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Sleepwalking Into a Brave New World: The Implications of Lethal Autonomous Weapon Systems

Major Daniel E. Hogan

JCSP 47

Master of Defence Studies

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SLEEPWALKING INTO A BRAVE NEW WORLD: THE IMPLICATIONS OF LETHAL AUTONOMOUS WEAPON SYSTEMS

By Major D.E. Hogan

TABLE OF CONTENTS

Table of Contents i

List of Figures ii

List of Tables iii

List of Abbreviations iv

Abstract viii

Chapter

1. Introduction 1

2. Defining Lethal Autonomous Weapons Systems (LAWS) 7

3. Military/Political Implications of LAWS 24

4. Legal Implications of LAWS 47

5. Ethical Implications of LAWS 70

6. International Discussions on LAWS 84

7. Conclusion 94

Appendix 1: Policy Recommendations 96

Appendix 2: Precursor Technologies, Demonstrators and LAWS Currently In Service 101

Glossary of Terms 118

Bibliography 120

LIST OF FIGURES

Figure 2.0: Diagram of the OODA Loop 12

Figure 2.1: Deep Learning as a Subset of Machine Learning and Artificial Intelligence 18

Figure 2.2: Deep Neural Network 19

Figure 5.0: Major Components of an Ethical Autonomous Robot Architecture 74

Figure A2.1: The Phalanx CIWS 102

Figure A2.2: The Super aEgis II 108

Figure A2.3: The X-47B 109

Figure A2.4: The Taranis 110

Figure A2.5: The *Sea Hunter* 111

Figure A2.6: The THeMIS Combat UGV with Protector RWS 113

Figure A2.7: The Type X RGV 113

Figure A2.8: The Harpy 114

LIST OF TABLES

Table 2.0: 10 Levels of Automation of Decision and Action Selection 11

LIST OF ABBREVIATIONS

AGI - Artificial General Intelligence

AI - Artificial Intelligence

AO - Area of Operations

APL - Anti-Personnel Landmines

AWS - Autonomous Weapon System

BDA - Battle Damage Assessment

BLW - Blinding Laser Weapons

C2 - Command and Control

CA - Canadian Army

CAF - Canadian Armed Forces

CCW - Convention on Certain Conventional Weapons

CDE - Collateral Damage Estimation

CID - Combat Identification

CIWS - Close-In Weapon System

CM - Cluster Munitions

C-RAM - Counter Rocket, Artillery and Mortar

CSKR - Campaign to Stop Killer Robots

DARPA - Defense Advanced Projects Agency

DL - Deep Learning

DMZ - Demilitarized Zone

DND - Department of National Defence

DRP - Directed Research Project

EMS - Electromagnetic Spectrum

FAW - Fully Autonomous Weapon

FCS - Future Combat System

GAC - Global Affairs Canada

GoC - Government of Canada

GGE - Group of Governmental Experts

GPS - Global Positioning System

HITL - Human-In-The-Loop

HOTL - Human-On-The-Loop

HOOTL - Human-Out-Of-The-Loop

HRW - Human Rights Watch

HSTL - Human-Starts-The-Loop

ICRAC - International Committee for Robot Arms Control

ICRC - International Committee of the Red Cross

ICJ - International Court of Justice

IDF - Israel Defense Forces

IEEE - Institute of Electrical and Electronic Engineers

IHL - International Humanitarian Law

IO - Intergovernmental Organization

IOT&E - Initial Operational Test and Evaluation

JTAC - Joint Terminal Attack Controller

LARs - Lethal Autonomous Robotics

LAWS - Lethal Autonomous Weapons System

LOAC - Law of Armed Conflict

LOCAAS - Low Cost Autonomous Attack System

MFA - Minister of Foreign Affairs

ML - Machine Learning

NATO - North Atlantic Treaty Organization

NGOs - Non-Governmental Organizations

NORAD - North American Aerospace Defense Command

NWPT - Nuclear Weapons Prohibition Treaty

OODA - Observe, Orient, Decide, and Act

P5 - Five Permanent Members of the United Nations Security Council

PGM - Precision-Guided Munition

PM - Prime Minister

RCAF - Royal Canadian Air Force

RCN - Royal Canadian Navy

R&D - Research and Development

RMA - Revolution in Military Affairs

ROE - Rules of Engagement

RPAS - Remotely Piloted Aircraft System

RWS - Remote Weapon Station

T&E - Test and Evaluation

TTPs - Tactics, Techniques, and Procedures

UAV - Unmanned Aerial Vehicle

UCAV - Unmanned Combat Aerial Vehicle

UGV - Unmanned Ground Vehicle

UK - United Kingdom

UMS - Unmanned Systems

UN - United Nations

UNGA - United Nations General Assembly

UNIDIR - United Nations Institute for Disarmament Research

UNSC - United Nations Security Council

US - United States

USAF - United States Air Force

US DoD - United States Department of Defense

US DoJ - United States Department of Justice

US DoS - United States Department of State

USMC - United States Marine Corps

USV - Unmanned Surface Vehicle

UUV - Unmanned Underwater Vehicle

V&V - Verification and Validation

WMD - Weapons of Mass Destruction

ABSTRACT

In the future, lethal autonomous weapon systems (LAWS) will carry out combat operations, transforming the battlefield into a site of cold, technological predation where humans are lethally targeted by machines. The slow march to this brave new world, wherein life-and-death decisions are ceded to LAWS, has already begun. Research and development (R&D) into LAWS continues today unabated, demonstrator platforms are being tested, and precursor LAWS are already in service. Over the last decade, a great debate on LAWS has erupted, pitting its proponents against its opponents and generating a rich discourse on this issue. A lack of consensus and leadership has served to stall international, state-level discussions on regulating LAWS. The world - oblivious and moving forward as if sleepwalking - seems locked on an inevitable path that leads straight towards the development, production and use of LAWS. Can this slow march be arrested? And what are the implications of the employment of LAWS?

By reviewing the discourse, this directed research project (DRP) will examine the potential military/political, legal and ethical implications of employing LAWS. After establishing a common start-state concerning LAWS-related definitions and concepts, this DRP will examine the military/political implications of employing LAWS, detailing potential benefits and risks. Next, this DRP will examine the legal implications of employing LAWS by outlining how they may or may not comply with the Law of Armed Conflict (LOAC)/International Humanitarian Law (IHL). Then, this DRP will examine whether the employment of LAWS is ethical by using both consequentialist and deontological ethical approaches. After this, this DRP will then review the current status of state-level LAWS discussions and outline which states may be able to lead on this global issue. Lastly, this DRP will make policy recommendations concerning LAWS for the Government of Canada (GoC) and international community.

CHAPTER 1: INTRODUCTION

INTRODUCTORY COMMENTS

> **First Law**:
> A robot may not injure a human being or, through inaction, allow a human being to come to harm.
> **Second Law**:
> A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
> **Third Law**:
> A robot must protect its own existence, as long as such protection does not conflict with the First or Second Law.
>
> - Isaac Asimov, The Laws of Robotics[1]

In his 1942 short story *Runaround*, American science fiction author, Isaac Asimov outlined his Three Laws of Robotics, which were a hierarchical set of rules meant to ethically and physically govern the robots of his stories.[2] Programmed into their "positronic brains," the Three Laws controlled the behavior and reasoning of these robots, protecting the humans who they were built to serve.[3] The elegance, simplicity and prescience of Asimov's Laws are hard to deny. They have their own intuitive logic. The idea that humanity could one day design machines capable of deciding to harm humans does seem manifestly wrong. Yet, that is exactly what is happening today with the development of lethal autonomous weapon systems (LAWS).

But what are LAWS? The most cited definition comes from the United States (US) Department of Defense Directive (DoDD) No. 3000.09, which defines LAWS as "[a] weapon system that, once activated, can select and engage targets without further intervention by a

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[1] Isaac Asimov, "Runaround," in *I, Robot* (New York, NY, USA: Bantam Dell, 2008), 37.
[2] *Ibid*.
[3] Paul Scharre, *Army of None: Autonomous Weapons and the Future of War* (New York, USA: W.W. Norton & Company, 2019), 26.

human operator."[4] Terms like "lethal autonomous robots [LARs]"[5] and "killer robots"[6] have also been previously used to describe LAWS. Despite the fact that weaponized military robots such as armed unmanned aerial vehicles (UAVs) are now a reality and have been used in recent armed conflicts in Iraq, Afghanistan, Syria and Libya, few in-service weapons today actually fall under this definition of LAWS.[7] This is the case because armed UAVs require direct human involvement to operate and apply lethal force. However, advances in artificial intelligence (AI) in the last decade have increased the possibility that LAWS could soon emerge and be deployed in nearly every warfighting domain, dramatically changing how future wars are waged. In a letter released on 28 July 2015, more than 1,000 AI/robotics researchers and 15,000 other endorsers called for a global ban on LAWS, noting that:

> AI technology has reached a point where the deployment of such systems [LAWS] is - practically if not legally - feasible within years, not decades, and the stakes are high: autonomous weapons have been described as the third revolution in warfare, after gunpowder and nuclear arms.[8]

Others, like former Chief Scientist of the US Air Force (USAF), Werner J.A. Dahm, believe that the technology behind LAWS already exists and that: "fully autonomous military strikes - from a purely technical perspective, it has been possible for some time to conduct them."[9] Irrespective of timeline, other commentators have concluded that the improved performance and capabilities

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[4] United States of America (USA), Department of Defense (DoD), *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09*, Washington, DC, USA: 12 November 2012, 13, https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodd/300009p.pdf.

[5] Christof Heyns, "Annual Report of the Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions: Lethal Autonomous Robotics and the Protection of Life," *United Nations Human Rights Council*, Report: A/HRC/23/47, New York, NY, USA: 9 April 2013, 5, http://www.icla.up.ac.za/images/un/hrc/Thematic%20report%20-%20LARs%20A-HRC-23-47_en.pdf.

[6] Armin Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons* (Surrey, UK: Ashgate Publishing Limited, 2009), 1.

[7] Jeffrey S. Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting," *Joint Force Quarterly* no. 67 (2012): 78, https://search-proquest-com.cfc.idm.oclc.org/docview/1271860635. From 2000-2010, the number of US UAVs increased in spectacular fashion from fewer than 50 to over 7,000.

[8] Future of Life Institute (FLI), "Autonomous Weapons: An Open Letter from AI and Robotics Researchers," Letter, 28 July 2015, last accessed 21 March 2021, https://futureoflife.org/open-letter-autonomous-weapons.

[9] Werner J.A. Dahm, "Killer Drones are Science Fiction," *The Wall Street Journal (Eastern Edition)*, 15 February 2012, https://search-proquest-com.cfc.idm.oclc.org/docview/921411133.

offered by armed UAVs mean that: "the development of [L]AWS is more or less inevitable."[10] Besides this, some of the world's largest defence manufacturers and militaries are investing heavily in LAWS research and development (R&D) and precursor technologies.[11] As Ronald Arkin has suggested: "the trend is clear: warfare will continue and autonomous robots will ultimately be deployed in its conduct."[12]

For now, though, the development of LAWS will likely continue to proceed gradually, as militaries maintain human involvement in lethal force decisions. However, as the battlefield becomes more complex and fast-moving, maintaining a human-in-the-loop may actually be seen as detrimental and inhibiting timely action. When this happens, lesser forms of human control will become more acceptable and autonomy will be incrementally ceded to increasingly sophisticated weapon systems - leading directly to LAWS. In this way, as Noel Sharkey has suggested, "we are sleepwalking into a brave new world where robots decide who, where and when to kill" - and a world far removed from Asimov's Three Laws.[13]

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[10] Robert Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems," *Ethics & International Affairs* 30, no. 1 (2016): 95, https://search-proquest-com.cfc.idm.oclc.org/docview/1771700843. See also: Michael N. Schmitt and Jeffrey S. Thurnher, "'Out of the Loop': Autonomous Weapon Systems and the Law of Armed Conflict," *Harvard National Security Journal* 4, no. 2 (2013): 231, https://harvardnsj.org/wp-content/uploads/sites/13/2013/01/Vol-4-Schmitt-Thurnher.pdf.

[11] Matthew Rosenberg and John Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own," *New York Times* (Online), 25 October 2016, https://www.nytimes.com/2016/10/26/us/pentagon-artificial-intelligence-terminator.html?mcubz=1.

[12] Ronald C. Arkin, "Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberative/Reactive Robot Architecture Part I: Motivation and Philosophy," *Proceedings of the 3rd Association for Computing Machinery/Institute of Electrical and Electronics Engineers (ACM/IEEE) International Conference on Human Robot Interaction*, March 2008, 123, https://ieeexplore-ieee-org.cfc.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=6249424.

[13] Noel E. Sharkey, "Comment & Debate: Robot Wars are a Reality: Armies Want to Give the Power of Life and Death to Machines without Reason Or Conscience," *The Guardian (London),* 18 August 2007, 29, https://search-proquest-com.cfc.idm.oclc.org/docview/246677475.

PROBLEM STATEMENT - IMPLICATIONS OF CROSSING THE RUBICON

> Based on current evidence, it would seem to be a matter of when, rather than if, modern militaries cross the technological Rubicon and employ fully autonomous weaponized robots in battle.
>
> - Neil C. Renic, A Gardener's Vision: UAVs and the Dehumanisation of Violence[14]

With LAWS development assumed to be inevitable, there are two significant questions to answer. The first, as Neil Renic suggests, is when will militaries choose to deploy LAWS (and in doing so, cross the technological Rubicon)? Answering this question would require prophecy; thus, it is outside of the scope of this directed research project (DRP). The second, though, is answerable; namely, what are the potential military/political, legal and ethical implications of employing LAWS? This question will be the focus of this DRP. It is an important one to answer as LAWS will bring about a fundamental reordering of the places of humans and machines on the battlefield - moving machines to the front and humans to the rear.[15] Until now, using lethal force against a human has always been a human decision; with LAWS, though, that paradigm changes. Thus, the automation of warfare through applications like LAWS will fundamentally change how wars are waged and its implications must be explored.

LAWS has sparked a vociferous debate amongst their proponents and opponents ranging from academics, theorists, ethicists, non-governmental organization (NGO) members, military personnel, lawyers and arms-control experts. This debate and the significant attention it has generated has, in turn, spawned state-level discussions on LAWS within international fora. These discussions may lead to an international, legally-binding instrument which pre-emptively bans

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[14] Neil C. Renic, "A Gardener's Vision: UAVs and the Dehumanisation of Violence," *Survival: Global Politics and Strategy* 60, no. 6 (2018): 66, https://doi.org/10.1080/00396338.2018.1542794.
[15] Rosenberg and Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own."

LAWS, regulates their use, or they could lead nowhere. These discussions and the debate on LAWS, though, are important nonetheless. Far too often, legal and ethical discourse lags behind technological innovations and their transformative effects. With LAWS, there is now an opportunity to get ahead of this curve by engaging in dialogue and discourse. Thus, the purpose of this project will be to examine in detail the potential military/political, legal and ethical implications of employing LAWS. A subsidiary purpose of this project will be to also consider the GoC's policy on LAWS, highlighting potential opportunities available to it.

CHAPTER ORGANIZATION

In Chapter 2, this DRP will establish a common start-state by outlining LAWS definitions and concepts. In particular, LAWS and autonomy will be defined. In terms of LAWS-related concepts, levels of autonomy, the Observe, Orient, Decide, and Act Loop (OODA Loop), human-in-the-loop/human-on-the-loop/human-out-of-the-loop systems, AI, and machine learning (ML) will be reviewed. Next, the contexts - environments, types of targets and roles - in which LAWS will likely be first employed will be examined. Lastly, precursor LAWS technologies, demonstrators and examples of in-service LAWS will be briefly described in this chapter and explored in more detail in Appendix 2.

In Chapter 3, this DRP will examine the intellectual debate concerning LAWS. Next, the proponents and opponents of LAWS will be examined in addition to their motivations. Lastly, the potential benefits and risks of LAWS - which are largely military and political in nature - will be reviewed as well as the current trends that undergird them.

In Chapter 4, this project will outline the legal implications of employing LAWS relative to the Law of Armed Conflict (LOAC). The following legal concerns related to LAWS will be examined: the Martens Clause and Article 36 of the Additional Protocol I (AP1) of the Geneva

Conventions; the principles of distinction, proportionality, military necessity, humanity and unnecessary suffering; accountability and liability; the opacity of deep learning (DL) AI in LAWS; and predictability and reliability concerns related to LAWS performance.[16]

In Chapter 5, the ethical implications of LAWS will be examined, using both consequentialist and deontological ethical approaches. For the former, a results-based approach will be utilized to review the risks posed to civilians/non-combatants by the use of LAWS and whether these can be minimized through the use of an "ethical governor" for LAWS.[17] For the latter, a process-based approach will be used to examine concerns like: the delegation of life-and-death decisions to machines; the undermining of human dignity; and human distancing from the battlefield.

In Chapter 6, state-level discussions on LAWS at the UN Office of Geneva (UNOG) under the auspices of the Convention on Certain Conventional Weapons (CCW) will be examined. The origins of these discussions, their current status, and those nations taking leading roles will be outlined. The evolution of the GoC's policy on LAWS will be discussed. Potential ways forward on developing an international, legally-binding instrument to govern LAWS will be outlined.

In Chapter 7, a brief conclusion for this DRP will be provided. Lastly, in Appendix 1, the author will make a series of policy recommendations on LAWS for the GoC and international community.

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[16] Will Knight, "The Dark Secret at the Heart of AI." *Technology Review* (1998) 120, no. 3 (2017), 56, https://www.technologyreview.com/2017/04/11/5113/the-dark-secret-at-the-heart-of-ai/.

[17] Ronald C. Arkin, Patrick Ulam and Brittany Duncan, *An Ethical Governor for Constraining Lethal Action in an Autonomous System*, Technical Report GIT-GVU-09-02, Atlanta, USA: Georgia Institute of Technology - Mobile Robot Lab, 2009, https://apps.dtic.mil/dtic/tr/fulltext/u2/a493563.pdf.

CHAPTER 2: DEFINING LETHAL AUTONOMOUS WEAPONS SYSTEMS

INTRODUCTORY COMMENTS

In Chapter 2, this DRP will establish a common start-state by outlining LAWS definitions and concepts found in the discourse. In terms of definitions, LAWS and autonomy will be defined. In terms of concepts, levels of autonomy, the OODA Loop, human-in-the-loop/human-on-the-loop/human-out-of-the-loop systems, AI, and ML will be examined. Next, the contexts - environments, types of targets and roles - in which LAWS will likely be first employed will be examined. Lastly, precursor LAWS technologies, demonstrators and examples of in-service LAWS will be briefly described in this chapter.

DEFINING LAWS AND AUTONOMY

Currently, the term 'autonomous weapon systems' (AWS) lacks an internationally agreed-upon definition.[18] As well, the term 'autonomy' itself and its derivative terms of 'autonomous', 'automated', and 'automatic' are frequently confused and haphazardly used. Both facts have, unfortunately, hindered international discussions as consequential dialogue is not possible when participants are not using standardized terminology. Thus, this section will attempt to remedy these terminology deficiencies.

The US DoD, in its landmark DoDD 3000.09, has provided several definitions related to AWS based levels of autonomy and the human-machine command-and-control (C2) relationship.[19] These definitions are widely referenced:

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[18] Kelley M. Sayler, "Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems," *Congressional Research Service (CRS)*, CRS Report, Washington, DC, USA: 1 December 2020, https://fas.org/sgp/crs/natsec/IF11150.pdf.

[19] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09...*, 13-15.

> • **Semi-autonomous weapon system**: A weapon system that, once activated, is intended to only engage individual targets or specific target groups that have been selected by a human operator.
> • **Human-supervised autonomous weapon system**. An autonomous weapon system that is designed to provide human operators with the ability to intervene and terminate engagements, including in the event of a weapon system failure, before unacceptable levels of damage occur.
> • **Autonomous weapon system**. A weapon system that, once activated, can select and engage targets without further intervention by a human operator.[20]

CCW discussions have largely focused on LAWS rather than AWS in general. The distinction of adding the term 'lethal' to 'autonomous weapon system' is significant and has been deliberately made in said discussions because the lethal targeting of humans is the CCW's central concern vice the targeting of materiel for destruction by AWS. As a result, LAWS has become the dominant term used in the discourse. Lastly, this DoDD 3000.09 definition of AWS does closely mirror LAWS definitions used by Campaign to Stop Killer Robots (CSKR) and Human Rights Watch (HRW); however, these NGOs have chosen to emphasize the lack of "meaningful human control" over LAWS in their definitions.[21]

Within DoDD 3000.09's definition of AWS, the use of the phrase "can select and engage targets" is significant.[22] During the use of lethal force, there are various engagement-related tasks including: acquiring, tracking, identifying, cueing potential targets, aiming weapons, selecting specific targets, prioritizing targets, timing of when to fire, manoeuvring and engagement.[23] Not all of these tasks are created equal, as some are more significant in terms of the role of human control.[24] Besides DoDD 3000.09, the ability to select and engage targets independently has also

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[20] *Ibid*.
[21] Michael C. Horowitz, "Why Words Matter: The Real World Consequences of Defining Autonomous Weapons Systems," *Temple International and Comparative Law Journal* 30, no. 1 (2016): 86, https://heinonline.org/HOL/P?h=hein.journals/tclj30&i=93.
[22] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09...*, 13.
[23] Paul Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I," *Just Security*, Article, New York University School of Law, New York, NY, USA: (9 July 2014), https://www.justsecurity.org/12708/autonomy-killer-robots-human-control-force-part/.
[24] *Ibid*.

been cited by HRW and International Committee of the Red Cross (ICRC) as being worthy of special concern.[25] Also, engagement-related tasks have different levels of risk, as manoeuvring a LAWS poses less risk than an engagement does. Thus, the ability to independently select and engage targets is where discussions on LAWS and their autonomy have concentrated on.

Discussions on the autonomy of LAWS have also been challenged by the haphazard use of derivative terms like 'autonomous', 'automated', and 'automatic' and by the "still blurry" line that exists between them.[26] These terms are not interchangeable but refer to levels of autonomy. The term 'automatic' refers to simple machines and threshold-based systems that respond to environmental inputs such as trip wires and mines.[27] The term 'automated' refers to more complex, rule-based systems such as semi-autonomous UAVs that are capable of taking off and landing without a pilot. Automated systems lack decision-making capabilities and are not independent. Instead, automated systems simply replace what was once a manual process with an automated one. The term 'autonomous' is used to describe machines that are able to self-direct, self-learn, or engage in unpredictable emergent behaviour. Autonomous systems analyse a wide range of variables before selecting the optimum solution. Below, William Marra and Sonia McNeil outline the level to which a machine is automated or autonomous using three variables:

(1) The frequency of operator interaction that the machine requires to function;

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[25] Human Rights Watch (HRW) and the International Human Rights Clinic (IHRC), Harvard Law School, *Losing Humanity: The Case Against Killer Robots*, Report, (19 November 2012), 2, https://www.hrw.org/report/2012/11/19/losing-humanity/case-against-killer-robots; International Committee of the Red Cross (ICRC), "Report of the ICRC Expert Meeting on Autonomous Weapon Systems: Technical, Military, Legal and Humanitarian Aspects," Summary Report, Geneva, Switzerland: (26-28 March 2014), 5, https://www.icrc.org/en/doc/assets/files/2014/expert-meeting-autonomous-weapons-icrc-report-2014-05-09.pdf. In similar formulations, HRW has referred to "selecting targets and delivering force," while the ICRC has expressed it as "selecting and attacking targets without human intervention."

[26] Scharre, *Army of None: Autonomous Weapons and the Future of War*..., 32.

[27] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I."

> **(2)** The machine's ability to function successfully despite environmental uncertainty; and
> **(3)** The machine's level of assertiveness as to each one of the various operational decisions that allow the machine to complete its mission.[28]

For Marra and McNeil, a machine is autonomous if it requires limited operator interaction, is high adaptable and can operate in unfamiliar environments, and "achieves mission objectives with a high level of assertiveness."[29] Assertiveness and decision-making in completing the mission are particularly key to the idea of autonomy and its application to LAWS. As Kjølv Egeland has stated, "[a] weapon system is autonomous if its initiation and use of force - i.e. firing of a weapon - cannot reasonably be traced back to one or a small group of human beings."[30] Because LAWS utilizes AI to replicate human cognitive reasoning, the causal chain between the use of force and humans is broken, as they operate autonomously.

To understand autonomy, it is useful to review the ten-level spectrum of autonomy created by Raja Parasuraman, Thomas Sheridan, and Christopher Wickens depicted in Table 2.0.[31]

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[28] William C. Marra and Sonia K. McNeil, "Understanding "the Loop": Regulating the Next Generation of War Machines," *Harvard Journal of Law and Public Policy* 36, no. 3 (2013): 1151, https://search-proquest-com.cfc.idm.oclc.org/docview/1415163546.
[29] *Ibid*, 1152-1155.
[30] Kjølv Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law," *Nordic Journal of International Law = Acta Scandinavica Juris Gentium* 85, no. 2 (2016): 94-95, https://heinonline.org/HOL/P?h=hein.journals/nordic85&i=97.
[31] Raja Parasuraman, Thomas B. Sheridan, and Christopher D. Wickens, "A Model for Types and Levels of Human Interaction with Automation," *IEEE Transactions on Systems, Man and Cybernetics, Part A, Systems and Humans* 30, no. 3 (2000): 287, https://ieeexplore-ieee-org.cfc.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=844354.

