with the appropriate requirements? The second concern is less focused on function, but instead questions whether the use of LAWS will make it more difficult to hold parties accountable for misconduct during armed conflict.[32]

Operational/Functional Laws

There are generally three areas of operational law that arguably affect consideration of LAWS. First, there is the set of legal norms that governs the appropriate justification for the initiation of armed conflict, called jus ad bellum, as noted above.[33] However, when critics and defenders address initiation of armed conflict, the critical issue is the potential for moral hazard rather than the law, as discussed previously under "Risks." The second area of operational law classifies weapons themselves as lawful or unlawful. Finally, law governs conduct of operations during war, or jus in bello.[34]

Weapons Law

A weapons evaluation for compliance with the laws of armed conflict considers first whether a weapon is prohibited per se, or prohibited under all circumstances, under the law of war. This status adheres to weapons that are banned pursuant to treaty as well as to weapons that cannot comply with legal requirements under any circumstance or method of use.[35] The first principal legal requirement is that the weapon does not cause suffering or injury beyond that required for a military purpose. For example, the use of glass ammunition is prohibited, without further evaluating the specific circumstances of use, because its use is considered to inflict unnecessary suffering. The second legal requirement is that weapons must be capable of being employed in a fashion to distinguish between military and civilian targets (which might be impossible either because of an incapacity to target or to control effects).[36]

Although some proponents of a ban on LAWS argue that such systems are per se illegal on the basis that they can never adequately distinguish between lawful and unlawful targets, opponents argue that this assertion ignores many lawful use scenarios.[37] They point out that even "dumb" bombs and indirect artillery fires are not per se illegal, since they can be used under circumstances in which civilians are

not present; for example, to target a cluster of tanks in an unpopulated area. Likewise, even autonomous weapons without any capability to distinguish between combatants and civilians might be used under limited circumstances in combat zones without noncombatants.[38] The resolution of this disagreement seems to turn on the likelihood of any scenario in which LAWS can perform at least equal to a human, with opponents of a ban pointing to the uncontroversial current use of over-the-horizon, or sensor-based, targeting as an analogy, and proponents of a ban arguing that these scenarios are extremely limited or unlikely.[39]

The second aspect of a weapon evaluation is based on the specific proposed uses of the weapon. In this case, each of the proposed uses of the weapon must be evaluated for the weapon system's compliance—under those sets of circumstances—with the law of war. This contextual evaluation primarily relies on the weapon system's ability to comply with the principles of distinction and proportionality during actual operational use.[40]

Law of Armed Conflict/Jus in Bello

Although a variety of principles form the basis of the law of armed conflict (the DOD identifies five), most consideration of autonomous weapon systems has focused on the foundational principle of distinction and its related principle of proportionality.[41] The requirement to take feasible precautions is also frequently raised, but has generated little meaningful debate.[42]

Distinction

Distinction is the requirement that warring parties distinguish between military and civilian objects and personnel during the course of conflict and is considered customary international law.[43] The primary concern, as discussed before, is that even if LAWS in principle are not per se indiscriminant, in practice they will simply be unable to distinguish between combatants and civilians.[44] The difficulty of this task is agreed, by all sides of the debate, to be a particularly acute concern in the context of irregular warfare. In these conflicts, combatants may be embedded within the larger civilian environment, which creates extremely complex decision-making scenarios.[45]

In addition, because LAWS lack empathy or human emotion, they are now, and may be in the future, unable to effectively determine the intentions of individuals on the battlefield, critical to distinguishing combatants and noncombatants. Consider, for example, complex situations involving noncivilian noncombatants legally entitled to protection, such as surrendering, wounded, or incapacitated fighters.[46]

Defenders of the technology, at least in terms of its potential, point out that future autonomous weapon systems may be more capable of distinguishing between combatants and civilians than human soldiers. Because LAWS' capabilities are not degraded by the same stress and emotional intensity that affects the judgment of soldiers in combat, and because LAWS have no need for self-defense, they can respond more tolerantly to ambiguous circumstances than similarly situated soldiers. For example, they might delay their response to threatening actions until the initiation of active hostility.[47] Also, governments interested in improving the accuracy of distinctions made by

such systems could employ shared standards of testing, as well as leveraging the benefit of evaluation by ethicists of complex or difficult distinction decisions.[48]