LEVELS OF AUTOMATION OF DECISION AND ACTION SELECTION	
HIGH	10. The computer decides everything, acts autonomously, ignoring the human.
	9. informs the human only if it, the computer, decides to
	8. informs the human only if asked, or
	7. executes automatically, then necessarily informs the human, and
	6. allows the human a restricted time to veto before automatic execution, or
	5. executes that suggestion if the human approves, or
	4. suggests one alternative
	3. narrows the selection down to a few, or
	2. The computer offers a complete set of decision/action alternatives, or
LOW	1. The computer offers no assistance: human must take all decisions and actions.

Table 2.0: 10 Levels of Automation of Decision and Action Selection.
Source: R. Parasuraman, T.B. Sheridan, and C.D. Wickens, "A Model for Types and Levels of Human Interaction with Automation."[32]

A machine at Level 1 is automated, while a machine at Level 10 is fully autonomous. This spectrum does not provide a clear line that divides automated from autonomous systems. Note that between Levels 1 and 5, human decision-making is required for a machine to take action. At Level 6 and beyond, decision-making is conducted by the machine as it is autonomous and human involvement gradually diminishes.

The distinction between being automated and autonomous is crucial to understanding the debate on LAWS. Today, humans are still involved in the selection and engagement of targets for semi-autonomous weapon systems. However, the trend towards ever-diminishing human involvement is real, while the line between semi-autonomous and autonomous operation is incredibly thin.[33]

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[32] *Ibid*, 287.
[33] For example, if communication links between a semi-autonomous weapon system and its controlling station are disrupted due to enemy jamming while it is in enemy territory, a stark choice will have to be made. If the system is

THE OODA LOOP AND CATEGORIES OF LAWS

The amount of autonomy afforded to a weapon systems can vary significantly. As such, a categorization of autonomy has been developed in LAWS discourse using the four-step decision-making process: Observe, Orient, Decide, and Act or "OODA Loop."[34] With the OODA Loop, a person observes their environment and gathers data through their senses. Second, they orient themselves, or interpret the information they have gathered. Third, they weigh the potential courses of action using their accumulated knowledge and then decide how to act. Fourth and finally, they act, executing the decision that they have made. In warfare, the key to victory is to create situations wherein one can make more accurate and quicker decisions than one's enemy - or, put another way, to operate within their OODA Loop. Thus, time is the dominant factor when it comes to decision-making. The OODA Loop is depicted in Figure 2.0:

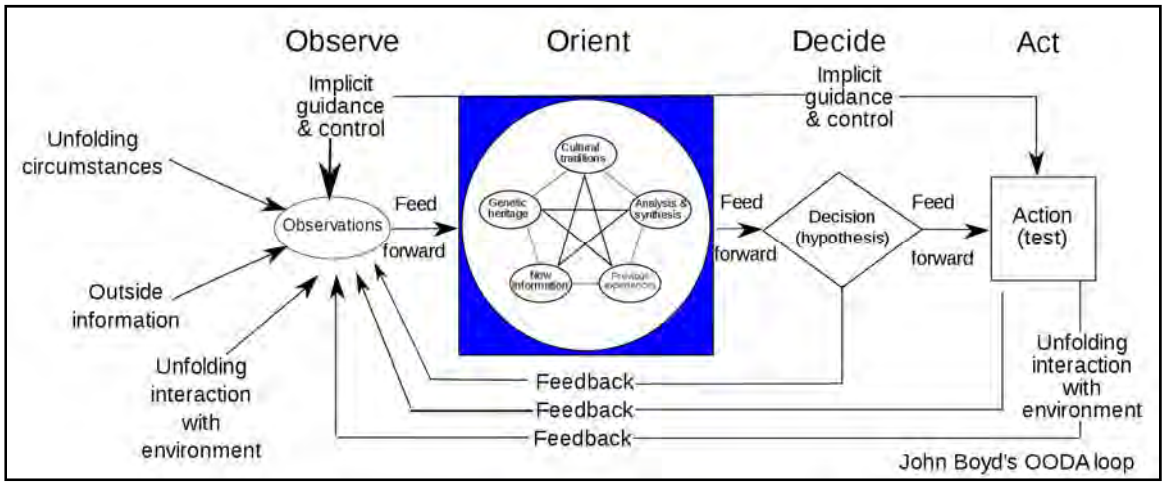

Figure 2.0: Diagram of the OODA Loop.
Source: Wikipedia, "OODA Loop."[35]

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approved to engage only pre-programmed targets selected by a human and failing this, it must return to base, it is recognized as being semi-autonomous. However, if the system is permitted to select and engage targets of opportunity or is approved to defend itself, then it is autonomous.

[34] Scott E. McIntosh, "The Wingman-Philosopher of MiG Alley: John Boyd and the OODA Loop," *Air Power History* 58, no. 4 (2011): 24-33, https://search-proquest-com.cfc.idm.oclc.org/docview/914457733. The OODA Loop was developed by USAF fighter pilot Colonel John Boyd through his observations of air combat between MiG-15s and F-86 Sabres during the Korean War.

[35] Wikipedia, "OODA Loop," last accessed 4 December 2020, https://en.wikipedia.org/wiki/OODA_loop.

The OODA Loop is still used today by militaries and has been applied to the fields of business, sports, engineering and robotics. Engineers and roboticists have applied the OODA Loop to demonstrate how machines operate, make decisions, and engage with their surrounding world.[36] As decision-making is so central to the LAWS debate concerning LAWS, the OODA Loop has become the dominant way to categorize them.

In their 2012 report entitled *Losing Humanity: The Case Against Killer Robots*, HRW and the International Human Rights Clinic (IHRC) used the OODA Loop to categorize LAWS into three main types:

> • **Human-in-the-loop weapons [HITL]**: Robots that can select targets and deliver force only with a human command;
> • **Human-on-the-loop weapons [HOTL]**: Robots that can select targets and deliver force under the oversight of a human operator who can override the robots' actions; and
> • **Human-off-of-the-loop weapons [HOOTL]**: Robots that are capable of selecting targets and delivering force without any human input or interaction.[37]

Based on the amount of human involvement in their actions, this categorization is meaningful. With each successive category, the OODA Loop is further compressed, as the weapon system is able to perceive the tactical situation and act independently with less human input, greatly shortening its decision time.

The first category, HITL, allows for the greatest amount of human supervision to the decision to kill. Here, the human is firmly embedded in the OODA Loop. Thus, although a HITL system may have some semi-autonomous capacities that allow it to execute a few tasks without human intervention, a human operator is still required to authorize an engagement and complete the decision cycle/"kill chain," which is defined by the USAF as: find, fix, track, target, engage

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[36] Marra and McNeil, "Understanding "the Loop": Regulating the Next Generation of War Machines"..., 1145.
[37] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots*..., 2.

and assess (F2T2EA).[38] With a HITL system, machines may analyze and present information to a human operator, who evaluates it and then authorizes the engagement. A HITL system provides the tightest human control but also offers the slowest response time, which may be problematic during time-critical engagements. The HITL system mirrors DoDD 3000.09's definition of a "semi-autonomous weapon system."[39]

With the second category, HOTL, a human monitors the autonomous operation of the weapon system and intervenes only when required; besides this infrequent intervention, the HOTL system is autonomous and does not require a human to operate it. The advantage of a HOTL system is that it allows for operation at machine speed in addition to human supervision. The issue with it is that a human may not be fast enough to analyze all of the system's actions during high-tempo operations and may act too late to effectively intervene. The HOTL system matches DoDD 3000.09's definition of a "human-supervised autonomous weapon system"; however, when human intervention is ineffective it can be viewed as functioning as a *de facto* "autonomous weapon system."[40]

The third category, HOOTL, involves a weapon system operating at its most autonomous level, as it is capable of selecting and engaging targets entirely on its own and based on specified parameters. After their activation, there is no further human intervention required in a HOOTL system; in fact, depending on operating conditions, intervention may be impossible. The HOOTL system is LAWS in its truest sense. Malfunction, fratricide and collateral damages are significant

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[38] John A. Tirpak, "Find, Fix, Track, Target, Engage, Assess," *Air Force Magazine* (Online), 1 July 2000, https://www.airforcemag.com/article/0700find/.
[39] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09...*, 13-15.
[40] *Ibid*.

risks posed by a HOOTL system. The HOOTL system tracks closely with DoDD 3000.09's definition of an "autonomous weapon system."[41]

For some LAWS proponents such as T.X. Hammes, the HOOTL category is "a bad definition."[42] For him, until "artificial intelligence gains the ability to design, build, program and position weapons," humans will still need to design autonomous systems, set engagement parameters through algorithms, activate them, and maintain and repair them.[43] In this way, Hammes prefers to refer to this third category as "human-starts-the-loop" (HSTL) because LAWS still require significant human input - it is merely front-end loaded.[44] For Hammes, the employment of HSTL systems are only necessary in operations wherein "humans simply can't keep up."[45] For operations wherein speed is not a key element, he concedes that "the only acceptable system remains human-in-the-loop."[46] However, as most operations could be construed as being time-critical in nature, it is hard to see how the use of HSTL systems or LAWS would not be abused by commanders claiming that speed is a requirement for mission success.

In describing current semi-autonomous weapon systems, Paul Scharre outlines three roles that human operators perform in relation to target selection and engagement. These roles are:

> 1. **The human as essential operator**: The weapon system cannot accurately and effectively complete engagements without the human operator.
> 2. **The human as moral agent**: The human operator makes value-based judgments about whether the use of force is appropriate. For example, the human operator decides whether the military necessity of destroying a particular target in a particular situation outweighs the potential collateral damage.

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[41] *Ibid*.
[42] T.X. Hammes, "Autonomous Weapons Are Coming, This is How We Get Them Right," *The National Interest*, 2 December 2018, https://nationalinterest.org/blog/buzz/autonomous-weapons-are-coming-how-we-get-them-right-37532. T.X. Hammes is a 30-year United States Marine Corps veteran and Distinguished Research Fellow at the US National Defence University.
[43] *Ibid*.
[44] *Ibid*.
[45] *Ibid*.
[46] *Ibid*.

> 3. **The human as fail-safe**: The human operator has the ability to intervene and alter or halt the weapon system's operation if the weapon begins to fail or if circumstances change such that the engagement is no longer appropriate.[47]

Applying these three roles to the aforementioned three categories is an instructive exercise to see the diminishing role of human control over these systems. With HITL systems, all three roles apply. With HOTL systems, only the human as fail-safe role applies. With HOOTL systems, none apply.

This discussion is also made more difficult by the fact that unmanned systems (UMS) are often designed to be able to operate as HITL, HOTL, and HOOTL systems, switching between each depending on operating conditions. This is significant but it should not unnecessarily derail discussion. What is key is whether or not the weapon system is operating autonomously when it selects and engages a target - those crucial fourth and fifth steps of the F2T2EA kill chain.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

For LAWS to operate as a HOOTL system, it must employ some form of AI to be able to select and engage targets. As Geoffrey S. Corn notes, LAWS are "weapons with the capacity to utilize AI to replicate human cognitive reasoning."[48] Thus, it is crucial to describe AI, its forms and the concepts that underpin it.

Put simply, AI involves the use of computing power - specifically, algorithms (set of rules) - to execute tasks that would typically require natural intelligence (E.g.: human) to complete.[49] As Michael Horowitz suggests, "AI...is best thought of as an umbrella technology or

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[47] Paul Scharre, "Centaur Warfighting: The False Choice of Humans Vs. Automation," *Temple International and Comparative Law Journal* 30, no. 1 (2016): 154, https://heinonline.org/HOL/P?h=hein.journals/tclj30&i=159.
[48] Geoffrey S. Corn, "Autonomous Weapon Systems: Managing the Inevitability of 'Taking the Man out of the Loop'," *Social Science Research Network (SSRN)*, Working Paper: (22 August 2014), last accessed 14 January 2021, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2450640.
[49] Michael C. Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability," *Journal of Strategic Studies* 42, no.6 (2019), 767, https://www-tandfonline-com.cfc.idm.oclc.org/doi/full/10.1080/01402390.2019.1621174.

enabler, like the combustion engine or electricity."[50] AI applications in both the civilian and military contexts are incredibly broad and expanding by the day. Military applications of AI include support to image recognition, supply management, automated cyber defence and LAWS. The earliest type of AI are rule-based, expert systems which perform tasks by following a series of algorithms programmed by humans that provide explicit instructions about how to act in a certain situation.[51] This type of AI is said to be "top-down" in nature.[52]

In the last decade, advances in computer processing power, data collection, and algorithm design have enabled significant progress in the development of a more flexible form of AI: machine learning (ML). With ML, a programmer does not write a pedantic list of rules to govern decision-making. Instead, the machine generates its own algorithms based on the data set it is given and a specified, desired output. Thus, the machine learns, develops a solution and "essentially programs itself."[53] ML is "bottom-up" in nature, as the machine learns much like a baby would - through trial and error and pattern recognition.[54]

A significant breakthrough occurred when the ML technique of "deep learning" (DL) was developed in 2012.[55] The relationship between AI, ML and DL is depicted in Figure 2.1.

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[50] *Ibid*.
[51] This rules-based type of AI is ubiquitous in society, supporting technologies such as airplane autopilots and tax-preparation software.
[52] Nathan J. Lucas, "Lethal Autonomous Weapons Systems: Issues for Congress," *Congressional Research Service (CRS)*, CRS Report, Washington, DC, USA: 14 April 2016, 17, https://crsreports.congress.gov/product/pdf/R/R44466/4.
[53] Knight, "The Dark Secret at the Heart of AI"..., 57.
[54] Lucas, "Lethal Autonomous Weapons Systems: Issues for Congress"..., 17.
[55] Paul Scharre, "Killer Apps: The Real Dangers of an AI Arms Race," *Foreign Affairs (New York, N.Y.)* 98, no. 3 (2019), 136, https://heinonline.org/HOL/P?h=hein.journals/fora98&i=557.

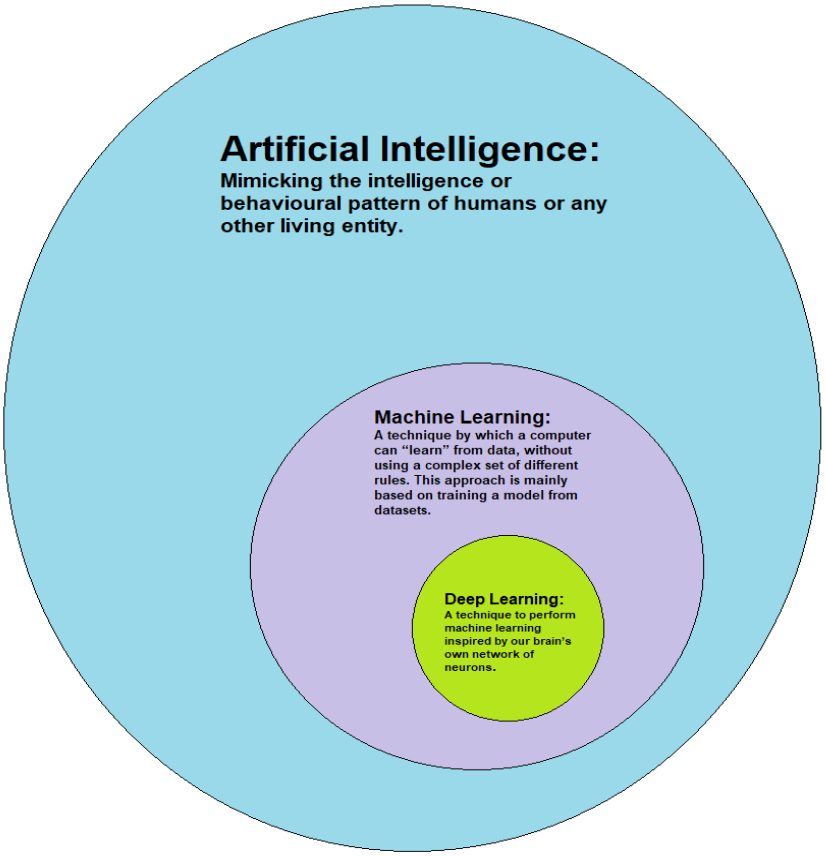

Figure 2.1: Deep Learning as a Subset of Machine Learning and Artificial Intelligence.
Source: Wikipedia, "Deep Learning."[56]

DL relies upon the use of deep neural networks, which are fashioned after biological neurons - cells which allow for communication between the brain and nervous system through the transmission of electrical impulses. Below, Scharre describes the functioning of an artificial neural network:

> An artificial neural network starts out as a blank slate; it doesn't know anything. The system learns by adjusting the strength of the connections between neurons, strengthening certain pathways for right answers and weakening the connections for wrong answers.[57]

[56] Wikipedia, "Deep Learning," last accessed 4 December 2020, https://en.wikipedia.org/wiki/Deep_learning.
[57] Scharre, "Killer Apps: The Real Dangers of an AI Arms Race"..., 136.

With a deep neural network, there are multiple layers of artificial neurons that exist between the output and input layers as depicted in Figure 2.2.[58]

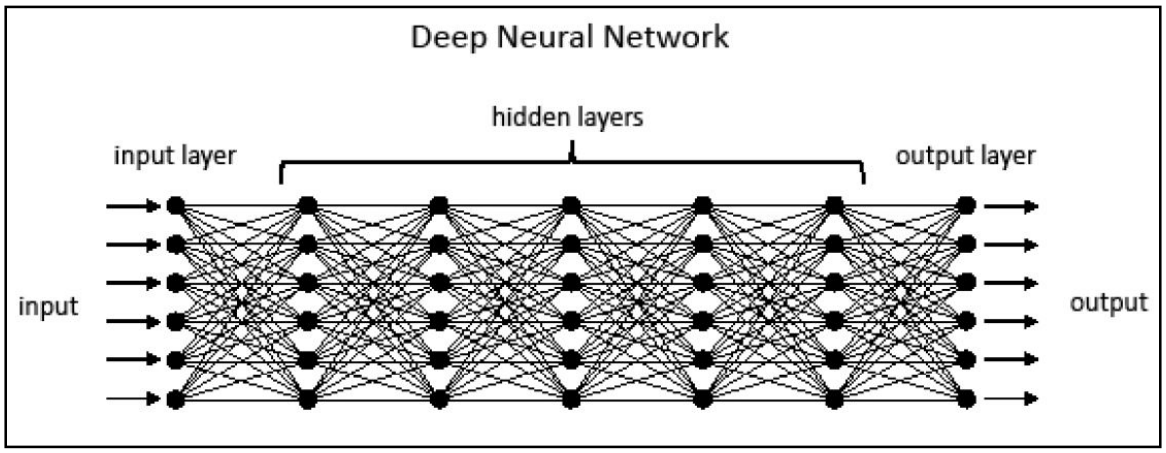

Figure 2.2: Deep Neural Network.
Source: Michael C. Horowitz and Paul Scharre, "Artificial Intelligence: What Every Policymaker Needs to Know."[59]

These extra layers allow for more variability in pathway strength; thus, a DL AI can better cope with complex information.[60] Since this 2012 breakthrough, DL AI has started to exceed best human performances and outstrip older, rules-based AI systems.[61] DL AI can now "tackle problems once thought too complex for computers" and may be able to provide the decision-making capacity for LAWS.[62]

The type of AI used in LAWS is significant. If it is top-down, it may be possible for designers to program C2 limitations to promote ethical and legal compliance or, at the very least, provide human operators with a kill switch to abort an unethical or illegal action.[63] As well, although the behavior of rules-based AI systems may not always be predictable, they are usually

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[58] Wikipedia, "Deep Learning."
[59] Michael C. Horowitz and Paul Scharre, "Artificial Intelligence: What Every Policymaker Needs to Know," *Center for a New American Security*, Report, Washington, DC, USA: (June 2018), 5, https://www.cnas.org/publications/reports/artificial-intelligence-what-every-policymaker-needs-to-know.
[60] Scharre, "Killer Apps: The Real Dangers of an AI Arms Race"..., 136.
[61] *Ibid*, 137. Deep learning AI has been created that, as Scharre notes, "can match or exceed the best human performance in recognizing faces, identifying objects, transcribing speech, and playing complex games, including the Chinese board game Go."
[62] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting"..., 79.
[63] Lucas, "Lethal Autonomous Weapons Systems: Issues for Congress"..., 17.

explainable because an observed behaviour can typically be traced down to a specific algorithm or interaction of algorithms during an after-the-fact examination.[64] Alternatively, if the AI for LAWS is bottom-up, it will be more difficult to ensure ethical and legal compliance and incorporate an override function. It will also be difficult to explain after-the-fact the causes of errant behavior in DL AI because their trained deep neural networks are complex and their internal parameters are often opaque. Although powerful results can be achieved using DL AI, the underlying science to explain its behaviour and learned logic is lacking. Thus, employing a bottom-up AI in LAWS comes with risk.

For all the potential that DL AI has, all types of current AI are "narrow" or weak as their learned expertise tends to be confined to a single domain.[65] Current AI is unable to engage in the same general-purpose reasoning used by humans to complete varied tasks such as writing a note, drinking a glass of water and receiving a phone call over the span of 5 minutes. This type of AI - referred to as artificial general intelligence (AGI) or strong AI - is very much hypothetical and still science fiction. AI experts disagree widely on when AGI will be created; some suggest it could be achieved in the next decade while others contend that it will never happen.[66] John McGinnis believes that AGI is "plausible" and that it will be a pre-requisite for the development of LAWS.[67] For Armin Krishnan, AGI is "the Holy Grail in AI research: highly desirable, but still unattainable."[68] Whether AGI can actually be developed is "still very much disputed."[69]

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[64] Horowitz and Scharre, "Artificial Intelligence: What Every Policymaker Needs to Know"..., 4.
[65] Scharre, *Army of None: Autonomous Weapons and the Future of War*..., 95-99.
[66] *Ibid*, 232.
[67] John O. McGinnis, "Accelerating AI." *Northwestern University Law Review* 104, no. 3 (Summer 2010): 1253-1255, https://search-proquest-com.cfc.idm.oclc.org/docview/840560052. John McGinnis is a Northwestern University law professor. He argues that "AI-driven robots on the battlefield may actually lead to less destruction, becoming a civilizing force in wars as well as an aid to civilization in its fight against terrorism."
[68] Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons*..., 48.
[69] *Ibid*.

CONTEXT IN WHICH LAWS MAY BE USED

It has been suggested that LAWS may be better suited to operate - at least, initially - in certain contexts like uncluttered environments, against anti-materiel targets and/or only used in a defensive role. Restricting LAWS in this fashion would enable weak AI to be used. It would also limit the potential for collateral damage.

Firstly, uncluttered environments such as underwater, on the high seas, at high altitude or in remote areas tend to be locations that are uniform and change slowly. Civilians are unlikely to be present in them. Thus, a LAWS using weak AI could be reasonably expected to perform better in terms of target discrimination in an uncluttered environment than in a densely-populated, urban one.

Secondly, AWS could be limited to anti-materiel targets, engaging only non-human, inanimate objects. Such restrictions would reduce the potential for collateral damage. However, it would not totally eliminate it as humans may be undetected in the target area, be within the range of AWS weapon effects, or their physiological needs may be compromised if the target is key infrastructure.

Thirdly, the use of LAWS in a defensive role is far more palatable to most than it being used in a offensive role. In fact, as Appendix 2 outlines, some of the oldest military applications of precursor LAWS platforms have been those designed for the defensive role. These systems tend to be stationary and used to fire at inanimate objects like missiles and mortars. They execute pre-programmed actions within established parameters in environments that are controlled, functioning with limited real-time human control as HOTL systems.[70] Systems like these include the Phalanx Close-in Weapon System (CIWS) which is able to autonomously engage multiple,

[70] Jürgen Altmann and Frank Sauer, "Autonomous Weapon Systems and Strategic Stability," *Survival: Global Politics and Strategy* 59, no. 5 (2017): 118, https://doi-org.cfc.idm.oclc.org/10.1080/00396338.2017.1375263.

fast-moving inbound missiles. The fact that systems like the Phalanx CIWS have been in service for over three decades without generating notable public concern does suggest some acceptance of them.[71] In fact, offensive LAWS - not defensive LAWS - has been the primary focus of LAWS opponents.

LAWS will likely continue to be deployed in uncluttered environments, against anti-materiel targets and/or only used in a defensive role. The question remaining is will they be used in other contexts? Throughout history, numerous technologies have been developed to solve a particular set of problems but were later employed in ways not originally envisaged by their designers. For LAWS, it has been suggested that they may be initially deployed in aforementioned limited contexts but will likely migrate into more complex ones that they were not tested for, as confidence in the technology improves.[72] Also, there is always the potential that unarmed autonomous platforms - which may be used for reconnaissance or surveillance tasks - could later be armed.[73] The MQ-1 Predator UAV is a recent example of a unarmed surveillance platform that was later and hastily armed with AGM-114 Hellfire missiles.[74]

PRECURSOR TECHNOLOGIES, DEMONSTRATORS AND LAWS CURRENTLY IN SERVICE

Tied to definitional disputes on what exactly constitutes a LAWS, there is a related dispute in the discourse concerning whether LAWS presently exist or not. This dispute largely

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[71] United Nations, Institute for Disarmament Research (UNIDIR), "The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values," *UNIDIR Resources*. No. 3. n.p., 2015, 20, https://www.files.ethz.ch/isn/190017/considering-ethics-and-social-values-en-624.pdf.

[72] United Nations, Institute for Disarmament Research (UNIDIR), "Framing Discussions on the Weaponization of Increasingly Autonomous Technologies," *UNIDIR Resources*. No. 1. n.p., 2014, 8, https://unidir.org/files/publications/pdfs/framing-discussions-on-the-weaponization-of-increasingly-autonomous-technologies-en-606.pdf.

[73] *Ibid*.

[74] Wikipedia, "General Atomics MQ-1 Predator," last accessed 15 February 2021. https://en.wikipedia.org/wiki/General_Atomics_MQ-1_Predator. In the immediate aftermath of 9/11, it was hastily deployed to Afghanistan by the USAF and its first armed mission occurred on 7 October 2001, just 8 months after its first armed test and 6 years after its initial fielding.

exists because, as Egeland has suggested, "[t]he increasing automation of weapons and weapon platforms provides a large grey area."[75] Within this grey area, some LAWS proponents such as Arkin and Hammes contend that LAWS exist and have been in service for decades.[76] Most commentators involved in the LAWS debate such as HRW, do believe that LAWS "do not yet exist, but [that] technology is moving in the direction of their development and precursors are already in use."[77] Scharre has offered an intermediate argument, as he contends that LAWS "generally do not exist today with two exceptions: the Harpy and the PMK-2 encapsulated torpedo mine."[78] In Appendix 2, precursor technologies for LAWS, demonstrators and the two examples of LAWS highlighted by Scharre are examined in detail. In Appendix 2, what is clear is that LAWS: are close to becoming a reality and being developed for use in every major warfighting domain; accidents involving precursor LAWS technology have occurred and are indicative of the types of accidents to be expected with LAWS; and demonstrators are frequently not armed during testing, allowing nations to skirt LOAC requirements.

CONCLUDING REMARKS

In conclusion, Chapter 2 has established a common start-state for the reader, as it has outlined LAWS definitions and concepts: automation, autonomy, the OODA Loop, HITL/HOTL/HOOTL/HSTL, AI, ML and DL. In addition, this chapter has examined the contexts in which LAWS will likely be used first. Lastly, this chapter - in tandem with Appendix 2 - has examined precursor LAWS technologies, demonstrators and two examples of in-service LAWS platforms.

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[75] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law"..., 93.
[76] Ronald C. Arkin, "Ethics and Autonomous Systems: Perils and Promises [Point of View]," *Proceedings of the IEEE* 104, no. 10 (2016): 1780. https://ieeexplore-ieee-org.cfc.idm.oclc.org/document/7571204; T.X. Hammes, "Autonomous Weapons Are Coming, This is How We Get Them Right."
[77] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots*..., 3.
[78] Paul Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part II," *Just Security*, Article, New York University School of Law, New York, NY, USA: (9 July 2014), https://www.justsecurity.org/12712/autonomy-killer-robots-human-control-force-part-ii/.

CHAPTER 3: MILITARY/POLITICAL IMPLICATIONS OF LAWS

INTRODUCTORY COMMENTS

In Chapter 3, LAWS proponents and opponents will be examined. This chapter will explore the great debate that both camps are currently engaged in, by detailing the arguments that are frequently levelled in favour of and against LAWS: namely, their potential benefits and risks. These benefits and risks are largely military/political in nature and they are indicative of and, in some cases, a response to certain trends currently confronting modern militaries.

PROPONENTS AND OPPONENTS OF LAWS AND THE GREAT DEBATE

The Great Debate

Over the last decade, an intensifying debate on LAWS has developed between two opposing camps: the opponent pro-ban movement and a coalition of proponents actively engaged in LAWS R&D. This debate on LAWS has been hampered, at times, by heated rhetoric and an inability to agree on foundational LAWS definitions. Because political motivations drive both sides, a value-neutral discussion on the facts related to LAWS has proven to be elusive while regulatory efforts in international fora have been stalled. When one strips away the rhetoric and the definitional disputes, the core issue animating and dividing both sides becomes clear: namely, should lethal force decisions be ceded to LAWS.

Whether they admit it or not, both proponents and opponents are engaged in a not-so-subtle battle to win over public opinion, as they know the decisive impact that it could have for the future of LAWS. For example, public revulsion of LAWS could halt public funding of its R&D immediately. Nowhere is this fight more evident than in the use of or avoidance of popular science fiction in order to frame the LAWS debate for the public. For example, LAWS opponents have frequently pointed to the popular *Terminator* and *Matrix* film series to describe

LAWS and a horrific future that awaits humanity if its R&D continues. Realizing its potency, proponents have assiduously avoided referring to science fiction and derided its damaging framing of this issue.[79]

LAWS Proponents

LAWS proponents primarily consist of the world's leading nations in its R&D: specifically, Russia, US, United Kingdom (UK), China, South Korea and Israel. These nations are closely supported by defence manufacturers and a myriad of aligned academics, scientists, military personnel, and lawyers, who provide expertise on the military potential, legal compliance and ethical concerns related to LAWS. Proponent nations and their supporters oppose calls to ban LAWS, arguing that they will be premature, undesirable and ineffective.[80] Firstly, they contend that it would be premature to ban LAWS because, in their view, true LAWS have not yet been fielded.[81] Secondly, they argue that a ban would be undesirable because LAWS could make warfare more humane and lawful.[82] Thirdly, they argue that a LAWS ban would be ineffective because: autonomous technology is dual-use and civilian applications will continue to be developed; LAWS fielding is inevitable; peer/near-peer adversaries will continue to develop LAWS, putting those that shun it at a military disadvantage; and a ban will be unenforceable.[83] Besides their stance against a LAWS ban, proponent nations have also slowed efforts to establish a regulatory framework to govern LAWS. Proponent nations are keen not to

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[79] Rosenberg and Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own." The US Deputy Secretary of Defense from 2014-17, Robert O. Work has said: "There's so much fear out there about killer robots and Skynet [the murderous AI network of the *Terminator* movies]. That's not the way we [the Pentagon] envision it at all."

[80] Kenneth Anderson and Matthew Waxman, "Law and Ethics for Robot Soldiers," *Policy Review (Washington, D.C.)* 176, no. 4 (Dec 2012): 36, https://search-proquest-com.cfc.idm.oclc.org/docview/1239260811.

[81] Schmitt and Thurnher, "'Out of the Loop': Autonomous Weapon Systems and the Law of Armed Conflict"..., 231 and 234.

[82] *Ibid*, 234.

[83] Hammes, "Autonomous Weapons Are Coming, This is How We Get Them Right."; Anderson and Waxman, "Law and Ethics for Robot Soldiers"..., 40 and 48.

outlaw precursor LAWS that are currently in service due to the investment that they have made, the capabilities that they provide, and because public concern is minimal. Lastly, proponent nations tend to issue ambiguous policy statements concerning LAWS, providing them with policy flexibility and allowing LAWS R&D to carry on unabated.

To better understand LAWS proponent nations and their motivations, an examination of the US and its policy on LAWS does provide some useful insight. In terms of US policy, DoDD 3000.09 was released on 21 November 2012.[84] DoDD 3000.09 defines semi-autonomous, human-supervised and autonomous (E.g.: LAWS) weapon systems in basic terms, drawing technical distinctions between them. It also outlines the formal DoD procedure for the development, review, and use of these weapon systems. DoDD 3000.09 does explicitly delimit LAWS by stating that it may only "be used to apply non-lethal, non-kinetic force, such as some forms of electronic attack, against materiel targets."[85] As well, DoDD 3000.09 does require that all three types of weapon systems be designed to "allow commanders and operators to exercise appropriate levels of human judgment over the use of force."[86] As commentators have noted, what constitutes 'appropriate' is amorphous and "unclear."[87] In August 2018, an American working paper that was submitted to the Group of Governmental Experts (GGE) of the CCW did attempt to clarify the intent behind this phrase, noting:

> 'Appropriate' is a flexible term that reflects the fact that there is not a fixed, one-size-fits-all level of human judgment that should be applied to every context. What is 'appropriate' can differ across weapon systems, domains of warfare, types of warfare, operational contexts, and even across different functions in a weapon system. Some functions might be better performed by a computer than a human being, while other functions should be performed by humans. [88]

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[84] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09...*, 1.
[85] *Ibid*, 3.
[86] *Ibid*, 2.
[87] Richard Purcell, "Autonomous Weapons: The Ultimate Military Game Changer?" *The National Interest*, 21 October 2018, https://nationalinterest.org/blog/buzz/autonomous-weapons-ultimate-military-game-changer-33937.
[88] United States of America (USA), Department of State (DoS), *Human-Machine Interaction in the Development, Deployment and Use of Emerging Technologies in the Area of Lethal Autonomous Weapons Systems*, Working

Thus, the use of the phrase "appropriate levels of human judgment" in relation to LAWS by the US is quite ill-defined, deliberately malleable and provides options for R&D.[89] That said, it must be noted that DoDD 3000.09 is the first document on LAWS from any nation that outlines protocols for their development even if its language is vague and spacious.[90]

Through R&D, the US has been moving steadily towards developing LAWS, mobilizing its defence manufacturers toward the effort and investing billions of dollars in precursor technologies over the last two decades.[91] Recent roadmaps of most US armed services have expressed a clear intention to develop and eventually use autonomous weapon systems in certain operational contexts.[92] The autonomous aerial, ground, and underwater platforms outlined in Appendix 2 do show that these plans are well advanced. These R&D efforts are, in fact, the centrepiece of the US DoD's "Third Offset Strategy," which was announced on 15 November 2015.[93] In short, an offset is a means of asymmetrically compensating for a military disadvantage; the US has adopted an offset strategy twice before against the Warsaw Pact during the Cold War.[94] The Third Offset Strategy is explicitly meant to counter both China and Russia, their respective programs of military modernization, and to enable the US to maintain its position

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paper presented to the GGE of the CCW, Session 2, Geneva, Switzerland: 28 August 2018, 2, https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/documents/GGE.2-WP4.pdf.

[89] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09*..., 2.

[90] To date, DoDD 3000.09 remains the only formal American document outlining LAWS protocols.

[91] Rosenberg and Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own." In the US DoD's 2016 budget, $18 billion USD was allocated to be spent over three years on technologies required for autonomous weapons. Some of the largest US defense manufacturers working on precursor technologies are: Raytheon, Boeing, Lockheed Martin, and Northrop Grumman.

[92] Noel E. Sharkey, "The Evitability of Autonomous Robot Warfare," *International Review of the Red Cross (2005)* 94, no. 886 (2012-2013): 788, https://search-proquest-com.cfc.idm.oclc.org/docview/1370609152/fulltext/27D748D043804517PQ/1?accountid=9867.

[93] Kelsey D. Atherton, "Are Killer Robots the Future of War? Parsing the Facts on Autonomous Weapons," *New York Times (Online)*, 2018, 2, https://search-proquest-com.cfc.idm.oclc.org/docview/2133334363.

[94] The First Offset Strategy was built on the nuclear advantage of the US during the 1950s, while the Second Offset concentrated on its superiority in computer and missile-guidance technology from 1975-1989.

as the world's dominant military power. Robert Work, an architect of this Third Offset Strategy, describes its explicit goal:

> China and Russia are developing battle networks that are as good as our own. They can see as far as ours can see; they can throw guided munitions as far as we can...What we want to do is just make sure that we would be able to win as quickly as we have been able to do in the past.[95]

To be able to do this, the US seeks to exploit new, innovative technologies such as military robotics, machine autonomy, and AI to build smarter, faster networks and better integrate humans with machines than their adversaries can.[96]

However, much like the US, China and Russia are also attempting to develop LAWS, investing heavily in it. As Work has noted, "we know that China is already investing heavily in robotics and autonomy and the Russian Chief of General Staff Gerasimov recently said that the Russian military is preparing to fight on a roboticized battlefield."[97] Thus, although the US has imposed self-restrictions on LAWS via DoDD 3000.09, there is no guarantee that its state and non-state adversaries will feel so constrained.[98] This is a key refrain for LAWS proponents like Major Zachary Morris, as they believe that refusing to develop LAWS will not actually prevent risks but amplify them.[99] For them, LAWS will eventually proliferate as a technology, and the US will find itself unprepared and at a military disadvantage if its adversaries field LAWS before

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[95] Rosenberg and Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own." Robert O. Work is now a senior fellow at the Center for a New American Security (CNAS).
[96] *Ibid*.
[97] Danielle Muoio, "Russia and China are Building Highly Autonomous Killer Robots," *Business Insider* (15 December 2015), https://www.businessinsider.com/russia-and-china-are-building-highly-autonomous-killer-robots-2015-12.
[98] Stephanie Carvin and Michael John Williams. *Law, Science, Liberalism, and the American Way of Warfare: The Quest for Humanity in Conflict* (Cambridge, UK; New York: Cambridge University Press, 2015), 1-224. For further reading, see Carvin and Williams' assessment of US warfighting, which is caught between two imperatives: ensuring US security by destroying threats and a requirement that the US conduct itself in a liberal and humane manner.
[99] Zachary L. Morris, "A Four-Phase Approach to Developing Ethically Permissible Autonomous Weapons," *Military Review* 98, no. 4 (2018): 5, https://www.armyupress.army.mil/Portals/7/Army-Press-Online-Journal/documents/Morris-v2.pdf.

it does. [100] As such, LAWS proponents like Major Jeffrey Thurnher instead recommend that the US "should fully commit itself to harnessing the potential of fully autonomous targeting" and not be surpassed by its adversaries.[101]

DoD officials like Work have fastidiously maintained that the US "will not delegate lethal authority for a machine to make a decision"[102] and that "there will always be a man in the loop."[103] Noah Shachtman has suggested that reassurances sound somewhat like brainwashing rather than sincere belief:

> Their mantra is a bit like the line they repeat again and again in the movie *The Manchurian Candidate*. "Sergeant Shaw is the kindest, bravest, warmest most wonderful human being."...It helps keep people calm that this isn't the Terminators.[104]

In fact, Work has couched his reassuring statements with caveats, noting that the US' self-imposed restrictions on LAWS may be unsustainable if an adversary fields them:

> We might be going up against a competitor who is more willing to delegate authority to machines than we are and, as that competition unfolds, we'll have to make decisions on how we can best compete...It's not something that we have fully figured out, but we spend a lot of time thinking about it.[105]

Journalists Matthew Rosenberg and John Markoff have also confirmed Pentagon deliberations on LAWS:

> Yet American officials are only just beginning to contend with the implications of weapons that could someday operate independently, beyond the control of their developers. Inside the Pentagon, the quandary is known as the Terminator conundrum, and there is no consensus about whether the United States should seek international

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[100] Hammes, "Autonomous Weapons Are Coming, This is How We Get Them Right."
[101] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting"..., 83.
[102] "David Ignatius and Pentagon's Robert Work Talk About New Technologies to Deter War," *Washington Post Live* video, 53:20, posted by *Washington Post (Online)*, 30 March 2016. https://www.washingtonpost.com/video/postlive/david-ignatius-and-pentagons-robert-work-on-efforts-to-defeat-isis-latest-tools-in-defense/2016/03/30/0fd7679e-f68f-11e5-958d-d038dac6e718_video.html.
[103] Rosenberg and Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own."
[104] Peter W. Singer, "In the Loop? Armed Robots and the Future of War," *Brookings Institution*, Article, Washington, DC, USA: (28 January 2009), https://www.brookings.edu/articles/in-the-loop-armed-robots-and-the-future-of-war/. Noah Shachtman is the editor of *Wired* magazine's military reporting section.
[105] "David Ignatius and Pentagon's Robert Work Talk About New Technologies to Deter War."

> treaties to try to ban the creation of those weapons, or build its own to match those its enemies might create.[106]

Although the US has delimited their use of LAWS in DoDD 3000.09, its terms are flexible and all policy options are still on the table.

LAWS Opponents

Over the last decade, LAWS opponents have united into a boisterous, civil society movement that explicitly seeks to "ban killer robots."[107] For opponents, LAWS represent a new class of weapons that are dangerous and distinct from current weapons. Opposition to LAWS initially began with a small group of concerned academics but has subsequently grown to include hundreds of NGOs and thousands of industry experts, scientists and luminaries. Through their transnational lobbying efforts, opponents have elevated the issue of LAWS to the attention of the general public and politicians alike, resulting in several like-minded governments and intergovernmental organizations (IOs) joining their ranks. Unlike LAWS proponents who tend to be defence and/or state-sponsored, the opposition to LAWS has emerged in a much more organic manner and with a broader appeal. The concept of maintaining "meaningful human control" over lethal force decisions has become a central tenet for them.[108] Lastly, as LAWS R&D continues, opponents are driven by a sense of urgency for immediate regulatory action against LAWS. Opponents realize that nations will be far less-inclined to ban LAWS after resources have been

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[106] Rosenberg and Markoff, "The Pentagon's 'Terminator Conundrum': Robots that could kill on their own."
[107] Nik Hynek and Anzhelika Solovyeva, "Operations of Power in Autonomous Weapon Systems: Ethical Conditions and Socio-Political Prospects," *AI & Society* 36, no. 1 (2021): 80, https://search-proquest-com.cfc.idm.oclc.org/docview/2492787143.
[108] Human Rights Watch (HRW) and the International Human Rights Clinic (IHRC), Harvard Law School, *Advancing the Debate on Killer Robots: 12 Key Arguments for a Pre-emptive Ban on Fully Autonomous Weapons*, Report, (8 May 2014), 24, https://www.hrw.org/sites/default/files/supporting_resources/advancing_the_debate_8may2014_final.pdf.

sunk into their R&D, platforms have been fielded, and their use has been normalized.[109] Thus, this debate represents a race against time for them.

The origins of the LAWS opposition movement can be traced back to Sharkey's article in *The Guardian* on 18 August 2007, in which he warned against the development of LAWS and called for international regulation.[110] Two years later, on 1 September 2009, Sharkey, along with several other aligned academics like Jürgen Altmann, Peter Asaro, and Robert Sparrow, established the International Committee for Robot Arms Control (ICRAC). An NGO, ICRAC has called for "[t]he prohibition of the development, production and use of armed autonomous unmanned systems."[111] On 19 October 2012, several NGOs agreed to create the Campaign to Stop Killer Robots (CSKR). The CSKR seeks "to ban fully autonomous weapons and thereby retain meaningful human control over the use of force."[112] To date, CSKR has united more than 172 NGOs in 65 nations and gained broad public support.[113] Thanks partly to CSKR's advocacy efforts, 30 nations support a LAWS ban, while 125 nations want LAWS to be regulated by a international, legally-binding instrument.[114]

On 19 November 2012, just three days before the publication of DoDD 3000.09, HRW and Harvard's IHRC published a 49-page report entitled *Losing Humanity. The Case Against*

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[109] Horowitz, "Why Words Matter..."..., 92.
[110] Sharkey, "Comment & Debate: Robot Wars are a Reality"..., 29.
[111] International Committee of Robot Arms Control (ICRAC), "About ICRAC," last accessed 19 March 2021, https://www.icrac.net/about-icrac/.
[112] Campaign to Stop Killer Robots (CSKR), "About," last accessed 19 March 2021, https://www.stopkillerrobots.org/about/.
[113] Hynek and Solovyeva, "Operations of Power in Autonomous Weapon Systems"..., 79. CSKR has won over thousands of experts, over twenty Nobel Peace Prize laureates, state governments as well as UN and the European Union (EU) elements to its agenda.
[114] Human Rights Watch (HRW), *Stopping Killer Robots: Country Positions on Banning Fully Autonomous Weapons and Retaining Human Control*, Report, (10 August 2020), 4, https://www.hrw.org/sites/default/files/media_2020/08/arms0820_web_0.pdf. Nations supporting a LAWS ban include: Algeria, Argentina, Austria, Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Cuba, Djibouti, Ecuador, Egypt, El Salvador, Ghana, Guatemala, Holy See, Iraq, Jordan, Mexico, Morocco, Namibia, Nicaragua, Pakistan, Panama, Peru, State of Palestine, Uganda, Venezuela, and Zimbabwe. China supports a ban on the use of LAWS but does not support a ban on LAWS development or production.

Killer Robots.[115] The oft-cited *Losing Humanity* is a foundational document for LAWS opponents, as it argues that LAWS are incompatible with LOAC, will endanger civilians/non-combatants and thus, should be banned.

On 28 July 2015, more than 1,000 AI and robotics researchers and 15,000 other endorsers signed an open letter calling for "a ban on offensive autonomous weapons beyond meaningful human control."[116] Signatories of this Future of Life Institute (FLI) letter included Steve Wozniak, Elon Musk, Stephen Hawking and Jack Dorsey along with Google DeepMind's Demis Hassabis and Mustafa Suleyman. The letter warned that:

> If any major military power pushes ahead with AI weapon development, a global arms race is virtually inevitable, and the endpoint of this technological trajectory is obvious: autonomous weapons will become the Kalashnikovs of tomorrow. Unlike nuclear weapons, they require no costly or hard-to-obtain raw materials, so they will become ubiquitous and cheap for all significant military powers to mass-produce. It will only be a matter of time until they appear on the black market and in the hands of terrorists, dictators wishing to better control their populace, warlords wishing to perpetrate ethnic cleansing, etc. Autonomous weapons are ideal for tasks such as assassinations, destabilizing nations, subduing populations and selectively killing a particular ethnic group. [117]

Lastly, the signatories indicated that they "have no interest in building AI weapons."[118]

In contrast to LAWS proponents, opponents do believe that a LAWS ban can be effective. Namely, they point to other weapons bans on blinding laser weapons (BLWs), anti-personnel landmines (APLs), or cluster munitions (CMs) as being successful.[119] Similarly, they believe that a curtailment of LAWS R&D is also possible, pointing to biological and chemical weapons as examples of bans that restricted their use amongst major nations, thereby retarding

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[115] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots...*, 1-49.
[116] FLI, "Autonomous Weapons: An Open Letter from AI and Robotics Researchers."
[117] *Ibid*.
[118] *Ibid*.
[119] HRW and IHRC, *Advancing the Debate on Killer Robots: 12 Key Arguments...*, 19, 24-26.

their development.[120] Lastly, should a pre-emptive ban on the development, production and use of LAWS prove elusive, some LAWS opponents are prepared to compromise and adopt a middle-of-the-road position: namely, a regulatory framework.[121]

POTENTIAL BENEFITS OF LAWS

For LAWS proponents, the potential benefits that they could offer are both significant and varied. As such, further LAWS R&D is warranted. These benefits are also indicative of and, in some cases, a response to certain trends that modern militaries are currently facing.

Reduced Exposure To One's Own Forces

One of the most compelling benefits of LAWS for using-nations is that war could be waged with limited friendly casualties. That said, this same benefit of protecting one's own military personnel by removing them from a battlefield can equally be achieved by using remote-controlled weapons.[122] Additionally, as LAWS will remove friendly human forces physically and mentally from the battlefield, mental health injuries are expected to be reduced.[123]

Dwindling Defense Budgets Coupled With The High Costs Of Military Personnel

LAWS may offer significant cost savings to using-nations. Currently, there is substantial pressure for governments to reduce defence spending. Yet, to field and maintain a modern military, a large pool of skilled labour must be recruited, trained, and retained by a nation. With the end of conscription, this task has become increasingly expensive for volunteer militaries that

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[120] *Ibid*, 24-25.
[121] Anderson and Waxman, "Law and Ethics for Robot Soldiers"..., 36.
[122] International Committee of the Red Cross (ICRC), "Ethics and Autonomous Weapons Systems: An Ethical Basis for Human Control?" Report, Geneva, Switzerland: (3 April 2018), 8, https://www.icrc.org/en/download/file/69961/icrc_ethics_and_autonomous_weapon_systems_report_3_april_2018.pdf.
[123] Tyler D. Evans, "At War with the Robots: Autonomous Weapon Systems and the Martens Clause," *Hofstra Law Review* 41, no. 3 (2013): 697, and 708-709, https://heinonline.org/HOL/P?h=hein.journals/hoflr41&i=729.

must now compete with the private sector.[124] To illustrate this trend, personnel costs for the US Armed Forces rose by 46% between 2000-2014 despite the fact that their force numbers essentially remained unchanged.[125] Commenting on military personnel costs in 2005, Tim Weiner noted that:

> The Pentagon today owes its soldiers $653 billion in future retirement benefits that it cannot presently pay. Robots, unlike old soldiers, do not fade away. The median lifetime cost of a soldier is about $4 million today and growing, according to a Pentagon study. Robot soldiers could cost a tenth of that or less.[126]

Indeed, unlike human soldiers, LAWS do not need to be fed, paid, housed, trained, or be administered pensions or medical care. Thus, LAWS could greatly reduce personnel requirements and achieve considerable budgetary savings.