Proportionality

Proportionality is the requirement that military action not cause excessive damage to civilian lives or property in relation to the military advantage to be gained from the action.[49] On one hand, many argue the proportionality judgment that is required by this rule is inherently complex and flexible and thereby fundamentally beyond the capabilities of an autonomous system. When a decision maker considers the allowable collateral impact of a single action (like dropping a bomb), proportionality requires understanding and integration of the surrounding circumstances of the immediate battlefield, as well as an overall strategic understanding of the goals of the military action in question. Additionally, determining whether collateral impact is excessive is arguably fundamentally inaccessible to LAWS because it embeds an irreducibly human judgment of reasonableness, which is a sort of rough-and-ready appeal to the human faculty of common sense and shared human values.[50]

On the other hand, technology defenders envision the commander activating the LAWS making proportionality judgements about the expected collateral impact resulting from activation of the entire system, drawing on previously established reliability measurements developed for that purpose.[51] When some critics have pointed out that such judgments are time-sensitive and cannot simply be preprogrammed, ban opponents have responded that ensuring their continued viability simply requires time limits to avoid the aging of these judgments.[52]

Collateral damage estimates for current weapon systems are regularly made using objective data and scientific algorithms. Some supporters of LAWS thereby argue that modern warfare regularly involves individuals executing a kinetic action (that is, dropping a bomb or firing a missile) with little or no capability or requirement to assess the specific conditions of the target immediately before its destruction or to perform an instantaneous proportionality assessment.[53]

As previously noted, the commander who sets the LAWS in motion, plays a critical role in the legal responsibility for its resulting action. However, there remain questions whether that commander, or any other individual, could be held appropriately accountable for war crimes committed by such a weapon system.[54]

Accountability and Liability

Critics of LAWS have raised legal objections relating to the chain of accountability for the actions of these systems. Because machines are not ethical actors, if an autonomous system carried out an action illegal under the laws of war (a war crime), holding someone responsible for that decision could be difficult or impossible.[55] Opponents of a ban counter that there is a long tradition of command responsibility for the actions taken by subordinates. If LAWS were used by a commander with the intention to commit a war crime, then the commander could be held responsible for that crime.[56] Likewise, if the LAWS were intentionally designed or manufactured with the purpose of being used to commit war crimes, or with reasonable knowledge

that they would be so employed, then the designers or manufacturers could also bear criminal liability.

However, while this intent might generate responsibility, arguably war crimes are most likely to occur as a result of an unintended action by the autonomous system, not as an element of deliberate design. Although commanders are responsible for the reasonably foreseeable actions of subordinates, critics are concerned that commanders, designers, and manufacturers will be excused from such responsibility because of the fundamentally complex and unpredictable nature of autonomous decision making. In this view, victims of war crimes committed by LAWS will lack redress, creating a fundamental lack of justice and responsibility associated with the use of these weapons. For this reason alone, some argue, LAWS should be banned.[57]

Of course, some note that Soldiers ordered to perform an otherwise lawful mission could commit war crimes as well.[58] While this still leaves some person criminally responsible for the misconduct, LAWS' defenders counter that this analysis places an excessive focus on individual criminal liability. [59] They point out that the law has effectively managed responsibility for a variety of circumstances involving not fully predictable outcomes, such as the law regarding pet behavior or criminal negligence.[60] Moreover, the law of state responsibility would seem to allocate legal responsibility and an obligation to provide appropriate redress to the belligerent state employing the LAWS, arguably making the establishment of individual culpability less urgent.[61] The question of whether noncombatant victims of LAWS-related violence—whether intentional, collateral, or accidental—can receive justice leads to a larger question about the moral propriety of LAWS.