There is another way in which LAWS could also offer significant cost savings. The need to have a human-in-the-loop for all UMS can be both cost and personnel prohibitive. To support a single tethered UAV, pilots, intelligence analysts, weapons technicians, sensor operators, and other crew members are required.[127] Due to their significant loiter times, UAVs require multiple shifts of said personnel to support them during a single mission. Thus, the more tasks that can be assigned to LAWS, the greater the potential savings. In fact, in a recent US DoD roadmap on UMS, there was recognition of this reality, as it pledged to "[t]ake the 'man' out of unmanned" systems.[128] As LAWS will require less human support, budget-constrained militaries will naturally gravitate towards them to reduce costs and maintain capabilities.

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[124] Jerry Useem, "At Work, Expertise Is Falling Out of Favor," *The Atlantic (Online)*, July 2019, https://www.theatlantic.com/magazine/archive/2019/07/future-of-work-expertise-navy/590647/.
[125] Purcell, "Autonomous Weapons: The Ultimate Military Game Changer?"
[126] Tim Weiner, "New Model Soldier Rolls Closer to Battle." *The New York Times (Online)*, 16 February 2005. https://www.nytimes.com/2005/02/16/technology/new-model-army-soldierrolls-closer-to-battle.html.
[127] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting"..., 79-80.
[128] United States of America (USA), Department of Defense (DoD), *Unmanned Systems Integrated Roadmap, FY2013-2038*, Government Printing Office, Washington, DC, USA: January 2014, 25, https://apps.dtic.mil/dtic/tr/fulltext/u2/a592015.pdf. It further explains: "Currently personnel costs are the greatest single cost in (the DoD), and unmanned systems must strive to reduce the number of personnel required to operate

Eliminating Human Constraints

> They [LAWS] don't get hungry...They're not afraid. They don't forget their orders. They don't care if the guy next to them has just been shot. Will they do a better job than humans? Yes.
>
> - Gordon Johnson, US Joint Forces Command[129]

LAWS proponents frequently cite the elimination of human constraints during their operation as significant benefits. On the battlefield, LAWS will not experience physical fatigue, stress, tiredness, confusion, fear, emotion or the need for self-preservation that their human counterparts will: all factors that can adversely affect human performance and judgement. Thus, not only do LAWS offer the prospect of improved performance but they may also provide an opportunity to make warfare more humane.[130] As well, it is assumed that LAWS will have greater range and endurance in addition to decreased support requirements.

In comparison with remotely-piloted armed UAVs, LAWS may be more preferable as humans have been removed. Namely, supporting UAVs operations is "on all accounts, extremely boring for the vast majority of the time they are in theatre."[131] As a result, pilot fatigue, error and distraction are often the cause of armed UAV accidents.[132] In not being controlled by human operators, LAWS could reduce such human-caused accidents.

Greater Accuracy In Targeting

Another benefit of LAWS is that they may offer greater accuracy in targeting than systems controlled by humans. LAWS will be able to observe large swaths of area with their

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and maintain the systems. Great strides in autonomy, teaming, multi-platform control, tipping, and cueing have reduced the number of personnel required, but much more work needs to occur."

[129] Peter W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century* (New York: Penguin Press, 2009), 63.

[130] Altmann and Sauer, "Autonomous Weapon Systems and Strategic Stability"..., 119.

[131] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems"..., 96.

[132] *Ibid*.

superior sensor suites and for longer periods, enabling better situational awareness.[133] This may enable LAWS to have greater precision and reduced collateral damage.[134] As the ICRC has rightly highlighted, though, such arguments have been offered for other technologies like remotely-piloted armed UAVs; however, these positive characteristics are not intrinsic to the weapon itself but rather to how it is used.[135]

Increased Speed Of Decision Making And Reaction

LAWS offers the benefit of operating at a higher tempo - at machine speed. Because it will likely be powered by ML AI, LAWS will have a speed-based edge in assembling information, data analysis, decision-making and reaction times, enabling faster operations than remotely-piloted or inhabited systems. The computing capabilities of ML AI will enable LAWS "to make tough decisions in a variety of complex scenarios through adaptation and learning."[136] As Arkin has suggested, LAWS will be able to "integrate more information from more sources far faster than a human possibly could in real-time before responding with lethal force."[137] In the land and maritime domains, CIWS like the C-RAM and Phalanx have proven their worth in protecting against projectile attacks better than any human could. In the air domain, because of its speed, LAWS may prove to be: better able to evade air defence threats; better in air-to-air combat; and quicker at providing close air support.[138]

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[133] Markus Wagner, "The Dehumanization of International Humanitarian Law: Legal, Ethical, and Political Implications of Autonomous Weapon Systems," *Vanderbilt Journal of Transnational Law* 47, no. 5 (2014): 1413. https://heinonline.org/HOL/P?h=hein.journals/vantl47&i=1423.

[134] Ronald C. Arkin, "Lethal Autonomous Systems and the Plight of the Non-Combatant," in *The Political Economy of Robots: Prospects for Prosperity and Peace in the Automated 21st Century*, edited by Ryan Kiggins, (London, UK: Palgrave Macmillan, 2018), 317-318. https://link-springer-com.cfc.idm.oclc.org/book/10.1007%2F978-3-319-51466-6.

[135] ICRC, "Ethics and Autonomous Weapons Systems: An Ethical Basis for Human Control?"..., 8.

[136] Daniel N. Hammond, "Autonomous Weapons and the Problem of State Accountability," *Chicago Journal of International Law* 15, no. 2 (2015): 660. https://search-proquest-com.cfc.idm.oclc.org/docview/1651730428/fulltextPDF/3061E16E19234C1FPQ/1?accountid=9867.

[137] Arkin, "Governing Lethal Behavior: Embedding Ethics..."..., 124. Ronald C. Arkin is a roboticist and Director of the Mobile Robot Laboratory at the Georgia Institute of Technology.

[138] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability"..., 769.

The need to fight at machine speed is just a continuation of the larger trends of increasing the speed of the target engagements and fighting within an enemy's OODA Loop. As time passes, the kill chain has gotten progressively shorter, as Krishnan notes:

> It has been pointed out that the time necessary for planning and executing an air strike was about three days during the 1991 Gulf War. The time was shortened to one hour during Operation Iraqi Freedom in 2003. In 2005, with the use of armed Predator drones continuously operating in the Gulf region "the whole thing, from legal decision to command to execution, took five minutes."[139]

In the near future, these trends may transgress the human ability to make timely battlefield decisions. In the future, when victory depends on decisions made in a matter of seconds, only LAWS may be fast enough for this pace of combat.[140] Inhabited and remotely-controlled systems are inevitably subject to delays caused by communication failures and human operators selecting and confirming targets. Such delays may lead to said systems being ineffective against an adversary using LAWS and able to make faster kill chain decisions.[141] Humans could become "the slowest part of the decision loop"[142] or "the weakest link in the 'kill chain'," making the use of LAWS "a matter of military effectiveness" for nations.[143] If confronted with such a situation, eliminating human involvement in HOTL systems and wholeheartedly embracing LAWS would be just a short step away. As Thurnher has postulated, to avoid a speed disadvantage, nations will develop LAWS and it will "become an ever growing segment of their military arsenals."[144] And while speed does convey a definite military advantage, it must also be noted, as the ICRC

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[139] Armin Krishnan, "Automating War: The Need for Regulation." *Contemporary Security Policy* 30, no. 1 (2009): 176, https://doi-org.cfc.idm.oclc.org/10.1080/13523260902760397, as quoted in Noah Shachtman, "Attack of the Drones," *Wired Magazine* 13.06 (1 June 2005). https://www.wired.com/2005/06/drones/.
[140] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems"..., 96.
[141] Jeffrey S. Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting: The Challenges of Modern Warfare*, edited by Paul A.L. Ducheine, Michael N. Schmitt and Frans P. B. Osinga (The Hague: T.M.C. Asser Press, 2015), 185, http://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=4084582.
[142] Purcell, "Autonomous Weapons: The Ultimate Military Game Changer?"
[143] Krishnan, "Automating War: The Need for Regulation"..., 176.
[144] Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting*..., 185.

suggests, that "it also erodes the potential for human intervention to prevent an unlawful, unnecessary or accidental attack."[145]

Freeing Humans From Dull, Repetitive Tasks

Another benefit of LAWS is the freeing up of human forces from necessary but dull, repetitive tasks such as local defense. As per Appendix 2, the use of the Sentry Tech, Super aEgis II, and SGR-Al systems are examples of precursor LAWS technologies being employed to fill such tasks. Such changes allow for human forces to be employed more efficiently elsewhere.

Greater Force Projection

Besides longer ranges, LAWS will also offer greater force projection because it will be less susceptible to communications jamming and cyber-attack and have limited to no bandwidth requirements. Thus, LAWS will be able to operate deeper behind enemy lines. Current UMS are primarily being employed against technologically-inferior adversaries (E.g.: terrorists and insurgents). These systems are completely reliant on their satellite communications tether to a human pilot; they are unable to accomplish their mission if that tether is cut.[146] In a future conflict with a peer/near-peer state adversary, the electromagnetic spectrum (EMS) will almost certainly be contested and communication links will be degraded. In such an environment, tethered UMS will be subject to electronic jamming, cyber-attacks and hijacking attempts; their tether will serve as a real vulnerability. In addition, military satellites would be among the first targets attacked during such a conflict.[147] In contrast, because LAWS do not require a communications tether, they do not have this vulnerability and will still be able to execute their mission even if the EMS is contested or satellites are destroyed.[148] That said, as LAWS will

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[145] ICRC, "Ethics and Autonomous Weapons Systems: An Ethical Basis for Human Control?"..., 22.
[146] Purcell, "Autonomous Weapons: The Ultimate Military Game Changer?"
[147] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems"..., 95.
[148] Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting*..., 185.

require some kind of navigation system, they may be susceptible to Global Positioning System (GPS) spoofing.[149] Lastly, irrespective of whether or not the EMS is contested, tethered UMS do require large amounts of data to be transmitted by satellite; this limits the number of UAVs that can be simultaneously deployed in an area of operations (AO).[150] As LAWS do not require data links, this issue is mitigated and more LAWS will be able to be deployed.

Underwater, bandwidth and constant data links are not possible. Also, communications blackouts are required to avoid detection. Thus, if Unmanned Underwater Vehicle (UUV) operations are to be expanded so that they can operate for long durations, over longer distances, and in a stealthy fashion, they will have to become autonomous.[151]

POTENTIAL RISKS OF LAWS

For the most part, the benefits of LAWS will offer tangible advantages to LAWS-using militaries at the tactical and operational-levels. In terms of potential risks posed by LAWS, there is a definite qualitative difference between them and the aforementioned benefits. In short, the risks of LAWS are of clear strategic concern.

The Potential For LAWS Malfunction

A significant risk posed by LAWS is malfunction. In the last decade, DL AI has demonstrated significant capabilities in various civilian applications such as speech and image recognition, and self-driving cars. That said, this same AI has also demonstrated deeply erroneous conclusions and fatal failures.[152] As mentioned, the behaviour of trained DL AI is

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[149] Krishnan, "Automating War: The Need for Regulation"..., 175.
[150] *Ibid*, 176.
[151] United Nations, Institute for Disarmament Research (UNIDIR), "The Weaponization of Increasingly Autonomous Technologies: Concerns, Characteristics and Definitional Approaches," *UNIDIR Resources*, No. 6, n.p., 2017, 16, https://www.unidir.org/files/publications/pdfs/the-weaponization-of-increasingly-autonomous-technologies-concerns-characteristics-and-definitional-approaches-en-689.pdf.
[152] Atherton, "Are Killer Robots the Future of War? Parsing the Facts on Autonomous Weapons." One such fatal example was the Tesla Model S, which when it was in autopilot mode, failed to recognize a tractor-trailer crossing the highway ahead of it and drove under it, killing the car's owner instantly in Florida on 7 May 2016.

opaque and not readily explainable. Thus, pairing this kind of AI with lethal weapons in LAWS is inherently risky and has the potential for unintended behaviours, accidents and spectacular failures if malfunctions occur. Such failures could include civilian deaths, fratricide and unintended military escalations. If LAWS are employed in cluttered, complex and/or urban environments, this risk of malfunction only increases. Sophisticated sensor suites and AI are not a panacea to enable LAWS to discriminate with greater precision against an uniformless enemy intermixed with a civilian populace.[153] If adversaries succeed in spoofing LAWS, the risk of accident increases while mission effectiveness declines.[154] The risk posed by a potential LAWS malfunction, as Altmann and Frank Sauer conclude:

> ...incentivises militaries to avoid full autonomy in weapon systems, and instead to retain humans in the chain of decision-making as a fail-safe mechanism. We argue that concerns of this nature are relevant not just at the operational level, but point to the potentially detrimental impact of AWS on overall strategic stability.[155]

If LAWS do malfunction, there will be no way to halt or correct in-progress engagements as LAWS will likely be operating autonomously and outside of communications range.

LAWS Arms Races And Proliferation

Next, the development of LAWS does pose a risk of triggering a global arms race and proliferation. All arms races are based on a couple of political dynamics. Firstly, arms races develop due to fears that technological progress being made by one's adversary will outpace one's own progress, allowing them to field a capability sooner. LAWS would provide a significant tactical advantage to nations that use them; as a result, peer/near-peer adversaries will

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[153] Roman Dremliuga, "General Legal Limits of the Application of the Lethal Autonomous Weapons Systems within the Purview of International Humanitarian Law," *Journal of Politics and Law* 13, no. 2 (2020): 118, https://heinonline.org/HOL/P?h=hein.journals/jpola13&i=297.
[154] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability"..., 771.
[155] Altmann and Sauer, "Autonomous Weapon Systems and Strategic Stability"..., 120.

be forced to develop LAWS in order to maintain a level playing-field.[156] Secondly, arms races can intensify when adversary capabilities cannot be confirmed. LAWS will be virtually indistinguishable from remotely-controlled UMS; the real difference between them is in their software, not hardware. Thus, it will be difficult for nations to confirm the actual LAWS capabilities of their adversaries.[157] Because of this opacity concerning capabilities, competition and perceived advantage will lead nations to accelerate LAWS R&D and deploy them before they have been properly tested.[158] Thus, the potential for a LAWS arms race is high.

In terms of proliferation, as tethered UMS require data links, only nations that operate satellites or have access to allied bandwidth can operate them.[159] As LAWS lack data requirements, more and smaller nations will be able to field them. Besides proliferation at the state-level, there is a definite risk that asymmetric, non-state actors may be able to engineer crude LAWS platforms after militarized versions have been deployed. Because LAWS is based on the dual-use technologies of AI and robotics, it will be difficult to control their technological diffusion.[160] Such an effort with LAWS would mirror what insurgents/terrorists have done in converting inexpensive, widely-available, civilian drones into remotely-piloted weapons. If obtained by non-state actors, LAWS will likely not be used in a LOAC-compliant manner, as autonomy is easier to achieve technologically than reliable discrimination.[161]

Lowering The Threshold For War

Another risk posed by LAWS is the lowering of the threshold for war. For all nations, the potential for friendly casualties is a significant, political impediment for either engaging in or

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[156] Wendall Wallach, "Terminating the Terminator: What to do about Autonomous Weapons," in Braden R. Allenby and Wendall Wallach, *The Applied Ethics of Emerging Military and Security Technologies* (London: Taylor & Francis Group, 2015), 254, http://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=4758577.
[157] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability,"...779-780.
[158] *Ibid*, 780.
[159] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems,"..., 95.
[160] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability,"...766.
[161] Lucas, "Lethal Autonomous Weapons Systems: Issues for Congress,"..., 14.

maintaining an armed conflict. Over the last three decades, Western democracies have increasingly opted to conduct bombing campaigns over prolonged ground combat because of the decreased likelihood of friendly casualties: for example, the bombing campaigns in Iraq in 1990-91, in Kosovo in 1999, and in Libya in 2011.[162] In these instances, the use of air power to achieve decisive effects without ground forces did make the decision for military intervention less risky for politicians and more palatable for the public. The employment of LAWS in combat is the natural extension of this trend. Below, Patrick Taylor Smith explains how LAWS will lower the threshold for war:

> Additionally, one could argue that that the primary benefit of LAWS - immunizing human soldiers from harm - leads to problems in the long run. If military operations become essentially costless to the attackers, then military force may no longer be understood as a last resort, potentially generating a kind of moral hazard. If the costs of a risky activity - military operations - are entirely externalized in that they are only suffered by targets, then we would expect attackers to use military operations more frequently.[163]

In short, sending LAWS to war rather than loved ones not only reduces the human sacrifice required but is more palatable to a nation.[164]

Indeed, friendly human casualties have been a major reason for why armed conflicts are not more prevalent than they currently are. Politicians are constrained from engaging in war by its costs; so if the costs of making war are decreased or eliminated through the use of LAWS, it is logical that more wars will be fought. This lowering of war costs through LAWS will also reduce the effort that nations invest in pursuing diplomacy before resorting to hostilities. As well, LAWS-using nations will likely adopt more aggressive postures during peacetime.[165] These same

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[162] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1420.
[163] Patrick Taylor Smith, "Just Research into Killer Robots," *Ethics and Information Technology* 21, no. 4 (2019): 285, https://search-proquest-com.cfc.idm.oclc.org/docview/2073877858.
[164] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1420.
[165] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems,"..., 106.

dynamics have already been exhibited through the American employment of armed UAVs in counter-terrorism operations. As a result of this, as Smith states:

> ...the United States has engaged in a policy of semi-permanent warfare against an amorphous, transnational entity, but it does so in ways that are comparatively costless from its perspective. As a consequence, American leaders have never been held to account and the war drags on.[166]

As the capabilities of LAWS will surpass tethered UAVs and provide less risks, this trend can only be expected to continue.

Conflict Escalation And Destabilizing Global And Regional Security

LAWS also pose the risk of escalating conflicts. Firstly, as LAWS are able to exercise lethal force without human supervision, there may be instances when force is exercised in an inappropriate or undesirable manner.[167] As such, LAWS have the potential to escalate conflicts in a way that is outside of direct human control. Also, as LAWS operates at machine speed and nations fear losing conflicts, LAWS could, as Horowitz suggests, "generate escalation pressure, including an increased incentive for first strikes."[168] And much like drones, LAWS will be able to support the execution of a new range of missions against targets that were previously out of range or too costly to engage.[169] Strikes against previously untouchable targets will likely lead to escalatory responses by the attacked side. Escalations of conflict along with arms races, proliferation to non-state actors, and a lowered threshold for war - all of which could be caused by LAWS - may lead to a destabilization of regional and/or global security.

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[166] Smith, "Just Research into Killer Robots,"..., 288.
[167] Peter Asaro, "On Banning Autonomous Weapon Systems: Human Rights, Automation, and the Dehumanization of Lethal Decision-Making," *International Review of the Red Cross (2005)* 94, no. 886 (2012): 692, https://search-proquest-com.cfc.idm.oclc.org/docview/1370609149.
[168] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability,"..., 766.
[169] UNIDIR, "The Weaponization of Increasingly Autonomous Technologies: Concerns, Characteristics and Definitional Approaches,"..., 6.

Bringing The War Home

Another risk with employing LAWS is the probability that attacks on the home-front will increase. In short, if the human forces of a LAWS-using nation are not present on the battlefield, its adversary will likely adapt and not directly engage LAWS as there will be no political benefit gained from doing so.[170] Political objectives are central to war: as Prussian General Carl von Clausewitz has suggested, "war is a mere continuation of policy by other means."[171] Thus, if an adversary is unable to achieve their political objectives by targeting LAWS, they will instead be incentivized to carry out attacks where they will be able to inflict human casualties: namely, against civilian targets on the home front of the LAWS-using nation. Lieutenant Brendon Mills of the United States Marine Corps succinctly sums up this risk below:

> However, in a world where we only fight with autonomous weapon systems, targeting our civilians would represent our enemy's only hope for success. And we're vulnerable....As someone who wears the uniform, I would welcome a world in which my friends and I did not have to place ourselves in harm's way to protect the nation. But my friends and I signed up so that our enemies will fight us instead of our families. And I worry that if humans don't fight our wars, we'll have more wars and our families will be the enemy's primary targets.[172]

Thus, although LAWS may minimize battlefield risks to friendly forces, it will put one's own civilian population at greater risk.

Losing 'Hearts And Minds'

Any LAWS-using nation does run the risk of losing the fight for the 'hearts and minds' of both its adversary's forces and civilians, and its own civilian populace. A powerful narrative about the LAWS-using nation employing "mindless, merciless killing machines" would likely

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[170] Lucas, "Lethal Autonomous Weapons Systems: Issues for Congress,"..., 15.
[171] Carl von Clausewitz, *On War*, edited by J.J. Graham and F. N. Maude (Jersey City, NJ, USA: Start Publishing LLC, 2013), 84, https://cfc.overdrive.com/media/1306062.
[172] Brendon Mills, "Rosa's Dystopia: The Moral Downside of Coming Autonomous Weapons Systems," *Foreign Policy* (18 June 2013), https://foreignpolicy.com/2013/06/18/rosas-dystopia-the-moral-downside-of-coming-autonomous-weapons-systems/.

develop amongst its adversary's forces and civilians, hardening their resolve to fight.[173] The use of LAWS would likely be decried as cowardly, cruel, unethical and a violation of International Humanitarian Law (IHL). The LAWS-using nation could come to be feared and loathed, while the potential for a durable, post-conflict peace would be limited.

Domestically, if there is a significant technological overmatch between the LAWS-using nation and the adversary forces, the hearts and minds of the home populace may be lost too. Images of LAWS slaughtering less technologically-advanced adversaries could quickly generate bad publicity, weaken domestic support for the conflict and turn world opinion against said nation. If political will for a conflict is undercut, as Krishnan suggests, "military victory might be irrelevant."[174] Such an occurrence could lead nations to shelve LAWS despite the considerable resources invested in them.

CONCLUDING REMARKS

> So, despite what one article called "all the lip service paid to keeping a human in the loop," the cold, hard, metallic reality is that autonomous armed robots are coming to war. They simply make too much sense to the people that matter.
>
> - Peter W. Singer, *In the Loop? Armed Robots and the Future of War*[175]

Despite the impassioned pleas of LAWS opponents to consider the potential, strategic-level risks posed by this technology, the tactical and operational-level benefits of LAWS will likely ensure the development, production and use of LAWS as Peter Singer laments above. In terms of benefits, LAWS offers the tantalizing promise of: longer range and endurance; improved precision; faster and cheaper mission accomplishment; and faster target

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[173] Daniel L. Davis, "Who Decides: Man or Machine?" *Armed Forces Journal*, (1 November 2007), http://armedforcesjournal.com/who-decides-man-or-machine/.
[174] Krishnan, "Automating War: The Need for Regulation,"..., 181.
[175] Singer, "In the Loop? Armed Robots and the Future of War."

engagement.[176] Often, when a new weapon allows one to more easily kill or injure their adversary at less risk to themselves, that weapon's efficacy seems obvious. However, as Aaron Johnson and Sidney Axinn have correctly noted, "the efficacy of a weapon is not justification for its use."[177] This point is borne out by past precedents of nations using abhorrent but effective weapons such as APLs and chemical weapons, which were later banned.

In this chapter, the great debate surrounding the development, production and use of LAWS was examined. Also, the proponents and opponents of LAWS and their motivations were reviewed. Lastly, this chapter also outlined the potential benefits and risks of LAWS, which are indicative of and, in some cases, a response to certain trends that are currently confronting modern militaries.

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[176] M. Guetlein, "Lethal Autonomous Systems - Ethical and Doctrinal Implications," US Naval War College Joint Military Operations Department Paper, February 2005, as quoted in Ronald C. Arkin, "The Case for Ethical Autonomy in Unmanned Systems." *Journal of Military Ethics* 9, no. 4 (2010): 334, https://www-tandfonline-com.cfc.idm.oclc.org/doi/full/10.1080/15027570.2010.536402.

[177] Aaron M. Johnson and Sidney Axinn, "The Morality of Autonomous Robots," *Journal of Military Ethics* 12, no. 2 (2013): 133, https://doi-org.cfc.idm.oclc.org/10.1080/15027570.2013.818399.

CHAPTER 4: LEGAL IMPLICATIONS OF LAWS

INTRODUCTORY COMMENTS

In this chapter, the legal implications of the employment of LAWS relative to LOAC/IHL will be outlined. This chapter will first examine two LOAC provisions that are relevant to new weapons like LAWS: the Martens Clause and Article 36 of the AP1 of the Geneva Conventions. Next, this chapter will outline whether LAWS will be capable of adhering to the five core principles of LOAC: distinction, proportionality, military necessity, humanity and unnecessary suffering. After this, this chapter will examine the problems of accountability and liability related to LAWS use. This chapter will then examine the inherent opacity of DL AI and its legal implications for LAWS. Lastly, this chapter will examine the problems of predictability and reliability related to LAWS performance. At its core, this chapter will attempt to answer two questions. Firstly, do LAWS comport with existing LOAC/IHL? And secondly, is existing LOAC/IHL sufficient to regulate LAWS or is a new international, legally-binding instrument specific to LAWS required?