Moral/Ethical Issues

The potential for autonomous weapon systems to make decisions about whether to take human life has generated discussion of risks and benefits, as well as legal concerns, but it has also raised more fundamental questions. Some, including Christopher Heyns, the United Nations Human Rights Council special rapporteur on extrajudicial, summary, or arbitrary executions, have indicated that the very notion of machines making the decision to take a human life is morally problematic.[62] As some describe, human dignity is at the core of the international law of human rights. Allowing a machine to make an independent judgment to take a life impugns that dignity.[63] Others argue that allowing machines to make the decision to kill treats human being as objects and denies their fundamental moral value.[64]

Ban opponents argue that moral intuition is based on excessive anthropomorphism of autonomous weapon systems, analogizing autonomous processing to human reasoning in a way that is unlikely to accurately reflect military technology within the foreseeable future. In their opinion, even a nondeterministic LAWS (that is, using a flexible learning algorithm) is not making a decision in an ethically meaningful sense any more than is an air-to-air missile or Patriot battery. Under this notion, the relevant decision to kill is made by the commander who assigns the LAWS its mission, sets limits in time and space, describes ROEs, and sets the LAWS into motion.[65] As discussed, still others accept the LAWS as a decision maker in a

morally relevant sense but argue that, when deployed, it will make better ethical decisions than a human Soldier.[66]

Autonomy May Highlight Broader Concerns

There are at least three major areas where the risks and ethical issues raised by critics of LAWS are not unique to these systems. Supporters of LAWS argue that critics only associate these issues with autonomy because they either have not considered or do not fully understand the array of technologies and doctrinal structures that— without autonomy—already generate the circumstances that give rise to critic's concerns. Specifically, even in the complete absence of autonomy, technological disparities result in a tremendous and increasingly disproportionate risk (civilian and military) between the United States and those enemies with whom we are currently engaged, producing the same moral hazard for decision makers. Likewise, along with reducing risk, stand-off weaponry of all types increasingly abstracts the initiator of lethal action from the individual killed in a way that raises fundamental questions regarding the dignity of individual human life. Finally, fragmentation of targeting and strike decision making is already characteristic of much operational tasking, and this mitigated character already complicates traditional notions of accountability and responsibility.

However, dismissal of these three critiques because they are not unique to LAWS is profoundly misguided. The fact that risk disproportion, lethal abstraction, and mitigated decision making are characteristic of modern US warfighting, independent of any particular technology, makes these critiques only more worthy of substantive engagement. Debate and discussion of autonomous weapon systems may bring into sharp focus risks and concerns—operational, legal, or ethical—which are characteristic of the entire host of evolving technologies and doctrines, and deserve engagement as constructive contributions on questions of national concern.

The United States' current conflicts with nonpeer nations and peoples have highlighted the disproportion in risk between us and our opponents, among both military members and civilian populations. While perhaps not significant in near-peer direct conflict (depending on the success of the third offset), such a disproportionate impact may distort the decision-making calculus of both military and civilian senior leaders, particularly in light of a US population who has little concern for enemy casualties or social impact on enemy nations. This heightened willingness of US leaders to intervene militarily may be reflected in the national conversation by flexibility in adherence to traditional notions of sovereignty (responsibility to protect) or by a broadening of national self-defense (anticipatory self-defense). Recent decades may reflect a growing willingness to seek the achievement of otherwise desirable political ends (replacement of a dictator or the prevention of ethnic abuses) via the application of military force precisely because its use risks so little in US military casualties and the societal impact that makes war "hell" is not felt domestically.

In addition to contributing to the diminished risk discussed above, stand-off weapons—from cruise missiles to RPAs—create an increasingly abstracted and technologically mediated interaction between the initiator of lethal action and the individual killed. Many, both inside and outside the military, find the personalization of

each decision to take a life the necessary sacrifice that humanizes the ruthless realities of combat. As the military continues to develop human-machine teaming concepts and technologies in a context much broader than LAWS, this moral insight may contribute to ensuring the final products reflect our national and personal values.