THE MARTENS CLAUSE & ARTICLE 36 OF THE ADDITIONAL PROTOCOL I OF THE GENEVA CONVENTIONS

As there is no treaty that directly covers LAWS, any LAWS-using nation would only have to comply with LOAC - also known as IHL or *jus in bello*. LOAC has developed over more than a century and is derived from a large body of international treaties and customary decisional law.[178] LOAC has a two-fold aim: to protect civilians from combat and protect soldiers from unnecessary suffering and cruelty, while also permitting activities to attain military objectives.[179] The application of LOAC is essential to restrain war's brutality and assist with the restoration of

[178] Hammond, "Autonomous Weapons and the Problem of State Accountability,"..., 672. This large body of customary decisional law and international treaties includes the Hague Convention of 1907, the four post-World War II Geneva Conventions, and their two Additional Protocols of 1977.
[179] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1384.

peace.[180] However, some commentators have suggested that LOAC is inadequate to meet all of the challenges that LAWS could pose.[181] Others, like Markus Wagner, have suggested that the LOAC "has shown a considerable capability to adapt its functional rules to meet challenges presented by newly developed weapon systems," because it does not focus on individual technologies like LAWS but, instead, applies broad principles to weapons and their effects.[182] LAWS proponents argue that the issue of whether LAWS comports with LOAC has "yet to be definitively resolved."[183] However, it is not clear on what basis such statements are made as the preponderance of available evidence suggests that LAWS do not comport with LOAC.

The Martens Clause

The Martens Clause is one of two LOAC provisions that are relevant to the emergence of new weapons like LAWS. The Martens Clause is a provision that is reflected in several LOAC instruments.[184] It was ostensibly designed to close loopholes within LOAC. The Martens Clause, as presented in AP1, is as follows:

> In cases not covered by this Protocol or by other international agreements, civilians and combatants remain under the protection and authority of the principles of international law derived from established custom, from the principles of humanity and from the dictates of public conscience.[185]

It is significant because it states that parties in an armed conflict are not just subject to treaty law and customary norms, but also to the principles of humanity and the dictates of the public conscience. In elevating these latter two to the same level as IHL, combatants in an armed

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[180] Johnson and Axinn, "The Morality of Autonomous Robots,"..., 130.
[181] Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons*..., 1-216. Krishnan generally argues that the rate of robotic technological development will render current international law largely ineffective.
[182] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1386.
[183] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting,"..., 78.
[184] The Martens Clause is reflected in the Hague Conventions of 1899 and 1907, and the 1977 Additional Protocols to the Geneva Conventions.
[185] United Nations, Treaty Collection, "Article 1(2), Part I to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.

conflict are bound to them as are the technologies and means/methods of warfare that they use.[186] Thus, it prevents the assumption that the absence of specific prohibitions permits the unregulated employment of technology. If a weapon violates the principles of humanity and the dictates of the public conscience, its use would be unlawful.[187] Humanitarian NGOs like HRW and the ICRC have argued that the Martens Clause "is a safety net for humanity" when it comes to assessing new technologies and means/methods of warfare.[188] For them, LAWS violates the dictates of the public conscience because it ceded life-and-death decisions to machines.[189] Limited public opinion data on the topic does support this assertion.[190] Also, the public conscience has been a historically, powerful force behind the prohibition of other weapons like poison gas in 1925, BLWs in 1995 and APLs in 1997.[191]

Article 36 Of Additional Protocol I Of The Geneva Conventions

Article 36 of AP1 of the Geneva Conventions is the second LOAC provision that is relevant to new technologies like LAWS. AP1 came into force in 1978 and 174 states are currently parties to it. AP1 signatories include several nations that are conducting LAWS R&D: China, UK, France and Russia. However, there are some notable nations conducting LAWS R&D that are not AP1 signatories: Israel and US; this is less problematic as AP1 has been ratified by an overwhelming majority of nations, making it customary international law. Also, as

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[186] Rupert Ticehurst, "The Martens Clause and the Laws of Armed Conflict," *International Review of the Red Cross* 37, no. 317 (1997): 125-126. https://doi.org/10.1017/S002086040008503X.
[187] Evans, "At War with the Robots: Autonomous Weapon Systems and the Martens Clause,"..., 717.
[188] ICRC, "Ethics and Autonomous Weapons Systems: An Ethical Basis for Human Control?"..., 5-6.
[189] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots*..., 25-26.
[190] A. Jung Moon, Peter Danielson, H.F. Machiel Van der Loos, "Survey-Based Discussions on Morally Contentious Applications of Interactive Robotics," *International Journal of Social Robotics* 4, no. 1 (2012): 77-96, https://search-proquest-com.cfc.idm.oclc.org/docview/2421245172. Public opinion data surveys conducted by A. Jung Moon, Peter Danielson, and H.F. Machiel Van der Loos in 2011 did find a general rejection of LAWS (81% against, 10% in favour) in comparison to remote-controlled UMS (53% against, 35% in favour). For the authors, the marked differences in these survey results were driven by three main rationales in the minds of respondents: the belief that only humans should make lethal force decisions; scepticism about the technology; and preservation of human responsibility and accountability. Although these survey results are over a decade old, they are still instructive.
[191] UNIDIR, "The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values,"..., 6.

Wagner has noted, US officials have repeatedly affirmed "the customary law nature of many, though not all, provisions of AP1."[192]

If a new class of weapons are not yet expressly forbidden or regulated, Article 36 mandates that nations are required to review new and modified weapons for their compliance with IHL. Article 36 reads as follows:

> In the study, development, acquisition, or adoption of a new weapon, means, or method of warfare, a High Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party.[193]

Given its customary law status, all nations must carry out legal reviews of new weapons during their study, development, or acquisition phases.[194] Although not an AP1 signatory, the US has mandated in DoDD 3000.09 that legal reviews of semi-autonomous and autonomous weapons must be conducted.[195] Sharkey has suggested that some nations may be skirting this Article 36 requirement to conduct legal reviews by testing unarmed autonomous demonstrators with the intention of arming them later, as he states:

> The reason why Article 36 may not have been applied and why autonomous lethal robots would be hard to get onto the CCW list is most likely because autonomous robots are not weapons systems until they are armed. Even locating people (targeting) does not make them weapons. It would only be possible to include them on the list after they have been developed which may then be too late. The worry is that arming an autonomous robot system will be a relatively simple add-on once the other technologies are in place. It is not difficult to repurpose a robot for combat as we have seen with the arming of the Predator drone in February 2001.[196]

As highlighted in Appendix 2, the X-47B and Taranis, which both have weapons bays but were not armed during testing, do bear out Sharkey's argument.

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[192] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1385.
[193] United Nations, Treaty Collection, "Article 36, Section I, Part III to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 21, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.
[194] Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting*..., 186.
[195] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09*..., 7-8.
[196] Sharkey, "The Evitability of Autonomous Robot Warfare,"..., 797.

PRINCIPLES OF LOAC: DISTINCTION

If LAWS are to be legal, they must be capable of adhering to the five core principles of LOAC: distinction, proportionality, military necessity, humanity and unnecessary suffering. Distinction compels belligerents to distinguish between combatants and civilians, and also between military and civilian objects. The principle of distinction can be found in Article 48 of AP1 and with related rules in Articles 51 and 52. Article 48 reads as follows:

> In order to ensure respect for and protection of the civilian population and civilian objects, the Parties to the conflict shall at all times distinguish between the civilian population and combatants and between civilian objects and military objectives and accordingly shall direct their operations only against military objectives.[197]

The intent behind Article 48 is to minimize the harm to civilians and their property. In a conflict, LAWS would need to be able to discern with a high degree of accuracy between what is civilian and military. Attacks that fail to distinguish are considered to be indiscriminate. Article 51(4)(b) prohibits indiscriminate attacks, as it defines them as being "[t]hose which employ a method or means of combat which cannot be directed against a specific military objective."[198] Just as commanders have a duty to distinguish before ordering an attack, so must LAWS be able to distinguish and be capable of attacking only military objectives. If it cannot, such a weapon system would already be unlawful under LOAC and not require a specific treaty ban.[199]

LAWS also potentially runs afoul of discrimination in Article 51(4)(c), which specifies that weapons cannot produce uncontrollable effects:

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[197] United Nations, Treaty Collection, "Article 48, Section I, Part IV to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 25, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.

[198] United Nations, Treaty Collection, "Article 51, Section I, Part IV to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 26-27, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.

[199] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law,"..., 96.

> 4(c). Those which employ a method or means of combat the effects of which cannot be limited as required by this Protocol; and consequently, in each such case, are of a nature to strike military objectives and civilians or civilian objects without distinction.[200]

As LAWS are meant to select and engage targets autonomously and function as HOOTL systems as required, there may be situations when a human cannot override or shutdown a malfunctioning LAWS. In such circumstances, LAWS would be uncontrollable, indiscriminate and thus, unlawful.

The ability to distinguish between civilians and military personnel is not as simple or binary as it seems. In many instances, as Wagner has suggested, distinction is "highly context-dependent" and requires abstract, qualitative analysis.[201] Although LAWS are likely to be equipped with advanced sensor suites and AI, this type of sophisticated qualitative analysis is likely beyond the capabilities of LAWS' AI. LAWS would likely struggle to distinguish between an active, surrendering, wounded, or incapacitated combatant.[202] As well, not every person who carries a weapon is directly involved in an armed conflict; as Sparrow reminds us, "in many parts of the world carrying a weapon is a matter of male honor."[203] Also, armed peacekeepers can often occupy the same area as combatants who may be a legitimate target. Even amongst civilians and military personnel, their status can change; for example, military personnel can lose their status as combatants if they become a prisoner of war, interned, or *hors de combat*. Similarly, civilians can divest themselves of their protected status by directly participating in combat.[204] Being able to make such judgements from afar are difficult enough for humans; it

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[200] United Nations, Treaty Collection, "Article 51, Section I, Part IV to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 26-27, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.
[201] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1393.
[202] HRW and IHRC, *Advancing the Debate on Killer Robots: 12 Key Arguments*..., 11.
[203] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems,"..., 98.
[204] Allyson Hauptman, "Autonomous Weapons and the Law of Armed Conflict," *Military Law Review* 218, (2013): 193, https://heinonline.org/HOL/P?h=hein.journals/milrv218&i=178.

would be extremely challenging, if not impossible, to program or train a LAWS AI to be able to distinguish to this level.

Over the last half century, the character of armed conflict has changed, making discrimination much more difficult. Namely, state-on-state warfare has given way to asymmetric conflicts that are often fought in complex, urban environments and amongst civilian populations. In said conflicts, combatants typically do not wear insignia or uniforms. Guerillas derive sustenance from the surrounding civilian population, emerging only to launch attacks. They actively attempt to blend in with this civilian population to render themselves immune from conventional attack from a more technologically advanced foe.[205] With the deployment of LAWS, this tactic, technique, and procedure (TTP) will certainty continue and likely become the default counter to LAWS. Even LAWS proponents like Thurnher concede that LAWS "would be unlawful to use" in such cluttered contexts due to their inability to discriminate.[206]

Lastly, AI in LAWS may be vulnerable to adversary spoofing. LAWS require image recognition systems to operate; these can be deceived by counter-AI camouflage. As Horowitz and Scharre have outlined, this tactic is based on an actual AI vulnerability which has no available solution:

> ...valid targets could be covered with camouflage designed to make them appear innocuous. AI researchers have demonstrated the ability to do this relatively easily – for example, making a stop sign appear to an image classifier to be a 45 mile per hour sign simply by adding some small black and white stickers. This form of passive environmental hacking could be done well in advance of an AI system scanning an environment, like a cognitive land mine waiting to fool a system when it arrives.[207]

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[205] Paul J. Springer, *Outsourcing War to Machines: The Military Robotics Revolution* (Santa Barbara, CA: Praeger, 2018), 158, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5255510.
[206] Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting*..., 188.
[207] Horowitz and Scharre. "Artificial Intelligence: What Every Policymaker Needs to Know"..., 15.

Thus, an adversary could make a school bus look like a mobile intercontinental ballistic missile launcher and vice versa, adversely influencing a LAWS engagement. For all of these reasons, the principle of distinction poses a significant obstacle to the legal employment of LAWS.

PRINCIPLES OF LOAC: MILITARY NECESSITY AND PROPORTIONALITY

The second and third core principles of LOAC are military necessity and proportionality. As Roman Dremliuga has suggested, "these two principles are inseparably linked."[208] As such, this section will discuss them together.

To begin, it should be noted that the principle of military necessity is not clearly articulated in any treaty. Instead, as Michael Schmitt notes, it "infuses" LOAC.[209] LOAC does recognize that the use of force in warfare is necessary and that some level of death and destruction is inevitable.[210] The principle of military necessity helps to focus the use of force only on those military objectives that contribute to an enemy's defeat. Thus, military necessity compels a combatant to review whether a potential target represents a valid military objective. The nature, location, use and purpose of the target should be considered before the decision to use force is taken.[211] LAWS would need to be able to make this kind of qualitative determination. Without AGI, it is not clear how LAWS would make such a determination.

The related principle of proportionality provides the requirement that the use of force against a target must not cause excessive civilian harm relative to its actual value as a military objective. Much like distinction, the principle of proportionality is meant to protect civilians. Proportionality poses greater legal challenges than distinction does to LAWS. The principle of

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[208] Dremliuga, "General Legal Limits of the Application of the LAWS..."..., 118.
[209] Michael N. Schmitt, "Military Necessity and Humanity in International Humanitarian Law..."..., 835.
[210] Stephanie Carvin, "Getting Drones Wrong," *The International Journal of Human Rights* 19, no. 2 (2015): 131, https://www-tandfonline-com.cfc.idm.oclc.org/doi/full/10.1080/13642987.2014.991212.
[211] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting,"..., 80.

proportionality was first codified in Article 51(5)(b) and Article 57(2)(a)(iii) of AP1.[212] Article 51(5)(b) reads as follows:

> 5. Among others, the following types of attacks are to be considered as indiscriminate:
> ...
> (b) an attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated.[213]

As Egeland has characterized, this provision functions as "a proportionality clause."[214] Although this provision is meant to protect civilians from indiscriminate attacks, the use of the term 'excessive' here is significant as it suggests that the use of force can be disproportionate. Article 57(2)(a)(iii) does reiterate this concept of excessiveness, as it states that prior to the use of force, a commander must:

> (2)(a)(iii) Refrain from deciding to launch any attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated.[215]

Attempts to define 'excessive' in these two provisions has proven illusory. Instead, a determination of excessiveness tends to be made "on a case-by-case basis" by weighing the reasonableness of the use of force against the anticipated military advantage to be gained and the expected collateral damage (E.g.: civilian casualties and damage) to be caused.[216] In short, the use of force is lawful if it is not expected to cause excessive collateral damage in relation to the military advantage gained. Thus, the greater the advantage gained from the use of force, the more

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[212] Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting*..., 188-189.
[213] United Nations, Treaty Collection, "Article 51, Section I, Part IV to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 26-27, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.
[214] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law,"..., 103.
[215] United Nations, Treaty Collection, "Article 57, Section I, Chapter IV, Part IV to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 29, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.
[216] Schmitt and Thurnher, "'Out of the Loop': Autonomous Weapon Systems and the LOAC"..., 254.

collateral damage will be tolerated under LOAC. This proportionality assessment is always completed before force is used, examining expected values rather than actual results to inform the decision to use force. These values are very dissimilar, fluid in nature and complex. Determining anticipated military advantage is difficult as it involves understanding tactics, military strategy, and operational aims within an ever-changing context. As Wagner has suggested, it is impossible "to assign numeric values to military targets as well as civilian damage" or devise any sort of proportionality relationship between them.[217] As such, proportionality assessments are inherently qualitative, subjective and contextual in nature.[218] As Thurnher notes, a proportionality assessment "equates to a judgment call, which has always belonged to a human."[219] The legality of this decision relies heavily on what any "reasonable person or... reasonable commander" would do if placed in similar circumstances.[220] For Egeland, "[t]ranslating such qualitative judgement into computer algorithms would be a monumental task."[221] This is all significant because, as many have suggested, it is difficult to see how LAWS could be programmed to conduct these proportionality assessments or determine to the same level that a human can.[222]

PRINCIPLES OF LOAC: HUMANITY AND UNNECESSARY SUFFERING

The fourth and fifth core principles of LOAC are humanity and unnecessary suffering. As both of these principles seek to minimize the suffering caused by war, it is best to consider them together. Basic considerations of humanity are already reflected in the Martens Clause,

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[217] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1396-1397.
[218] Sharkey, "The Evitability of Autonomous Robot Warfare,"..., 789-790.
[219] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting,"..., 81.
[220] *Ibid*.
[221] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law,"..., 108.
[222] Anderson and Waxman, "Law and Ethics for Robot Soldiers"..., 10; Wallach, "Terminating the Terminator..."..., 253; Wagner, "The Dehumanization of International Humanitarian Law..."..., 1398; Thurnher, "Means and Methods of the Future: Autonomous Systems," in *Targeting*..., 189. Even Thurnher concedes that "[i]t is unlikely an autonomous system will be capable of making independent value judgements as required by the proportionality principle."

establishing that humane treatment is absolute in its application to prisoners of war and civilians. The principle of unnecessary suffering is reflected in Article 35 of AP1; it follows that: "[i]t is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering."[223] These principles suggest that the biological, psychophysical, and moral elements of a person will be considered.[224] For example, threatening non-combatants with force does not impose physical suffering but it does demonstrate a lack of humanity, as the threat will impose psychophysical stress and moral injuries upon said non-combatants. To comply with these principles, both humane behaviour and the causes of suffering must be understood. Many commentators agree that LAWS will not be capable of understanding humane behaviour or suffering.[225]

ACCOUNTABILITY AND LIABILITY

The use of LAWS does raise serious legal questions concerning the issues of accountability and liability. If LAWS are deployed on a wide scale, it will be only a matter of time before a LOAC violation on operations inevitably occurs. When this happens, there will be a natural expectation that someone is held accountable and liable. But, as LAWS can select and engage targets without human oversight, who could reasonably be held to account? The answer to this question is incredibly unclear. Unlike the actions of HITL systems, the actions of LAWS

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[223] United Nations, Treaty Collection, "Article 35, Section I, Part III to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 21, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.

[224] Dremliuga, "General Legal Limits of the Application of the LAWS..."..., 119.

[225] Asaro, "On Banning Autonomous Weapon Systems..."..., 700-703; Klein, Ezra. "The Author Behind 'Arrival' Doesn't Fear AI. 'Look at How We Treat Animals." *New York Times (Online) - The Ezra Klein Show*, 30 March 2021. https://www.nytimes.com/2021/03/30/opinion/ezra-klein-podcast-ted-chiang.html?action=click&module=audio-series-bar&pgtype=Article&region=header&showTranscript=1. In his interview with Ezra Klein, Ted Chiang has stated his belief that machines must be capable of suffering before they can become moral agents: "Because long before we get to the point where a machine is a moral agent, we will have machines that are capable of suffering. Suffering precedes moral agency in sort of the developmental ladder. Dogs are not moral agents, but they are capable of experiencing suffering. Babies are not moral agents yet, but they have the clear potential to become so."

are not easily attributable to a specific person, obscuring the causal link between the use of force and human responsibility.[226]

That said, commentators have, nonetheless, suggested a whole host of individuals and entities for which culpability could be attributed for LAWS-commissioned war crimes. They include : the LAWS platform itself, programmers, defence manufacturers, commanders, and LAWS using-nations. However, none of these provide a satisfying resolution to this problem.

Establishing accountability is crucial because it provides victims with meaningful retributive justice and deters future harm to civilians.[227] In terms of the latter, the trying of suspected war criminals is viewed as essential to enabling the establishment of a durable, post-conflict peace.[228] Being able to attribute legal responsibility to a war criminal is also the fundamental basis of LOAC, as it presumes that those who commit war crimes and human rights abuses will be subject to liability. Being unable to attribute liability would render the LOAC principles completely ineffective. This would, as Sparrow has suggested, create "disastrous consequences for the ways in which wars are likely to be fought."[229] If culpability cannot be determined, "a responsibility vacuum" would naturally develop, providing impunity for any kind of LAWS use.[230] Christof Heyns, the former UN Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions, has suggested that such a total lack of legal responsibility for LAWS could provide a powerful pretext to ban them:

> The question of legal responsibility could be an overriding issue. If each of the possible candidates for responsibility identified above is ultimately inappropriate or impractical, a responsibility vacuum will emerge, granting impunity for all LAR use. If the nature of a

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[226] *Ibid*., 693.
[227] Robert Sparrow, "Killer Robots," *Journal of Applied Philosophy* 24, no. 1 (2007): 67. http://search.ebscohost.com.cfc.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=23774147&site=ehost-live&scope=site.
[228] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law,"..., 109.
[229] Sparrow, "Killer Robots,"..., 66.
[230] Michael C. Horowitz and Paul Scharre, "The Morality of Robotic War," *The New York Times*, 27 May 2015, 7. https://search-proquest-com.cfc.idm.oclc.org/docview/1683108359.

> weapon renders responsibility for its consequences impossible, its use should be considered unethical and unlawful as an abhorrent weapon.[231]

In fact, the inability to hold anyone accountable for war crimes has been a contributing factor for why certain weapons like APLs were banned in the past.[232]

LAWS

To find an accountable party for LAWS-commissioned war crimes, the first place to look would be at LAWS itself. Autonomous actors are viewed generally as being responsible for their own actions in terms of strict causality. However, while LAWS is, by definition, autonomous, it cannot be held accountable for its actions, as it is an inanimate system without moral agency, intention and guilt. Legally, these deficits are significant as most legal systems do require a clear demonstration of intent (*mens rea*) to achieve a conviction, while criminal culpability does require some form of moral agency. Also, some legal systems do have a requirement to show individual guilt.[233] With LAWS, making such legal demonstrations would be impossible as there is a complete absence of intent and moral agency when LAWS applies lethal force and a lack of guilt felt by it afterwards. As such, LAWS could not be held meaningfully accountable for its actions under the law; thus, as Egeland has suggested: "LAWS leapfrog individual legal responsibility."[234] More to the point, any attempt to try or court-martial a LAWS for the commission of war crimes would be an absurd spectacle.[235] Besides this, as the AI behind LAWS does lack clear intellectual and reasoning abilities, it is difficult to see how LAWS could ever be made to suffer from any punishment levied against it. One could shut the LAWS off or disassemble it; however, such punishments would not achieve rehabilitation or solve the actual

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[231] Christof Heyns, "Annual Report of the Special Rapporteur..."..., 15.
[232] Hammond, "Autonomous Weapons and the Problem of State Accountability,"..., 663.
[233] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1402-1403.
[234] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law,"..., 91.
[235] *Ibid*, 110.

underlying problem, which likely will reside in the software and algorithms of its AI. In being unable to punish LAWS, traditional legal means of deterrence become useless.[236] For all of these reasons, LAWS itself is, as Smith suggests, "the least plausible" actor to hold accountable for the war crimes it commits.[237]

Programmers

Some commentators have suggested that programmers could be held culpable for LAWS-commissioned war crimes.[238] After all, the AI on which LAWS relies to select and engage targets is built upon software and algorithms coded by programmers. For such a charge to lead to a conviction, it would have to be legally established that the AI was coded with malicious intent by one or more of the programmers, or that said programmers were somehow negligent.[239] Establishing either one of these would be exceptionally difficult. AI requires millions of lines of code, making it inherently complex and impossible for a single programmer to reasonably write alone. Instead, large teams of programmers are typically employed to complete such writing tasks. Because of their compartmentalization, few, if any, of these programmers will have complete oversight on just how this AI will perform once it is exposed to real-world conditions. Even if the coding is internally consistent, software and algorithms can still malfunction due to their interaction as Patrick Lin, George Bekey, and Keith Abney have noted:

> ...given a common misconception that robots will do only what we have programmed them to do. Unfortunately, such a belief is a [sic] sorely outdated, harking back to a time when computers were simpler and their programs could be written and understood by a single person. Now, programs with millions of lines of code are written by teams of programmers, none of whom knows the entire program; hence, no individual can predict

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[236] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1403.
[237] Smith, "Just Research into Killer Robots"..., 289.
[238] George R. Lucas, "Automated Warfare," *Stanford Law & Policy Review* 25, no. 2 (2014): 333, https://heinonline.org/HOL/P?h=hein.journals/stanlp25&i=333.
[239] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1404.

> the effect of a given command with absolute certainty, since portions of large programs may interact in unexpected, untested ways.[240]

Besides code interactions, there is the simple reality that LAWS are autonomous and have been designed for independent decision-making. While programmers would establish the parameters of the LAWS' AI, they, as HRW suggests, "could not predict with complete certainty the decisions a fully autonomous robot might eventually make in a complex battlefield scenario."[241] Because of this, finding programmers negligent and liable for LAWS-commissioned war crimes would not only be unreasonable but likely impossible. Thus, that leaves malicious intent as the only realistic means of prosecuting a programmer for LAWS-commissioned war crimes, which would likely be rare in occurrence.[242]

Defense Manufacturers

Some commentators have suggested that LAWS defence manufacturers could be held liable when their products violate LOAC.[243] Manufacturer liability would transform LAWS-commissioned war crimes into accidents, enabling victims or their families to seek damages.[244] In light of this potential legal exposure, manufacturers would have a real interest in making their LAWS as safe as possible. However, while manufacturer liability does have some intuitive

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[240] Patrick Lin, George Bekey, and Keith Abney, "Autonomous Military Robotics: Risk, Ethics, and Design," Report prepared for the US Department of Navy, Office of Naval Research, San Luis Obispo, CA, USA: California Polytechnic State University, 20 December 2008, 8, http://ethics.calpoly.edu/ONR_report.pdf.

[241] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots...*, 43-44.

[242] United States of America, Department of Justice, "Boeing Charged with 737 Max Fraud Conspiracy and Agrees to Pay over $2.5 Billion," *Justice News*, Office of Public Affairs, Washington, DC, USA: 7 January 2021, https://www.justice.gov/opa/pr/boeing-charged-737-max-fraud-conspiracy-and-agrees-pay-over-25-billion. On 7 January 2021, Boeing entered into a Deferred Prosecution Agreement (DPA) with the US Department of Justice (DoJ) and agreed to pay $2.5 billion USD in damages in order to resolve a criminal charge related to a conspiracy to defraud the Federal Aviation Administration's Aircraft Evaluation Group (FAA AEG) in connection with the FAA AEG's evaluation of Boeing's 737 MAX airplane. This case is relevant to this discussion because Boeing is a large American civilian aviation and defence manufacturer, two of its employees were found to have made "misleading statements, half-truths and omissions" in their interactions with regulators, while the resulting Boeing 737 MAX crashes of Lion Air Flight 610 and Ethiopian Airlines Flight 302 did result in 346 deaths and the grounding of Boeing 737 Max airplanes globally. The case does hold out the possibility that perhaps defence manufacturers could be made to pay hefty damages for LAWS-commission war crimes if their employees engage in similar disreputable behaviours.

[243] *Ibid*.

[244] Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons...*, 103-105.

appeal, there are some significant flaws with it as well. Firstly, defence manufacturers are almost never held liable for design defects in their products.[245] Secondly, the onus would be on victims - many of whom will likely be poor - to file lawsuits against well-capitalized manufacturers able to call upon the best legal representation available.[246] Lastly, holding manufacturers liable does not necessarily incentivize them to produce more LOAC-compliant LAWS; instead, manufacturers could simply increase prices for their nation-state customers to offset their liability risks.[247]

Commander

As primary users of LAWS, commanders may bear considerable liability in terms of their effects and LAWS-commissioned war crimes.[248] After all, commanders would authorize the arming and deployment of LAWS, set the rules of engagement (ROE), geographic area and time periods for operations, and the targeting priorities.[249] With the principle of command responsibility, commanders are said to be responsible for the crimes of their subordinates if there is: a clear supervisor-subordinate relationship; indications that a crime is about to be committed; and actions are not taken to prevent its commission.[250] In completing a mission, LAWS could be said to be fulfilling a quasi-subordinate role to its commander. But while this logic is appealing, LAWS are not human. As well, if programmers struggle to fully comprehend the coding of AI, it would not be reasonable to expect a commander to understand it either. Thus, to hold a commander responsible for the actions of LAWS, which he/she could neither control, foresee or

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[245] *Ibid*, 104.
[246] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots*..., 44.
[247] Hammond, "Autonomous Weapons and the Problem of State Accountability,"..., 666.
[248] Sparrow, "Killer Robots"..., 74.
[249] Morris, "A Four-Phase Approach to Developing Ethically Permissible Autonomous Weapons"..., 7.
[250] Benjamin Kastan, "Autonomous Weapons Systems: A Coming Legal "Singularity"?" *Journal of Law, Technology & Policy* 2013, no. 1 (2013): 67, https://heinonline.org/HOL/P?h=hein.journals/jltp2013&i=51. The objective of command responsibility is to ensure that commanders "more effectively control and monitor the conduct of subordinates and thereby deter harmful behaviour."

understand its actions would be well beyond the scope of command responsibility.[251] Thus, assigning liability to a commander for a LAWS-commissioned war crime and without clear *mens rea* is, as Egeland has suggested, "not possible under existing law, and would conflict with most people's sense of justice."[252]

Nation

Some commentators have suggested that nation-states would be the most liable for LAWS-commissioned war crimes.[253] Indeed, holding nations accountable for such crimes would be preferable because they are best positioned to ensure that LAWS use complies with LOAC over the long-term. Besides this, nations make the overarching decisions to both purchase and field LAWS; in contrast, programmers and manufacturers are merely responding to national demands and commanders are only implementing national defence policy decisions.[254] Thus, nations are arguably the most culpable for LAWS-commissioned war crimes. Article 91 of AP1 supports this idea as it specifies that:

> ...[a] Party to the conflict which violates the provisions of the Conventions or of this Protocol shall, if the case demands, be liable to pay compensation. It shall be responsible for all acts committed by persons forming part of its armed forces.[255]

Although LAWS are not persons and AP1 was ratified before LAWS, one could argue that the spirit of Article 91 also applies to LAWS as they are part of a nation's armed forces, are

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[251] United Nations, Treaty Collection, "Article 86, Section II, Part V to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 42-43, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.
[252] Egeland, "Lethal Autonomous Weapon Systems Under International Humanitarian Law,"..., 115.
[253] *Ibid*, 109-110; Asaro, "On Banning Autonomous Weapon Systems..."..., 693.
[254] Hammond, "Autonomous Weapons and the Problem of State Accountability,"..., 670.
[255] United Nations, Treaty Collection, "Article 91, Section II, Part V to Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)," 8 June 1977, 45, last accessed 23 March 2021, https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.

"artificial agents," and operate autonomously.[256] Lastly, nations have the required resources to appropriately compensate any victims. Thus, absent individual negligence or malicious intent, national accountability and liability for LAWS-commissioned war crimes is the better option.

There are two principal legal venues where a nation-state could be held liable for LAWS-commissioned war crimes: the International Court of Justice (ICJ) and domestic courts of a LAWS-using nation. However, the chance of obtaining justice will be limited. While the ICJ may offer a venue for victim nations to seek redress, it is hampered by the fact that most nations do not recognize its jurisdiction or authority.[257] Thus, the chances of LAWS-commissioned war crimes ever being heard at the ICJ are low. The other legal venue is domestic courts. Their effectiveness remains doubtful as victims will be poorly placed to file such lawsuits. Even if these barriers are overcome, the offending nation, as Hammond notes, "could still assert sovereign immunity to bar the action if the crime occurred during the course of an armed conflict," which would prevent the lawsuit "from proceeding past the filing stage."[258] Thus, while national liability for LAWS-commissioned war crimes seems appropriate, practical hurdles may make it insurmountable.

Organized Irresponsibility

With the wide range of aforementioned individual and collective actors involved in the development, production and use of LAWS, there is a real risk of a "potential accountability gap or vacuum" existing when a LAWS-commissioned war crime occurs.[259] As Wagner has suggested, such a vacuum would be tantamount to "a system of organized irresponsibility that

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[256] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems"..., 112.
[257] International Court of Justice, *The International Court of Justice Handbook*, 7th Edition, Mauberge, France: Triangle Bleu, 31 December 2018, 1-323, https://www.icj-cij.org/public/files/publications/handbook-of-the-court-en.pdf. The US, Russia and China do not recognize the ICJ's jurisdiction or authority.
[258] Hammond, "Autonomous Weapons and the Problem of State Accountability,"..., 685 and 657.
[259] Heyns, "Annual Report of the Special Rapporteur..."..., 14.

shuffles responsibility from one actor to another without holding anyone accountable in the end."[260] Such a system is reason enough for LAWS to be banned.[261] DoDD 3000.09 does make an attempt to deal with this issue, as it stipulates:

> Persons who authorize the use of, direct the use of, or operate autonomous and semi-autonomous weapon systems must do so with appropriate care and in accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement.[262]

However, this DoDD 3000.09 requirement is just a start towards preventing a system of organized irresponsibility from emerging in the US. Such requirements need more detail, need to be scaled-up to the international-level, need to broadened to include the collective accountability of a state, and need to be included in any legally-binding instrument that regulates LAWS.

THE OPACITY OF DEEP LEARNING AI IN LAWS

As DL AI possesses more potential than top-down AI, it will almost certainly be used in LAWS; by its very nature, it is inherently opaque. This opacity can be broken down into three main types - one legal and two related to technical complexity. Each type has significant legal implications.

Firstly, LAWS can be expected to be protected by "legal opacity."[263] Unfettered access to these weapon systems will certainly be "restricted not only by intellectual property law and trade secret law, but also by laws protecting military and strategic secrets."[264] Unauthorized access to said weapon systems could also be interpreted as espionage. As such, LAWS defence manufacturers will not be able to publish any classified data on their platforms.

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[260] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1409.
[261] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots*..., 45.
[262] USA, DoD, *Autonomy in Weapon Systems - Department of Defense Directive No. 3000.09*..., 3.
[263] Dremliuga, "General Legal Limits of the Application of the LAWS..."..., 119.
[264] *Ibid*.

Secondly, a system using DL AI can be incredibly difficult to understand if one lacks the requisite technical knowledge in mathematics and computer science. If the technical details of the DL AI used within LAWS were published, anyone outside of the immediate circle of programmers who designed it would still struggle to fully understand the intricacies of its function.

Thirdly, trained DL AI can be so complex and "frustratingly opaque" that understanding it and explaining the underlying science behind a behaviour is beyond our current means.[265] This issue is referred to as the problem of the "black box," wherein even the computer scientists do not fully understand what is happening inside a trained DL AI.[266] As previously mentioned, the behavior of rule-based AI is typically explainable after-the-fact. For DL AI, its behavior depends entirely on the training data that it has been given and/or the operational data it has sensed. Deep neural networks rely on the strength and weakness of the neural connections created between the input and output data, not on an explainable set of rules.[267] The underlying learned logic of the network is an unknown. [268] This black box issue would become very problematic in any criminal investigation of its behaviour. Thus, the opacity of DL AI does pose significant legal concerns for the use of LAWS.

PREDICTABILITY AND RELIABILITY CONCERNS RELATED TO LAWS

Tied to the unknowns of the DL AI controlling LAWS, real concerns have arisen concerning the reliability and predictability of LAWS performance; this is legally problematic. Predictability is knowing what will occur in the future. In technical terms, because LAWS will

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[265] Scharre, "Killer Apps: The Real Dangers of an AI Arms Race"..., 141.
[266] Knight, "The Dark Secret at the Heart of AI"..., 56.
[267] Horowitz and Scharre, "Artificial Intelligence: What Every Policymaker Needs to Know"..., 11.
[268] Davide Castelvecchi, "Can We Open the Black Box of AI?" *Nature (London)* 538, no. 7623 (2016): 21, https://www.nature.com/news/polopoly_fs/1.20731!/menu/main/topColumns/topLeftColumn/pdf/538020a.pdf. As DL AI has progressed, "deciphering the black box has become exponentially harder and more urgent."

likely employ deep-learning AI, which will be processing countless data inputs through multiple layers in a deep neural network, predictability in its performance will not be absolutely knowable but based on a probability distribution tied to its environmental inputs.[269] Thus, predictability for LAWS will be knowing with a high degree of probability that it will act in a particular way at a given time. In contrast, reliability differs as it is more akin to consistency. If LAWS is to be reliable, it will need to act in expected ways and have a consistent track record.

The complexity of the battlefield will pose real challenges to the predictability of LAWS performance, no matter the type of AI used. For top-down AI, it will be difficult, if not impossible, to code all of the software and algorithms required to account for all possible circumstances encountered on the battlefield. As such, predictable performance of LAWS using top-down AI is impossible outside of highly controlled contexts.[270] Conversely, with bottom-up AI, which is based on self-altering algorithms, LAWS must be trained like humans. It is still challenging for militaries to simulate war and all the situations that might arise within it; this makes the training of LAWS using bottom-up AI inherently difficult and incomplete. Also, LAWS using bottom-up AI will likely develop "emergent behaviours" - positive or negative - that will be completely unforeseeable.[271] As bottom-up AI is inherently goal-oriented, it seeks the best course of action to achieve the desired output.[272] Bottom-up AI is not restricted by human expectations or experience; thus, emergent behaviours are exhibited as it interprets its environment far differently from how a human would. This emergent behaviour is often surprising, may be undesirable and is certainly unpredictable. Lastly, irrespective of the type of

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[269] UNIDIR, "The Weaponization of Increasingly Autonomous Technologies: Concerns, Characteristics and Definitional Approaches"..., 12-13.
[270] HRW and IHRC, *Advancing the Debate on Killer Robots: 12 Key Arguments*..., 6. https://www.hrw.org/sites/default/files/supporting_resources/advancing_the_debate_8may2014_final.pdf..
[271] Atherton, "Are Killer Robots the Future of War? Parsing the Facts on Autonomous Weapons"..., 3.
[272] Horowitz and Scharre, "Artificial Intelligence: What Every Policymaker Needs to Know"..., 11.

AI used in LAWS, all current AI is "brittle"; thus, LAWS will lack the flexibility of humans and not be able to "apply 'common sense' to adapt to novel situations" found on the battlefield.[273]

A lack of predictability and reliability with LAWS will also impact commanders who deploy LAWS. If a commander is unable to completely trust the performance of LAWS, they will likely be unwilling to use them if they could be held accountable/liable for their unforeseen actions. Few Western commanders would assume the legal risk of LAWS-commissioned war crimes and the threat that this could pose to their careers, reputations or personal liberty.

CONCLUDING REMARKS

In this chapter, the legal implications of the employment of LAWS relative to LOAC were outlined. Firstly, the Martens Clause and Article 36 of AP1 were examined. In regards to the former, it was suggested that LAWS violates the dictates of the public conscience; thus, they would be considered to be unlawful. In terms of the latter, the requirement that nations must legally review new weapons like LAWS for their compliance with IHL was highlighted; it was suggested that some nations may be skirting this requirement with their LAWS demonstrators. Secondly, this chapter outlined the five core principles of LOAC - distinction, proportionality, military necessity, humanity and unnecessary suffering - and detailed how LAWS will be unable to comply with any of them. Thirdly, the profound problems of accountability and liability in relation to LAWS use were examined. The potential liability of LAWS itself, programmers, defence manufacturers, commanders and LAWS-using nations for LAWS-commissioned war crimes was considered: none of these actors represented a completely satisfying, liable party. As well, the potential for a system of organized irresponsibility to emerge surrounding LAWS use was also examined. Fourthly, this chapter examined the inherent opacity of DL AI in LAWS, while the problems that unexplainable AI will pose to post-incident investigations were

[273] Scharre, "Centaur Warfighting: The False Choice of Humans Vs. Automation"..., 151.

emphasized. Fifthly, this chapter reviewed predictability and reliability concerns related to LAWS performance and the associated legal implications that these will have for their users. At its core, this chapter has sought to answer two related questions: does LAWS comport with existing LOAC and is existing LOAC sufficient to regulate LAWS? In terms of the former, LAWS do not comport with existing LOAC. In terms of the latter, a new international, legally-binding instrument that explicitly addresses LAWS would be useful to dispel any legal uncertainties concerning their use.

CHAPTER 5: ETHICAL IMPLICATIONS OF LAWS

INTRODUCTORY COMMENTS

In Chapter 5, the ethical implications of the employment of LAWS will be examined. This chapter will seek to answer the question of whether or not the use of LAWS is ethical. This DRP will use both consequentialist and deontological ethical approaches to examine this question. As the consequentialist ethical approach is concerned with the results/consequences of an act, the risks that LAWS pose civilians/non-combatants and whether these risks can be mitigated by an "ethical governor" will be examined.[274] As a deontological ethical approach is focused on the ethical nature of the act/process itself, this DRP will examine how the LAWS use results in the following concerns: the delegation of life-and-death decisions to machines, the undermining of human dignity, and the continued distancing of humans from the battlefield. The use of multiple ethical approaches can be useful because - although they may have different frameworks - they can often come to the same ethical determination.[275] It is for this reason that these two ethical approaches will be used. Lastly, as ethics involve widely-accepted principles of human practice, which are also frequently enshrined in LOAC/IHL, there will be some content overlap between this chapter and the previous one.[276]

CONSEQUELIALIST ETHICS & LAWS

The consequentialist ethical approach seeks to find moral justification in the consequences of the act; thus, it is results-driven. For LAWS, this approach is focused on the consequences of their use: specifically, will their use result in greater or fewer risks for civilians and civilian objects? On this question, there is considerable debate between LAWS opponents

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[274] Arkin, Ulam and Duncan, *An Ethical Governor for Constraining Lethal Action in an Autonomous System*.
[275] UNIDIR, "The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values"..., 3.
[276] Previously-made arguments and points will be summarized in Chapter 5 as required and not repeated in their entirety.

and proponents; opponents contend that LAWS will present greater risks, while proponents argue the exact opposite. The focus of the consequentialist ethical approach on civilians and civilian objects is not surprising because ethical concerns related to LAWS are the most acute in relation to their targeting of humans.

LAWS And The Risks That They Pose To Civilians

As previously discussed, the use of LAWS will increase the probability of harmful consequences for civilians and civilian objects due to the limitations of its AI. Firstly, brittle AI in LAWS may result in unintended accidents and malfunctions that could lead to civilian casualties and fratricide. Secondly, LAWS will likely fail to effectively distinguish between civilians and military personnel as distinction analysis is highly context-dependent, qualitative in nature, and likely requires AGI. Distinction analysis for LAWS in cluttered, complex and/or urban environments will be next to impossible. LAWS' inability to discriminate will likely lead to collateral damage. Thirdly, as the principle of military necessity requires that a combatant establish if a target represents a valid military objective, LAWS without AGI will be unable to make such a qualitative determination, likely leading to unnecessary death and/or destruction. Fourthly, as proportionality assessments weigh the anticipated military advantage to be gained versus the expected collateral damage to be caused by the use of force and such assessments are qualitative, subjective and contextual in nature, LAWS with brittle AI will be ineffective at these. As a result, the potential for civilian casualties due to the disproportionate use of force will be increased. Fifthly, as the principles of humanity and unnecessary suffering require an ability to understand both humane behaviour and suffering and LAWS is incapable of either, the potential for collateral damage caused by LAWS is elevated. Lastly, as bottom-up AI will likely be used in LAWS and it is unpredictable, inherently goal-oriented, and not constrained by human

experience or expectations, the undesirable emergent behaviours that it will display will lead to increased collateral damage. For all of these reasons, the use of LAWS will likely lead to harmful consequences for both civilians and civilian objects, meaning their use is unethical from a consequentialist point of view.

An "Ethical Governor" For LAWS

Using a consequentialist ethical approach, proponents of LAWS have put forth the counter-argument that they will actually have a less deleterious impact on civilians and civilian objects than their human counterparts during an armed conflict.[277] Arkin is the most prominent advocate of this view. He argues that LAWS could render armed conflict, less destructive, risky, and indiscriminate; as such, he believes that there is a moral imperative to deploy LAWS.[278] Arkin believes that LAWS will perform more ethically than humans, as he states: "I am convinced that they [LAWS] can perform more ethically than human soldiers are capable of."[279] For him, this belief is sustained by the differences between humans and LAWS: namely, LAWS: do not have fight-or-flight or self-preservation instincts; can sacrifice themselves; will be better able to sense; will not be influenced by emotions; do not suffer from cognitive biases; and will be able to integrate information from multiple sources quickly.[280] However, as critics have noted, Arkin's argument betrays a clear rhetorical strategy. For example, Arkin exploits the moral shortcomings of humans in armed conflicts to put forth a technological solution like LAWS. In describing Arkin's arguments, commentators like Asaro have noted that: "[t]here is something profoundly odd about claiming to improve the morality of warfare by automating humans out of

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[277] Arkin, "Governing Lethal Behavior: Embedding Ethics..."..., 124.
[278] Arkin, "The Case for Ethical Autonomy in Unmanned Systems"..., 332-341. Some of Arkin's research has been sponsored by the US Army Research Office.
[279] Ronald C. Arkin, *Governing Lethal Behavior in Autonomous Robots*, Boca Raton, FL, USA: CRC Press Taylor & Francis Group, 2009, 47-48.
[280] Arkin, "The Case for Ethical Autonomy in Unmanned Systems"..., 333-334.

it."[281] As well, Arkin frequently uses anthropomorphic language to describe LAWS, explicitly stating that they will perform more ethically than humans despite the fact that they are incapable of moral reasoning.[282]

For his arguments, Arkin has received sustained and withering criticism: critics have noted that LAWS will be unable to perform distinction analysis or proportionality determinations.[283] In response to these criticisms, he has made two counter-proposals: that an "ethical governor" be used inside LAWS and that a human operator be allowed to supervise LAWS' ethical reasoning.[284] In terms of the first proposal, his ethical governor is a complex piece of constraint-based software that would entail LAWS conducting a two-step process prior to engaging with lethal force.[285] A LAWS using an ethical governor must first review sensory information and ascertain if an attack is barred under its ROE and LOAC/IHL (E.g.: constraints). If either are violated, the engagement would not be able to proceed; if they are not violated, the engagement can proceed if it is permitted under the LAWS' operational orders. For the second step, the LAWS must conduct a proportionality determination, wherein the ethical governor quantifies the likelihood of an effective engagement and potential for collateral damage, and then uses an algorithm to evaluate the proposed engagement.[286] The engagement can only occur if it "satisfies all ethical constraints and minimizes collateral damage in relation to the military

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[281] Asaro, "On Banning Autonomous Weapon Systems..."..., 703.
[282] Sharkey, "The Evitability of Autonomous Robot Warfare"..., 791.
[283] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems"..., 97-104; Asaro, "On Banning Autonomous Weapon Systems..."..., 696-703; and Wallach, "Terminating the Terminator..."..., 253.
[284] Arkin, "Governing Lethal Behavior: Embedding Ethics..."..., 127; Arkin, *Governing Lethal Behavior in Autonomous Robots*..., 203-209.
[285] Arkin, Ulam and Duncan, *An Ethical Governor for Constraining Lethal Action in an Autonomous System*.
[286] Arkin, *Governing Lethal Behavior in Autonomous Robots*..., 187.

necessity of the target."[287] Arkin's ethical governor and its relation to the overall LAWS ethical architecture is depicted in Figure 5.0.[288]

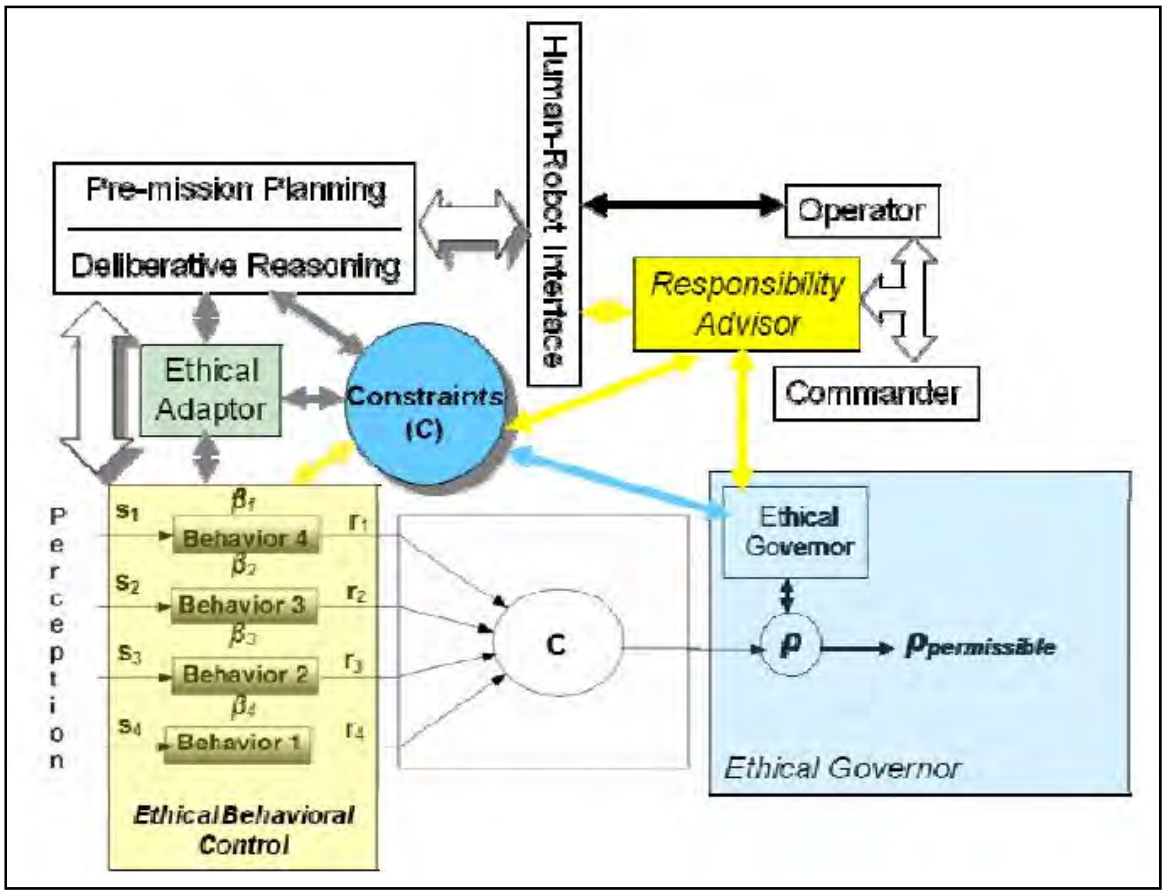

Figure 5.0: Major Components of an Ethical Autonomous Robot Architecture.
Source: Ronald C. Arkin, Patrick Ulam and Brittany Duncan, "An Ethical Governor for Constraining Lethal Action in an Autonomous System."[289]

The idea that LAWS can operate ethically due to an ethical governor has been criticized for many assumptions and vagaries. Firstly, the ethical governor relies on the computing of quantitative assessments by design, using binary yes-or-no answers to complete its engagement evaluations; however, as was previously described, distinction analysis or proportionality determinations are qualitative in nature and subject to change in highly-fluid conflict

[287] *Ibid*.
[288] Arkin, Ulam and Duncan, *An Ethical Governor for Constraining Lethal Action in an Autonomous System*.
[289] *Ibid*.

environments. Secondly, a LAWS equipped with an ethical governor can follow its programming and replicate an action deemed to be moral; however, that does not mean that the LAWS has engaged in moral reasoning or is able to ethically handle a situation outside of its programming. Thirdly, IHL/LOAC provide rules and heuristic guidelines to be followed by combatants, relying on them to apply compassion and good judgement at all times; even with an ethical governor, LAWS is incapable of compassion.[290] Lastly, the ethical governor itself is theoretical and highly speculative in nature. No working prototype has ever been produced likely because such software is, as Wagner has suggested, "difficult and potentially impossible to achieve."[291]

Arkin's second proposal of having a human monitor LAWS' ethical reasoning would allow an operator to intervene to prevent LAWS from conducting an unethical engagement.[292] This proposal is somewhat odd, though, as it negates two of LAWS' core benefits: namely, its ability to operate autonomously and in environments wherein a communications link is not possible. If LAWS has to rely on human supervision, it is, in effect, a semi-autonomous weapon system.