Finally, critiques of accountability of autonomous weapon activation suggest that the growing fragmentation of seemingly singular actions such as identify, target, or execute may have implications for accountability and responsibility, and that our traditional rules-based evaluations may not be keeping up with the changing character of war. While the military tradition of command attribution (making the commander responsible regardless of personal involvement) may function to counter ethical complacency resulting from diffusion of decision making across a bureaucratic organization, it doesn't resolve the absence of individual legal accountability identified by critics. Leaving aside autonomy, any modern kinetic strike may arise from a complex human-technological intelligence and targeting process, automated estimation of collateral impact, and group decision making, and may reasonably raise questions about the commander's understanding of the reliability of the technology involved. Even actions seemingly indicative of criminal negligence may become increasingly difficult to effectively prosecute, as each individual involved owns only a small portion of the overall compounded error.[67]

Summary

As seen in the table, the debate on LAWS is multifaceted with participants falling in a broad range from proponents supportive of LAWS development, to opponents seeking an outright ban—with many analysts falling between these extremes and focused on risk-awareness and comprehensive regulation. The discussion covers a wide variety of issues, including operational risk, legal factors, and overarching moral/ethical considerations. As commercial technology advances and the DOD continues to develop human-machine teaming and autonomy, LAWS will become ever more central to the US military's competitive advantage. It is increasingly important that military professionals, outside simply the technical arena, understand the grounds of discussion and the arguments being advanced. Even when the critique presented is not unique to LAWS, it may reflect a meaningful engagement with continuing developments characteristic of US warfighting. Understanding the intuitions being expressed, along with a willingness to be flexible where appropriate, will allow military and civilian leadership to guide the armed forces' development and employment of these and other weapon systems to ensure future warfare is conducted in a manner consistent with American values while still maintaining the technological advantages which are the backbone of the American way of war. ✪

Notes

1. Congressional Research Service Report R44466, *Lethal Autonomous Weapon Systems: Issues for Congress*, 14 April 2016, https://www.everycrsreport.com/files/20160414_R44466_47dffae4ebc5e9ea08 00c8f1b062d9b9dce81436.pdf.

2. Consider the first autopilot, developed in 1912, as a sort of militarily relevant autonomous system (see Laurence R. Newcome, *Unmanned Aviation—A Brief History of Unmanned Aerial Vehicles* [Reston, VA: American Institute of Aeronautics and Astronauts, 2004], 16). Controversy and concern about autonomous weapons can be traced back far longer, well before the existence of any such system. For example, *Frankenstein, or The Modern Prometheus* by Mary Shelley, largely reflects many of the current concerns with the risks and unpredictable results of autonomous weapons development; *see also* the United Nations Office in Geneva, Switzerland), *Advance Copy of the Report of the 2015 Informal Meeting of Experts on LAWS*, 13–14 November 2014, 9, http://www.genf.diplo.de/contentblob/4567632/Daten/5648986/201504berichtexpertentreffenlaws.pdf.

3. Sydney J. Freedberg Jr., "Hagel Lists Key Technologies for US Military; Launches 'Offset' Strategy," *Breaking Defense*, 16 November 2014, http://breakingdefense.com/2014/11/hagel-launches-offset-strategy-lists-key-technologies/; and Zachary Keck, "A Tale of Two Offset Strategies," *The Diplomat*, 18 November 2014, http://thediplomat.com/2014/11/a-tale-of-two-offset-strategies/.

4. Deputy Secretary of Defense Bob Work, "The Third Offset Strategy and its Implications for Partners and Allies," delivered at Willard Hotel, Washington, DC, 28 January 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies; and Secretary of Defense Chuck Hagel, " 'Defense Innovation Days' Opening Keynote," delivered at Newport, RI, 3 September 2014, http://www.defense.gov/News/Speeches/Speech-View/Article/605602; *see also* Robert O. Work and Shawn Brimley, *20YY: Preparing for War in the Robotics Age*, Center for a New American Security, January 2014, 10–16, Deputy Secretary of Defense Bob Work, "Reagan Defense Forum," https://www.cnas.org/publications/reports/20yy-preparing-for-war-in-the-robotic-age.

5. Deputy Secretary of Defense Bob Work, "Reagan Defense Forum: The Third Offset Strategy," delivered at Reagan Presidential Library, Simi Valley, CA, 7 November 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/628246/reagan-defense-forum-the-third-offset-strategy.