DEONTOLOGICAL ETHICS & LAWS

The deontological ethical approach classifies an act as morally right or wrong as a result of the character of the act itself; in this way, it said to be action/process-driven. For LAWS, this approach places emphasis on the human role or lack thereof in the use of lethal force and on the rights of those against whom the force is directed. For commentators, there are three deontological ethical concerns with LAWS use: the delegation of life-and-death decisions to machines, the undermining of human dignity, and the continued distancing of humans from the battlefield.

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[290] Asaro, "On Banning Autonomous Weapon Systems..."..., 700.
[291] Wagner, "The Dehumanization of International Humanitarian Law..."..., 1422.
[292] Arkin, *Governing Lethal Behavior in Autonomous Robots*..., 203-209.

Delegating Life-And-Death Decisions To Machines

> The function that robots cannot perform for us - that is, the function we should not allow them to perform for us - is the decide function. Men should decide to kill other men, not machines. This is a moral imperative that we ignore at great peril to our humanity. We would be morally bereft if we abrogate our responsibility to make the life-and-death decisions required on a battlefield as leaders and soldiers with human compassion and understanding. This is not something we would do. It is not in concert with the American spirit.
>
> - Colonel Lee Fetterman, Training and Doctrine Capabilities Manager for the US Army Future Combat Systems (FCS)[293]

Is it ever ethically acceptable to delegate lethal decision-making responsibilities to LAWS? For Asaro, this question captures the "central moral and legal issue" concerning the debate on LAWS.[294] Johnson and Axinn have argued that the debate on LAWS should "focus on this most important question" rather than being distracted by discussions "on the details of the technology [of LAWS] or its efficacy."[295] For Colonel Fetterman above and others, the answer to this question is clear: the decision to kill a human has to be made by a human and to cede this decision to a machine would be unethical.

For commentators, the delegation of life-and-death decisions to LAWS is ethically problematic for two main reasons: it creates a disconnect between human intentions and the use of lethal force, and it promotes a lack of accountability. For the first reason, the process of making life-and-death decisions reflects human agency and intentions; thus, these decisions must not be delegated down to LAWS. The decision to take a life is only legitimate if it is non-arbitrary. Without human control, supervision, and responsibility involved in lethal force decisions, there is no way to guarantee that such decisions are not arbitrary. Put another way, humans must retain authority and control over lethal force decisions because only humans can

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[293] Davis, "Who Decides: Man or Machine?"
[294] Asaro, "On Banning Autonomous Weapon Systems..."..., 695.
[295] Johnson and Axinn, "The Morality of Autonomous Robots"..., 134.

engage in moral reasoning.[296] As Toby Walsh has suggested: "[y]ou can't have machines deciding whether humans live or die. It crosses new territory. Machines don't have our moral compass, our compassion and our emotions. Machines are not moral beings."[297] Heyns echoes this idea below:

> ...[A] human being somewhere has to take the decision to initiate lethal force and as a result internalize (or assume responsibility for) the cost of each life lost in hostilities, as part of a deliberative process of human interaction...Delegating this process dehumanizes armed conflict even further and precludes a moment of deliberation in those cases where it may be feasible. Machines lack morality and mortality, and should as a result not have life and death powers over humans.[298]

Thus, if the weighty decision to end a human life is not meaningfully taken by a human, war would become dehumanized.

For the second reason, the use of LAWS will likely lead to a situation where there is an unclear chain of accountability and "responsibility gap" as was previously suggested.[299] Such a situation would be inherently immoral.[300] The process of making a lethal force decision must maintain the causal link between the intention of the human employing LAWS and the consequences of their decision to use it. In this way, human agency in this decision-making process is required if moral responsibility for that decision is to be upheld. In being morally responsible, the human employing LAWS is answerable to others about the decision to use force and its consequences, and is able to articulate the reasons for said decision when questioned by others.[301] To do this, this human must be actively involved in the lethal force decision-making

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[296] Vincent Boulanin, Neil Davison, Netta Goussac, and Moa Peldan Carlsson, *Limits on Autonomy in Weapons Systems: Identifying Practical Elements of Human Control*, Report, Stockholm, Sweden: Stockholm International Peace Research Institute: 1 June 2020, 12, http://www.jstor.org/stable/resrep25354.8.
[297] Claudia Dreifus, "Toby Walsh, A.I. Expert, is Racing to Stop the Killer Robots: A Conversation With," *New York Times (Online)*, 30 July 2019, https://search-proquest-com.cfc.idm.oclc.org/docview/2266245933. Toby Walsh in an AI expert.
[298] Heyns, "Annual Report of the Special Rapporteur..."..., 17.
[299] ICRC, "Ethics and Autonomous Weapons Systems: An Ethical Basis for Human Control?"..., 9.
[300] Sharkey, "The Evitability of Autonomous Robot Warfare"..., 791.
[301] Boulanin, Davison, Goussac, and Carlsson, *Limits on Autonomy in Weapons Systems*..., 12.

process. With LAWS, there is no such human involvement; thus, as Heyns suggests, not only would there be a "vacuum of legal responsibility" but also "a vacuum of moral responsibility."[302] As Asaro suggests, even just the act of "intentionally designing systems that lack responsible and accountable agents is in and of itself unethical, irresponsible, and immoral."[303] Besides this, without moral responsibility to satisfy ethical concerns and ensure LOAC compliance, as Sharkey tells us, "many more civilian lives could be endangered."[304]

Due to the fact that life-and-death decisions are being delegated to LAWS, Wendall Wallach has made an interesting proposal that LAWS should be designated as *mala in se* under international law.[305] A long-standing concept in LOAC/IHL, activities designated *mala in se* are said to be "evil in and of themselves."[306] Weapons deemed to be *mala in se* include chemical and biological weapons, which, like LAWS, can have horrific, uncontrolled and indiscriminate effects. LAWS are worthy of this designation, as Wallach states:

> I contend that machines picking targets and initiating lethal and non-lethal force are not just a bad idea, but also *mala in se*. Machines lack discrimination, empathy, and the capacity to make the proportional judgments necessary for weighing civilian casualties against achieving military objectives. Furthermore, delegating life and death decisions to machines is immoral because machines cannot be held responsible for their actions.[307]

In this way, Wallach is specifically proposing that the use of LAWS without human supervision be declared *mala in se* and, as such, illegal. Yet, the use of armed UMS would remain legal provided that they are under full human control because accountability for targeting decisions, errors and collateral damage would belong solely to humans. Wallach proposes that this *mala in se* declaration against LAWS be captured in "an international principle that machines should not

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[302] *Ibid*.
[303] Asaro, "On Banning Autonomous Weapon Systems..."..., 695.
[304] Sharkey, "The Evitability of Autonomous Robot Warfare"..., 791.
[305] Wallach, "Terminating the Terminator..."..., 253.
[306] *Ibid*.
[307] *Ibid*.

be making decisions that are harmful to humans."[308] Said principle would function just like the other core principles of LOAC.

Undermining Human Dignity

Closely linked to the previous deontological ethical concern is the fear that the value of human life will be debased through LAWS use. Specifically, it is argued that as LAWS are intrinsically amoral and unaccountable machines, using them to kill humans would treat the latter as objects and would infringe upon the fundamental human values of dignity and the right to life.[309] In short, it is significant not just if a human is killed but in what manner are they killed. As Smith has suggested, "being killed by a machine is inherently or intrinsically degrading."[310] On this point, Johnson and Axinn recognize that "humans are sometimes accidentally killed by machines," but for them, being killed by LAWS is something different altogether, as they state: "for an autonomous robot/drone to be programmed to kill a human is to treat a rational being as if it were merely an object."[311] Heyns closely echoes this objectification concern, as he states:

> ...to allow machines to determine when and where to use force against humans is to reduce those humans to objects; they are treated as mere targets. They become zeros and ones in the digital scopes of weapons which are programmed in advance to release force without the ability to consider whether there is no other way out, without a sufficient level of deliberate human choice about the matter.[312]

For most, the idea that humans could be diminished to mere objects whose fate is not decided by themselves or by others, but by a machine will be deeply unsettling. In such a world, the use of

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[308] Wendall Wallach, "Terminating the Terminator..."..., 253.
[309] Altmann and Sauer, "Autonomous Weapon Systems and Strategic Stability"..., 119-120.
[310] Smith, "Just Research into Killer Robots"..., 284.
[311] Johnson and Axinn, "The Morality of Autonomous Robots"..., 134.
[312] Christof Heyns, "Autonomous Weapon Systems: Human Rights and Ethical Issues," Presentation to the CCW Meeting of Experts on Lethal Autonomous Weapon Systems, 14 April 2016, as quoted in ICRC, "Ethics and Autonomous Weapons Systems..."..., 10.

LAWS would, as Heyns suggests, "denigrate the value of life itself," while human dignity would lose all meaning.[313]

Increased Human Distancing From The Battlefield

> To fight from a distance is instinctive in man. From the first day he has worked to this end, and he continues to do so.
>
> - Colonel Charles-Jean-Jacques-Joseph Ardant du Picq, *Battle Studies: Ancient and Modern Battle*[314]

The third deontological ethical concern about the use of LAWS is the increased human distancing - physically, psychologically and temporally - from the battlefield that they will enable. Such distancing, as Colonel du Picq noted above, is not new but a long-standing trend in warfare which continues to this day and is reflected in weapons like armed UAVs. Thus, the deployment of LAWS would represent a further extension of this trend wherein the distance between the attacker and the target is increased on multiple levels. As Lieutenant-Colonel Dave Grossman has noted, as distance increases between attacker and target, it becomes psychologically easier for military personnel to perform acts that they would usually be hesitant to do.[315] As Grossman has argued, humans have an innate hesitancy to kill one another.[316] While this reluctance may be open for debate, the reality is that this distancing through long-range weapons has circumvented this reluctance from ever emerging, as direct, close-up observation of weapons effects is often not possible. Joanna Bourke does well to describe this phenomena in modern warfare in general, as she argues that: "[c]ombatants were able to maintain an emotional distance from their victims largely through the application of (and almost exclusive focus upon)

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[313] Heyns, "Annual Report of the Special Rapporteur..."..., 20.
[314] Charles-Jean-Jacques-Joseph Ardant du Picq, *Battle Studies: Ancient and Modern Battle*, Project Gutenburg EBook of Battle Studies, Translated by John N. Greely and Robert C. Cotton, 1921, Part II: Chapter 1, ast accessed 21 March 2021, https://www.gutenberg.org/files/7294/7294-h/7294-h.htm.
[315] Dave Grossman, *On Killing: The Psychological Cost of Learning to Kill in War and Society*, Revised Ed. (New York: Back Bay Books, 2009), 97-137.
[316] *Ibid*.

technology."[317] For her, such technology in warfare facilitates a form of "numbed killing."[318] And while this distancing trend is not new, what is novel about LAWS in relation to it is that lethal force decisions have been completely ceded to machines. Thus, any sort of guilt is quelled in those who deploy LAWS.

The use of armed UAVs provides us with excellent insight into what LAWS use could ethically lead to. With armed UAVs, human fighting forces have been replaced by machine proxies in AOs like Somalia, Pakistan and Yemen; piloted by drone operators on the other side of the world, armed UAVs have, as Renic tells us:

> ...terminated the long-standing configuration of the battlefield as a realm of mutual risk. What is imposed in its place is the closest approximation yet achieved to perfect military asymmetry – a unilateral projection of violence by weaponized aerial robots. In many cases, targeted enemies are not only defenceless at the precise moment of their death, but have been dispossessed of their very capability to apply lethal force against the military forces of the opposing side. This pushes the understanding of such violence beyond any conceivable notion of 'fighting', a term that presupposes some degree of mutual contestation. Rather, what prevails is a form of technological predation.[319]

With armed UAVs, there is a great disparity in capability, risk and threat between the less vulnerable, technologically-superior forces equipped with this technology and those who they target. This imbalance and the distance between attacker and target would only be accentuated with the use of LAWS, as there are no human operators selecting and engaging targets. The ethical concern with both this imbalance and distance is that it has led to the dehumanization of killing, as this "pursuit of risk-free warfare" places a disproportionately greater value on friendly lives than on the lives of those in the AO (E.g.: enemy and civilian).[320] With armed UAVs, war has changed from, as Renic has suggested, "a battle between enemies of roughly equal standing

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[317] Joanna Bourke, *An Intimate History of Killing*, (New York, NY, USA: Basic Books, 1999), xvii.
[318] *Ibid*.
[319] Renic, "A Gardener's Vision: UAVs and the Dehumanisation of Violence"..., 61.
[320] Sparrow, "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems"..., 106.

to an administrative liquidation of obstacles."[321] As history has shown, the probability of atrocities increases when an enemy is dehumanized by its opponent; thus, the dehumanization engendered by armed UAVs does not portend well for a reduction in atrocities through the use of LAWS as Arkin has suggested.

CONCLUDING REMARKS

> It is because we can choose to break Asimov's rules - i.e. our own moral rules of thumb that we are responsible for the choices we make. A human being has moral standing for that reason. Robots don't choose whether to follow their program or not; consistency is their strong suit, not ours.
>
> - Christopher Coker, *AI and the Future of War*[322]

In Chapter 5, the ethical implications of LAWS were examined. This chapter sought to answer the question of whether or not the use of LAWS is ethical. To answer this question, both consequentialist and deontological ethical approaches were employed. The consequentialist ethical approach focused on the consequences and risks of LAWS use to civilians/non-combatants. It was found that the employment of LAWS will likely result in harmful consequences for civilians and civilian objects. As well, Arkin's proposal to equip LAWS with ethical governors to ensure their moral operation was examined and found to be highly speculative, unproven and not practically demonstrated. Next, a deontological ethical approach was used to examine the ethical nature of the act/process of using LAWS. Specifically, three deontological ethical concerns were examined: the delegation of life-and-death decisions to machines, the undermining of human dignity, and the continued distancing of humans from the battlefield. With all three concerns, LAWS use was found to be enabling unethical acts and

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[321] Renic, "A Gardener's Vision: UAVs and the Dehumanisation of Violence"..., 66.
[322] Christopher Coker, "Artificial Intelligence and the Future of War," *Scandinavian Journal of Military Studies* 2, no. 1 (2019): 58, https://doaj.org/article/32b4f8c15c2b41fbb6bfd845f3db7e31.

processes. Thus, to answer this chapter's question: the use of LAWS would be profoundly unethical.

CHAPTER 6: INTERNATIONAL DISCUSSIONS ON LAWS

INTRODUCTORY COMMENTS

The legal and ethical implications posed by LAWS have led to significant dialogue in international institutions and amongst arms control experts, as there is presently no legally-binding instrument to govern LAWS. Since 2014, LAWS has been regularly discussed at the UNOG under the auspices of the CCW. This chapter will examine the origins of these discussions and their current status, and outline potential ways forward.

ONGOING INTERNATIONAL DISCUSSIONS

As a result of the lobbying efforts of CSKR and others, the issue of LAWS made its way to the United Nations in early 2013. On 9 April 2013, Heyns submitted an official report to the Human Rights Council of the United Nations General Assembly (UNGA) on it.[323] In this report, he recommended that UN member states "declare and implement national moratoria on at least the testing, production, assembly, transfer, acquisition, deployment and use of LARs."[324] Heyns also called "for the establishment of a high level panel" to study LAWS. [325] In response to his report, the UNGA agreed to discuss LAWS within the framework of the CCW. The CCW is a multilateral arms control treaty meant to "ban or restrict the use of specific types of weapons that are considered to cause unnecessary or unjustifiable suffering to combatants or to affect civilians indiscriminately."[326] The CCW entered into effect in 1983. The CCW is modular in nature, as it consists of two main components: a short Framework Convention and the Protocols annexed to the Convention. The Protocols deal with specific weapons; they are negotiated as needed and

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[323] Heyns, "Annual Report of the Special Rapporteur..."..., 1-22.
[324] *Ibid*, 21.
[325] *Ibid*.
[326] United Nations, Office for Disarmament Affairs, "The Convention on Certain Conventional Weapons," last accessed 19 March 2021, https://www.un.org/disarmament/the-convention-on-certain-conventional-weapons/.

then attached to the Convention, which allows the CCW to be well-suited to handle new weapons like LAWS.[327]

At a CCW meeting on 14-15 November 2013, it was agreed to convene an informal Meeting of Experts to discuss LAWS from 13-16 May 2014.[328] In his recounting, Scharre points to the definitional confusion that was pervasive at this initial meeting: "[d]iscussion was robust, serious, and thoughtful, but through it all ran a strong sense of confusion about what exactly participants were, in fact, talking about."[329] A further two informal Meetings of Experts were held in 2015 and 2016. In December 2016, in a move indicating a formalisation of their LAWS-related discussions, CCW signatories established the GGE to meet on 13 November 2017 with a mandate to evaluate questions concerning LAWS. Since then, the GGE has met regularly in Geneva and discussed LAWS in-depth.

After several years of discussions on LAWS, dialogue continues but the CCW signatories are still sharply divided; they largely fall into three main camps. A group of 30 nations are in favour of a global LAWS ban. Others, like Germany and Japan, are non-committal and might be willing to entertain a regulatory framework on LAWS, but are anxious not to offend their allies in the final group. The final group consists of LAWS proponent nations like Russia, US, UK, Israel and France. They view a pre-emptive ban of LAWS as premature and are very reticent to restrict LAWS capabilities, which they view as crucial for future armed conflicts. This last group has generally slowed and obstructed the progress of CCW discussions, while their funding of

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[327] *Ibid*. The Protocols of the CCW are as follows: Protocol 1 - Non-detectable Fragments; Protocol 2 - Prohibitions or Restrictions on the Use of Mines, Booby Traps and Other Devices; Protocol 3 - Prohibitions or Restrictions on the Use of Incendiary Weapons; Protocol 4 - Blinding Laser Weapons (BLW); and Protocol 5 - Explosive Remnants of War.

[328] United Nations Office at Geneva (UNOG), "Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects," Final Report: CCW/MSP/2013/10, Convention on Conventional Weapons, Geneva, Switzerland: 16 December 2013, 4, https://undocs.org/pdf?symbol=en/CCW/MSP/2013/10.

[329] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I."

LAWS R&D has only accelerated. China has taken a somewhat conflicted stance on LAWS in these discussions, as it supports a LAWS ban but also invests heavily in military applications of AI and LAWS R&D.[330] In effect, CCW discussions have improved the overall understanding of LAWS, but not much else.

LAWS opponents have been largely dissatisfied with the lack of progress made via CCW discussions on LAWS.[331] On 21 August 2017, Tesla's Musk and Google DeepMind's Demis Hassabis and Mustafa Suleyman, and 114 other AI experts published an open letter which implored the GGE to achieve tangible progress on the issue, warning that: "[w]e do not have long to act. Once this Pandora's box is opened, it will be hard to close."[332] Since then, some LAWS opponents have gone so far as to suggest that GGE discussions have actually regressed. Namely, they have noted that the language used by the American, Russian and Israeli delegations since 2018 has increasingly focused on potential LAWS benefits and downplayed its risks.[333] As well, Russia, US, and Israel have also made concerted efforts to remove references to "human control" from the final reports of recent GGE meetings.[334] In fact, this key phrase is barely referenced in the GGE's final report from 2019.[335] The idea of maintaining "meaningful human

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[330] Elsa Kania, "China's Strategic Ambiguity and Shifting Approach to Lethal Autonomous Weapon Systems," *Lawfare*, 17 April 2018, last accessed 20 March 2021, https://www.lawfareblog.com/chinas-strategic-ambiguity-and-shifting-approach-lethal-autonomous-weapons-systems.
[331] Hynek and Solovyeva, "Operations of Power in Autonomous Weapon Systems..."..., 81.
[332] Future of Life Institute (FLI), "An Open Letter on the United Nations Convention on Certain Conventional Weapons," Letter, 21 August 2017, last accessed 21 March 2021, https://futureoflife.org/autonomous-weapons-open-letter-2017/.
[333] Ray Acheson, "CCW Report: Civil society perspectives on the CCW Group of Governmental Experts on Lethal Autonomous Weapon Systems, 27-31 August 2018," *Reaching Critical Will - CCW Report* 6(11), edited by Ray Acheson, New York, NY, USA: (4 September 2018), 1, last accessed 14 March 2021. https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/reports/CCWR6.11.pdf.
[334] *Ibid*, 7-8; Ray Acheson, "CCW Report: Civil society perspectives on the CCW Group of Governmental Experts on Lethal Autonomous Weapon Systems, 20–21 August 2019," *Reaching Critical Will - CCW Report* 7(6), edited by Ray Acheson, New York, NY, USA: (21 August 2019), 5-6, last accessed 14 March 2021. https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2019/gge/reports/CCWR7.6.pdf.
[335] United Nations Office at Geneva (UNOG), "Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects," Final Report: CCW/MSP/2019/9, Group of Governmental Experts

control" in the use of lethal force is not only the core issue of the entire LAWS debate but it is a principle that was first introduced during that initial informal Meeting of Experts in 2014 and generated considerable support.[336] For opponents, any weakening of this principle represents a major setback.[337]

LAWS, by its very nature, does pose some challenges to enacting a ban or regulatory framework. Firstly, past successful arms control agreements have typically dealt with "discrete technologies" like APLs.[338] In contrast, LAWS relies on complex, dual-use and strategically advantageous technologies like AI and robotics; thus, finding agreement to restrict the development of these technologies in LAWS has proved challenging. Secondly, as LAWS are still largely under development and have not been widely fielded, the potential horrors of their use has not yet been experienced like, for example, chemical weapons were during World War I and then subsequently banned in 1925.[339]

To some degree, progress via the GGE process has been stymied by how the GGE functions and its weak mandate. Firstly, GGE meetings on LAWS typically occur only once or twice a year over a two-four day period. Secondly, the GGE's actual mandate is weak, as its objective is to discuss LAWS and then report back to the CCW with recommendations. The GGE has not received authorization to negotiate on a new CCW protocol covering LAWS. Instead, and only recently in 2019, the GGE was tasked to consider "aspects of the normative

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from Convention on Conventional Weapons, Geneva, Switzerland: 13 December 2019, 1-11. https://undocs.org/CCW/MSP/2019/9.

[336] UNIDIR, "The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values"..., 7.

[337] Darrell M. West and John R. Allen, *Turning Point: Policymaking in the Era of Artificial Intelligence* (Washington, DC, USA: Brookings Institution Press, 2020), 147.

[338] *Ibid*.