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15. The legal basis for just war analysis derives from the variety of sources including international agreements and unwritten customary international law. *Department of Defense Law of War Manual*, 39–49.

16. Sharkey, "Killing Made Easy," 122; Wallach, *Ensuring Human Control*; UNOG, *Informal Meeting of Experts*, 5; Wallach and Allen, "Framing Robot Arms Control," 125; and Heyns, Report of the Special Rapporteur, para. 57-58; HRW and IHRC, *Losing Humanity*, 39–41.

17. Schmitt and Thurnher, "Out of the Loop," 232; and Anderson and Waxman, "Law and Ethics for Robot Soldiers," 13. Arguably, using human lives as a calculated method to impose decision-making costs on politicians represents an actualization of the same moral problems posed by opponents of LAWS—in potential—when considering machine-determined lethal fires (see the "Moral/Ethical Issues" section). That is, human lives used as "means" to a political end, without individuation. *See also* 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*, American University Washington College of Law, Research Paper No. 2013-11, 18, http://ssrn.com/abstract = 2250126 (arguing moral equivalence to hostage taking to influence political decisions).

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22. Steene, interview by the author.

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40. Guarini and Bello, "Robotic Warfare," 147; Thurnher, *The Law That Applies*; Schmitt and Thurnher, "Out of the Loop," 249–51; and Kanwar, "Post-Human Humanitarian Law," 8.

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42. With the exception of discussing whether the use of ethical autonomous weapons might be required under some circumstances, which is addressed in the "Positive Improvements in Ethical Warfare" section.

43. Thurnher, *The Law That Applies;* Schmitt and Thurnher, "Out of the Loop," 251; and Anthony and Holland, *The Governance of Autonomous Weapons*, 428.

44. Sharkey, "Killing Made Easy," 118; Wallach, *Terminating the Terminator*; HRW and IHRC, "Advancing the Debate," 5; Anderson and Waxman, "Law and Ethics," 10; Heyns, Report of the Special Rapporteur, para. 67; and HRW and IHRC, *Losing Humanity*, 31.

45. Guarini and Bello, "Robotic Warfare," 130; Sharkey, "Killing Made Easy," 118; Thurnher, *The Law That Applies*; Heyns, Report of the Special Rapporteur, para. 68; and ICRC, *Expert Meeting on "Autonomous Weapon Systems,"* 2.

46. Guarini and Bello, "Robotic Warfare,"131–32; Sharkey, "Killing Made Easy," 116–18; HRW and IHRC, "Advancing the Debate," 5, 11; HRW and IHRC, *Shaking the Foundations*, 13; and Heyns, Report of the Special Rapporteur, para. 67–68.

47. Wallach, *Ensuring Human Control*; Guarini and Bello, "Robotic Warfare," 148; Johnson, Meyers, Richards, et al., *Unmanned Effects*, 10; Schmitt and Thurnher, "Out of the Loop," 240, 262, 264–65; Thurnher, "No One at the Controls," 80–81; and Heyns, Report of the Special Rapporteur, para. 54, 69.

48. Defense Science Board, *The Role of Autonomy in DOD Systems*, 62–64.

49. Anthony and Holland, *The Governance of Autonomous Weapons*, 428; Thurnher, *The Law That Applies*; and Heyns, Report of the Special Rapporteur, para. 70.

50. Sharkey, "Killing Made Easy," 123–24; Wallach, *Terminating the Terminator;* HRW and IHRC, "Advancing the Debate," 6; HRW and IHRC, *Shaking the Foundations*, 16; Marra and McNeil, "Understanding 'The Loop,' " 60–62; Anderson and Waxman, "Law and Ethics," 10; HRW and IHRC, *Losing Humanity*, 31; and Schmitt and Thurnher, "Out of the Loop," 254, 256–57; Thurnher, *The Law That Applies*.

51. Schmitt and Thurnher, "Out of the Loop," 256; and Thurnher, "No One at the Controls," 82–83.

52. HRW and IHRC, "Advancing the Debate," 6; and Thurnher, *The Law That Applies;* Schmitt and Thurnher, "Out of the Loop," 256; and Thurnher, "No One at the Controls," 82–83.

53. Consider, for example, a cruise missile, which may take several hours to strike with no recall capability. See also Scharre and Horowitz, *An Introduction to Autonomy*, 10; and Schmitt and Thurnher, "Out of the Loop," 255.

54. Peter M. Asaro, "A Body to Kick, but Still No Soul to Damn: Legal Perspectives on Robotics," in *Robotic Ethics*, 171, http://www.peterasaro.org/writing/Asaro%20Body%20to%20Kick.pdf; Sharkey, "Killing Made Easy," 124; HRW and IHRC, "Advancing the Debate," 13; HRW and IHRC, *Shaking the Foundations*, 19; Heyns, Report of the Special Rapporteur, para. 78; and HRW and IHRC, *Mind the Gap*, 19–20.

55. Sharkey, "Killing Made Easy," 116–17; Wallach, *Terminating the Terminator*; HRW and IHRC, *Shaking the Foundations*, 19–22; HRW and IHRC, "Advancing the Debate," 13; UNOG, *Informal Meeting of Experts on LAWS*, 14; Heyns, Report of the Special Rapporteur, para. 76; and HRW and IHRC, *Mind the Gap*, 18–37.

56. Guarini and Bello, "Robotic Warfare," 151–52; HRW and IHRC, *Shaking the Foundations*, 19–20; Schmitt and Thurnher, "Out of the Loop," 278; Heyns, Report of the Special Rapporteur, para. 78; and Patrick Lin, George Bekey, and Keith Abney, *Autonomous Military Robotics: Risk, Ethics, and Design*, US Department of the Navy, award #N00014-09-1-1152, N00014-08-1-1209, 20 December 2008, 66, http://ethics.calpoly.edu/ONR_report.pdf (arguing responsibility adheres to the initiator of the autonomous systems' actions).

57. Sharkey, "Killing Made Easy," 117; HRW and IHRC, "Advancing the Debate," 12–13; HRW and IHRC, *Shaking the Foundations*, 19; HRW and IHRC, *Mind the Gap*, 18–37; and UNOG, *Informal Meeting of Experts on LAWS*, 14.

58. Schmitt, "Autonomous Weapon Systems," 13.

59. HRW and IHRC, *Mind the Gap*, 13; Guarini and Bello, "Robotic Warfare," 149–50; and Anderson and Waxman, "Law and Ethics," 12.

60. Asaro, "A Body to Kick," 177.

61. Anderson and Waxman, "Law and Ethics for Robot Soldiers," 17.

62. Sharkey, "Killing Made Easy," 116; Wallach, *Terminating the Terminator*; HRW and IHRC, "Advancing the Debate," 21; HRW and IHRC, *Shaking the Foundations*, 23–24; UNOG, *Informal Meeting of Experts on LAWS*, 17; Anderson and Waxman, "Law and Ethics," 11; Ray Acheson, *The Unbearable Meaninglessness of Autonomous Violence*, Campaign to Stop Killer Robots, CCW Report, 16 April 2015; and Heyns, Report of the Special Rapporteur, para. 89–97.

63. Universal Declaration of Human Rights, preamble, para. 1; HRW and IHRC, *Shaking the Foundations*, 23–24; and Heyns, Report of the Special Rapporteur, para. 89–97.

64. Rob Sparrow, "Can Machines Be People? Reflections on the Turing Triage Test," in *Robotic Ethics*, 306, http://arteca.mit.edu/book/robot-ethics.

65. Guarini and Bello, "Robotic Warfare," in *Robotic Ethics*, 152, http://arteca.mit.edu/book/robot-ethics; Defense Science Board, *The Role of Autonomy*, 48; Kanwar, "Post-Human Humanitarian Law," 5; and UNOG, *Informal Meeting of Experts on LAWS*, 9, 20.

66. *See the* "Potential Improvements in Ethical Warfare" section of this article.

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