[339] The use of chemical weapons were subsequently banned in 1925 due to public revulsion concerning their effects.

and operational framework" on LAWS during its 2020 and 2021 meetings.[340] Thirdly, GGE discussions adhere to the CCW practice of consensus recommendations and voting, which tends to result in "lowest common denominator outcomes."[341] In this way, as Elvira Rosert and Sauer have suggested, "the current GGE process is, in fact, aptly described as going slow and aiming low."[342] The CCW's "rule of consensus" has allowed proponent nations the ability to stymie efforts to ban or regulate LAWS.[343] This consensus decision-making process has left LAWS opponents without recourse in the face of great power interests.[344] Indeed, as Arkin has suggested, "progress toward a consensus is slow at best and may never emerge."[345] Yet, despite the obvious lack of progress, state signatories still view the CCW as the most "appropriate venue for debating and regulating LAWS" with GGE recommendations forming the basis of such regulation.[346]

THE GLOBAL SOUTH AND THEIR OPPOSITION TO LAWS

Within the GGE, 28 of the 30 nations calling for a pre-emptive ban of LAWS are from the Global South. Closely supported by NGOs like CSKR, these nations have been, as Ingvild Bode notes, some of "the most active participants...in terms of both the number and the substance

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[340] United Nations Office at Geneva (UNOG), "Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects," Final Report: CCW/MSP/2019/9, Group of Governmental Experts from Convention on Conventional Weapons, Geneva, Switzerland: 13 December 2019, 5. https://undocs.org/CCW/MSP/2019/9.

[341] Hynek and Solovyeva, "Operations of Power in Autonomous Weapon Systems..."..., 90. Consensus recommendations in the CCW are largely attributable to its Cold War origins.

[342] Elvira Rosert and Frank Sauer, "How (Not) to Stop the Killer Robots: A Comparative Analysis of Humanitarian Disarmament Campaign Strategies," *Contemporary Security Policy* 42, no. 1 (January 2021): 20, https://doi.org/10.1080/13523260.2020.1771508.

[343] Daisuke Akimoto, "International Regulation of "Lethal Autonomous Weapons Systems" (LAWS): Paradigms of Policy Debate in Japan," *Asian Journal of Peacebuilding* 7, no. 1 (2019): 324, https://search-proquest-com.cfc.idm.oclc.org/docview/2469264950.

[344] Hynek and Solovyeva, "Operations of Power in Autonomous Weapon Systems..."..., 93.

[345] Ronald C. Arkin, "Ethics and Autonomous Systems: Perils and Promises [Point of View]," *Proceedings of the IEEE* 104, no. 10 (2016): 1779-1781, 1780. https://ieeexplore-ieee-org.cfc.idm.oclc.org/document/7571204.

[346] Rosert and Sauer, "How (Not) to Stop the Killer Robots..."..., 20.

of their interventions" in the GGE meetings.[347] In fact, GGE statements from Global South nations against LAWS have become increasingly forceful and coordinated. For example, on 9 April 2018, the African Group delivered a clear and strong joint statement in support of a ban on LAWS:

> The African Group finds it inhumane, abhorrent, repugnant, and against public conscience for humans to give up control to machines, allowing machines to decide who lives or dies, how many lives and whose life is acceptable as collateral damage when force is used.[348]

Such unequivocal statements reveal the frustration of Global South nations with the lack of progress with the GGE process. Through such statements, Global South nations are asserting leadership, as Bode suggests: "in the case of LAWS, it is countries of the Global South rather than Western states such as Norway or Canada that are taking the lead."[349]

There are several factors that are motivating Global South nations at the GGE. Firstly, Global South nations like Pakistan do strongly oppose LAWS because they know that their nations may become a future battlefield for LAWS, as has been experienced with the use of armed UAVs over their territory.[350] Secondly, as offensive LAWS will likely be long-range, carry significant payloads and incorporate advanced AI, Global South nations know that such platforms will be expensive and fielded only by nations with the means to do so (E.g.: not them). Thus, their opposition to LAWS is also somewhat self-interested as they are attempting to avoid technological overmatch in a future conflict.[351]

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[347] Ingvild Bode, "Norm-making and the Global South: Attempts to Regulate Lethal Autonomous Weapons Systems." *Global Policy* 10, no. 3 (2019), 359, https://onlinelibrary-wiley-com.cfc.idm.oclc.org/doi/full/10.1111/1758-5899.12684.
[348] African Group, "Statement by the African Group," Statement to the GGE on LAWS of the CCW, Geneva, Switzerland: 9 April 2018, https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/statements/9April_African-Group.pdf.
[349] Bode, "Norm-making and the Global South..."..., 362.
[350] *Ibid*, 361.
[351] Krishnan, "Automating War: The Need for Regulation"..., 190.

CANADIAN GOVERNMENT POLICY ON LAWS

The GoC's policy on LAWS has evolved over the last decade. Canada has been a regular participant in CCW discussions since their inception. Yet, Canada's contributions have been limited and lacked substance. Thus, Canada has been far more of an observer that has "chosen to remain on the sidelines" than an active participant.[352]

Indications of the GoC's initial policy stance on LAWS were evident in the Canadian Department of National Defence's (DND) 2017 publication *Strong, Secure, Engaged* (*SSE*). In it, DND identified "autonomous systems" as one of several technologies that have "the potential to change the fundamental nature of military operations."[353] As well, *SSE* did reiterate the Canadian Armed Forces' (CAF) commitment "to maintaining appropriate human involvement in the use of military capabilities that can exert lethal force."[354] This CAF commitment was an important indicator of GoC policy as it aligns closely with the concept of "meaningful human control" over LAWS that has been promoted by LAWS opponents.[355] On 13 December 2019, the GoC stance on LAWS was cemented and any ambiguity was removed. In a ministerial mandate letter, Prime Minister (PM) Justin Trudeau directed his Minister of Foreign Affairs (MFA), François-Philippe

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[352] Branka Marijan, "Canada's deafening silence on the creation of Autonomous Weapons," *Toronto Star* (Online), 9 October 2020, https://www.thestar.com/opinion/contributors/2020/10/09/canadas-deafening-silence-on-the-creation-of-autonomous-weapons.html.

[353] Canada, Department of National Defence, *D2-386/2017E, Strong, Secure, Engaged (SSE)* (Ottawa, CA: 2017), 55, last accessed 9 November 2020, http://dgpaapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf.

[354] *Ibid*.

[355] HRW and IHRC, *Advancing the Debate on Killer Robots: 12 Key Arguments...*, 24; Campaign to Stop Killer Robots (CSKR), "About," last accessed 19 March 2021, https://www.stopkillerrobots.org/about/; FLI, "Autonomous Weapons: An Open Letter from AI and Robotics Researchers." https://futureoflife.org/open-letter-autonomous-weapons. NGOs like HRW, CSKR and the FLI have all advocated for the maintenance of "meaningful human control" over LAWS.

Champagne to: "advance international efforts to ban the development and use of fully autonomous weapon systems."[356]

REGULATORY OPTIONS OUTSIDE OF THE CCW

LAWS is but one of several weapon systems where efforts to internationally regulate them through the CCW framework have ultimately failed and been stymied by the great powers. Efforts to completely ban the use of APLs and CMs via the CCW were also blocked.[357] Instead, APLs were banned via the Ottawa Treaty, which came into force on 1 March 1999.[358] Similarly, CMs were banned through the Oslo Treaty, which came into force on 1 August 2010.[359] Although several great powers are non-signatories to these two arms control treaties, both treaties do enjoy considerable global support with 164 states party to the Ottawa Treaty and 111 states party to the Oslo Treaty. Although APL and CM use has not been eliminated, both treaties have significantly curtailed their use as it is now challenging for defence manufacturers to make them profitably and at economies of scale, and for non-signatories to deploy them without significant international consternation.[360] If consensus cannot be found in the CCW on LAWS, the arms control model established by the Ottawa and Oslo Treaties could be used for LAWS. Lastly, besides regulatory treaties, other options available include national bans, non-binding resolutions, common understandings, and political declarations against LAWS.[361] Thus, if CCW discussions fail, there are other, less-comprehensive options available to curtail LAWS use.

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[356] Canada, Office of the Prime Minister, *Minister of Foreign Affairs Mandate Letter*, 13 December 2019, last accessed 13 January 2021, https://pm.gc.ca/en/mandate-letters/2019/12/13/minister-foreign-affairs-mandate-letter. Global Affairs Canada (GAC) is the GoC lead on LAWS.
[357] Hynek and Solovyeva, "Operations of Power in Autonomous Weapon Systems..."..., 86.
[358] The Ottawa Treaty is also known as the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction.
[359] The Oslo Treaty is also known as the Convention on Cluster Munitions.
[360] Asaro, "On Banning Autonomous Weapon Systems..."..., 706.
[361] Rebecca Crootof, "The Killer Robots are here: Legal and Policy Implications," *Cardozo Law Review* 36, no. 5 (2015): 1897-1903, https://heinonline.org/HOL/P?h=hein.journals/cdozo36&i=1943.

LACK OF MIDDLE POWER TO LEAD LAWS REGULATORY EFFORTS

Efforts to ban or regulate LAWS, in general, have also been hindered by the fact that there is no Western middle power that has stepped forward to guide the LAWS opponent movement. With the Ottawa Treaty, Canada was the middle power that led efforts to ban APLs, while Norway did the same for CMs via the Oslo Treaty. With Protocol 4 of the CCW, France and Sweden were instrumental in its ratification.[362] Thus, there is a real opportunity for Canada - if it wants it - to lead again in efforts to ban or regulate LAWS. In the last two years, though, Global Affairs Canada's (GAC) continued anemic contributions to the GGE have certainly not been suggestive of a Canadian desire to assume such a leadership role and has drawn sharp criticism. Branka Marijan described Canada's participation in the 21-25 September 2020 GGE meeting as follows:

> If Canada intended not to make waves over a week ago at United Nations meetings on lethal autonomous weapons - otherwise known as killer robots - then mission accomplished. One of the few countries not to make an individual or joint statement at the gathering in Geneva, Canada only took the floor once, to clarify that the chair had called on it by mistake.[363]

If Canada does not want to assume a leadership role at the GGE on LAWS, it could still serve as a type of "patron" to a Global South nation, guiding them on how to successfully bypass CCW-based arms control in favour of an *ad hoc* regime akin to the Ottawa Treaty.[364]

CONCLUDING REMARKS

In conclusion, efforts to ban or regulate LAWS under the CCW framework have been slow and consensus remains elusive. Despite tangible support to ban LAWS amongst Global South nations, LAWS proponent nations have been successful in obstructing progress in the GGE. As well, perhaps out of desire in not wanting to offend their great power allies, middle

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[362] Rosert and Sauer, "How (Not) to Stop the Killer Robots..."..., 20-21.
[363] Marijan, "Canada's deafening silence on the creation of Autonomous Weapons."
[364] Hynek and Solovyeva, "Operations of Power in Autonomous Weapon Systems..."..., 91.

powers have been reticent to lead efforts to ban or regulate LAWS inside the CCW. In speaking about CCW discussions, Bode wisely cautions:

> ...we should not expect overnight results: although recent humanitarian disarmament efforts, such as the NWPT [Nuclear Weapons Prohibition Treaty], came to fruition in a (surprisingly) short amount of time, many other non-proliferation or disarmament issues have taken decades to enter the negotiation stage.[365]

Thus, international dialogue on LAWS continues but without consensus or progress.

[365] Bode, "Norm-making and the Global South..."..., 362.

CHAPTER 7: CONCLUSION

CONCLUSION

> Asimov's Laws of Robotics have been a very successful literary device. Perhaps ironically, or perhaps because it was artistically appropriate, the sum of Asimov's stories disprove the contention that he began with: it is *not* possible to reliably constrain the behaviour of robots by devising and applying a set of rules.
>
> - Roger Clarke, *Asimov's Laws of Robotics: Implications for Information Technology - Part II*[366]

Through his science fiction, Asimov was able to apply his Laws to the robots of his imagination, placing them in possible, future real-world scenarios. As Clarke notes, what Asimov found was that his Laws failed not because of any design weakness of their algorithms but rather because life itself does not have an algorithmic nature.[367] Life, just like war, does not follow any pre-determined path or pattern. As such, suggestions that the use of LAWS will be controlled, predictable, legal, and ethical must be taken with a grain of salt. In reviewing the vast array of LAWS-related discourse penned by LAWS proponents and opponents alike, this DRP author has sought to maintain an open mind and to evaluate both sides of this great debate based on the strength of their respective arguments. However, over time, the sheer preponderance of evidence against LAWS and the persuasiveness of the arguments made by LAWS opponents has led the author to conclude that LAWS are manifestly illegal, unethical, unpredictable, uncontrolled and their use poses grave risks to global peace and strategic stability. As such, the development, production and use of LAWS should be prohibited through a pre-emptive, international ban or failing that, curtailed through a regulatory framework. While the technology behind LAWS is still relatively nascent, there now exists an opportunity to reject technological determinism and control their development. Indeed, the enduring popularity of science fiction

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[366] Roger Clarke, "Asimov's Laws of Robotics: Implications for Information Technology - Part II," *Computer* 27, no. 1, 1994, 65, https://doi.org/10.1109/2.248881.
[367] *Ibid*, 57-66.

involving autonomous weapons does suggest that there is a significant public revulsion to the prospect that a human life could one day be extinguished simply because of the decision of a machine. Thus, the author believes that there would be significant support for either of the above initiatives.[368] In short, humanity must maintain meaningful control over both the use of weapon systems and life-and-death decision-making in warfare; we cannot outsource these responsibilities to machines. We owe it to ourselves - and to our enemies - to maintain these responsibilities.

Finally, this DRP has also sought to examine the GoC's policy on LAWS and highlight potential opportunities open to our nation. A year and a half ago, the GoC staked out a clear and indisputable position in opposition to the development, production and use of LAWS. Canada continues to participate in CCW discussions on LAWS. The problem, though, is this participation has been just that - participation. Canada has not made substantive contributions in the GGE nor has it demonstrated a desire to lead. As a middle power, Canada has actively led, been successful with, and garnered praise for its past arms-control efforts. Should it not want to carry on with this honourable Canadian tradition in relation to LAWS, the GoC can still provide technical advice to Global South nations at the forefront of international efforts to ban LAWS. The ball is truly in Canada's court.

[368] UNIDIR, "The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values"..., 8.

APPENDIX 1: POLICY RECOMMENDATIONS

POLICY RECOMMENDATIONS

The purpose of this DRP was to determine what are the potential military/political, legal and ethical implications of employing LAWS. The author of this DRP recommends that the use of LAWS be banned or at the very minimum, regulated at the international-level. This recommendation and others below were reached through a methodical and detailed examination of the LAWS-related discourse. As the discourse tends to be dominated by politically-motivated parties - some of whom make haphazard use of anthropomorphic language in relation to LAWS - and as LAWS is an emerging technology, this examination was not without its challenges. Thus, this DRP followed a very deliberate roadmap to get to this point. In Chapter 2, a common start-state was established as LAWS definitions and concepts were outlined. Next, the aforementioned implications of the use of LAWS were examined: specifically, political and military implications were detailed in Chapter 3; legal implications in Chapter 4; and ethical implications in Chapter 5. Lastly, a review of the ongoing international discussions on LAWS was conducted in Chapter 6, tracing their origins, describing their current status, and outlining paths forward. With this roadmap now complete, the author would like to put forward the following recommendations on LAWS, which can be pursued by the GoC and international community:

- **Taking Action While One Still Can** - There is still a small window of opportunity for the international community to act collaboratively and pre-emptively to shape the future of LAWS before they are fielded on a wide scale. This opportunity must be seized with a sense of urgency. As Chapter 3 demonstrated, the trends are clear: the automation of killing, the robotization of the battlefield, operational tempo, and investment in LAWS R&D are all increasing, while defence budgets are increasingly coming under pressure.

These trends are a potent mix that, if left unchecked, will lead to the inevitable emergence of LAWS. Once LAWS are fielded on a significant scale by one nation and are viewed as conferring a military advantage on said nation, other nations will follow just to level the playing field. At that point, efforts to ban or regulate this technology will be vigorously resisted and insurmountably difficult.[369] Indeed, much as the signatories of the 2017 FLI letter have warned concerning the development of LAWS: "[w]e do not have long to act. Once this Pandora's box is opened, it will be hard to close."[370] Thus, it is recommended that the international community and nation-states like Canada act now on LAWS, while the amount of autonomy ceded to weapon systems can still be controlled.

- **Frank Discussions** - In any sort of official, international discussion pertaining to LAWS, it is recommended that the harsh realities of their use be acknowledged without equivocation or subterfuge. In short, LAWS represent a paradigmatic shift in military technology because life-and-death decisions have been ceded to machines outside of human control. The technology behind LAWS is unproven and the suggestion that LAWS can be programmed to act ethically on the battlefield is speculative at best and has never been practically demonstrated. The use of LAWS does diminish human dignity and is manifestly unethical. Although discussions on LAWS can sometimes be distracted by definitional disputes or spacious language, the above core realities cannot be diminished. Our current moment must be seized and a new international, legally-binding instrument that requires that the meaningful human control over both the use of weapon systems and life-and-death decision-making in warfare must be established. By drawing

[369] Carvin, "Getting Drones Wrong"..., 132.
[370] FLI, "An Open Letter on the United Nations Convention on Certain Conventional Weapons."

a principled, clear line in terms of what can and cannot be automated in warfare, various slippery slopes that lead directly towards the use of LAWS can be avoided. It is recommended that Canada actively lead efforts to draw this principled, clear line in relation to the use of LAWS during ongoing discussions at the CCW's GGE.

- **National Ban** - In line with the aforementioned direction of the Canadian PM to his MFA, it is recommended that the GoC draft and table federal legislation to ban the development, production and use of LAWS. As passage of this legislation will take time, it is recommended that the following intermediate steps be taken: a declaration by the GoC of an immediate, indefinite moratorium on the development, production and use of LAWS should be made and associated policy statements by the DND issued to the CAF. Such measures would provide an example for like-minded nations to emulate and send a clear signal to defence manufacturers that there is no market for LAWS in Canada.
- **International Ban** - It is recommended that Canada lead efforts and/or provide technical advice to like-minded nations to establish a comprehensive, pre-emptive and legally-binding instrument to ban the development, production and use of LAWS. Ideally, this instrument would be negotiated under the auspices of the CCW and come to form one of its protocols. Should this prove not possible due to a lack of consensus within the CCW for such a measure, it is recommended that this instrument be negotiated in an *ad hoc* forum outside of the CCW much like the Ottawa and Oslo Treaties were. Such an *ad hoc* instrument would be negotiated by like-minded nations who believe that LAWS will lead to the dehumanization of warfare, and would be closely supported by aligned NGOs. Even if nations actively engaged in LAWS R&D will not sign such an instrument, if it is signed and ratified by a majority of nations, it will eventually become recognized as

customary law and lower the chances of LAWS proliferation. While past arms-control instruments have been concentrated on specific weapons, their effects or their indiscriminate nature, a ban on LAWS would need to focus on the prohibition of inadequate human control over LAWS and the ceding of lethal force decisions to it. This ban would establish said prohibitions as international norms. Without a doubt, a ban on LAWS will be a challenging endeavour that will be undermined by LAWS proponents at every opportunity. However, in light of the long list of negative implications that LAWS pose, such as ban is needed and is a morally-desirable, politically-prudent solution.

- **Regulatory Framework** - If efforts to craft, negotiate and ratify an international ban on LAWS fail, it is recommended that Canada and like-minded nations adopt a fallback/intermediate position and attempt to regulate LAWS through a legally-binding, arms control framework. This framework would be best served if it seeks to limit the number and types of LAWS that can be deployed by signatory nations in addition to the contexts in which they can be used. As discussed in Chapter 2, limiting the use of LAWS to certain contexts - uncluttered environments, against anti-materiel targets and/or only in the defensive role - will greatly reduce the potential for LOAC violations caused by them.
- **Accountability Mechanism** - For any sort of international regulatory framework on LAWS to be effective, an accountability mechanism must be established as part of this framework. In terms of accountability, nations intending on using LAWS would need to agree to having any LAWS-related legal disputes resolved by an international tribunal like the ICJ and recognize the authority of such tribunals to hear said disputes. This would enable victim nations to hold offending nations liable for any LAWS-

commissioned war crimes, providing a means for meaningful retributive justice. It is recommended that Canada insist for the inclusion of such an accountability mechanism into said framework during its negotiation.

- **Legal Reviews** - Lastly, it is recommended that Canada advocate for nations engaged in LAWS R&D to conduct legal reviews of these weapons in accordance with Article 36 of AP1. These legal reviews need to: ensure that LAWS are consistent with the requirements of LOAC/IHL; be conducted in good faith; and occur throughout the development and testing phases of these weapons.

APPENDIX 2: PRECURSOR TECHNOLOGIES, DEMONSTRATORS AND LAWS CURRENTLY IN SERVICE

PRECURSOR TECHNOLOGIES, DEMONSTRATORS AND LAWS CURRENTLY IN SERVICE

In this appendix, precursor technologies for LAWS, demonstrators and the two examples of LAWS highlighted by Scharre are examined in detail. What becomes clear in Appendix 2 is that crude forms of LAWS are closer to becoming a reality than one may think. These platforms are being developed for all major warfighting domains, which is suggestive of their broad application. Lastly, operational accidents involving precursor LAWS technologies have been significant and are indicative of the kinds of accidents that could occur if LAWS are deployed on a larger scale and pre-maturely.

CIWS - Phalanx And Centurion C-RAM

In service today, there are several weapon systems that use limited machine decision-making autonomy. Some of the most notable ones can be found at sea, like the previously mentioned Phalanx, which is a CIWS-type weapon and is depicted in Figure A2.1.

Figure A2.1: The Phalanx CIWS.
Source: Wikipedia, "Phalanx CIWS."[371]

First fielded by the US Navy in 1984, the Phalanx was designed to be a last line of defence for naval vessels against the threat of anti-ship missiles and to a lesser degree, surface torpedoes, small boats and helicopters. It uses "a combination of radars, computers, and rapid-firing, multiple-barrel rotary [20 mm] cannons placed on a rotating turret" to engage threats that approach the vessel that it is defending.[372] The Phalanx is an entirely self-contained unit, which is ideal for mounting on support ships, which have limited sensors and lack integrated targeting systems.[373] The Phalanx was a direct response by the US Navy to the threats of the late Cold War period. Specifically, ship-mounted Phalanx systems were meant to engage at machine speed salvos of as many as 60 Soviet cruise missiles at a time. Since it was first fielded in 1984, the Phalanx was meant to principally be a highly-automated, HOTL system but subsequent upgrades have enabled it to also be set to an autonomous mode of operation in a high-threat environment,

[371] Wikipedia, "Phalanx CIWS," last accessed 20 February 2021, https://en.wikipedia.org/wiki/Phalanx_CIWS."
[372] *Ibid*.
[373] *Ibid*.

wherein it can "autonomously find, track, and destroy enemy anti-ship missiles" without human intervention.[374] As Work has said, the Phalanx was programmed “to have a totally automatic setting, and literally the human at some point pushes the button and the machine makes all the decisions.”[375] The Phalanx is currently used by 15 nations, while other nations have fielded other similar CIWS-type systems such as the AK-630V (Russia), Goalkeeper (Netherlands), Meroka (Spain) and the Type 730 CIWS (China).

The Centurion Counter Rocket, Artillery and Mortar (C-RAM) system is essentially the US Army's terrestrial version of the Phalanx - taken off a ship and mounted onto a flatbed truck. First deployed to Iraq in 2005 and then later to Afghanistan, the Centurion has been employed to counter persistent, incoming indirect fire threats to coalition tactical infrastructure. There are some differences between the Phalanx and Centurion. For example, as the airspace above a Centurion can be expected to be more congested with both friendly and civilian aircraft, the system uses "overlapping safeties, both automated and human" and requires that "human operators must take a positive action before each engagement."[376] Also, the ammunition used by each system is different. The Phalanx uses 20 mm tungsten or depleted uranium-based armour-piercing rounds designed to destroy a missile's airframe, making it no longer aerodynamic. The Centurion, on the other hand, uses 20 mm High-Explosive Incendiary Tracer, Self-Destruct (HEIT-SD) rounds designed to explode on impact or tracer burnout, thus reducing the collateral damage potential for rounds fired near an urban area which failed to impact the target.[377] The Centurion's operational history has not been completely perfect as a Centurion once locked onto a US military helicopter flying over Baghdad to shoot it down. Although the Centurion did not

[374] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting," 79.
[375] Atherton, "Are Killer Robots the Future of War? Parsing the Facts on Autonomous Weapons"..., 2.
[376] Scharre, "Centaur Warfighting: The False Choice of Humans Vs. Automation"..., 157-158.
[377] Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century*..., 38.

engage in this instance, this incident did result in the systems being reconfigured to prevent future friendly fire incidents.[378]

Aegis Combat System

In the sea domain, the Aegis Combat System (ACS) was developed for US Navy guided-missile destroyers and cruisers to protect them against missile and aircraft attacks; it was first deployed in 1983 and designed to counter Soviet threats. The heart of the ACS is the Aegis Weapon System (AWS), which is composed of an "AN/SPY-1 Radar, MK 99 Fire Control System, Weapon Control System, Command and Decision (C&D) Suite, and SM-2 Standard Missile family of weapons."[379] Whereas the Phalanx uses a cannon at close range for defense, the AWS uses missiles to defend its parent vessel at range against missiles of various type and aircraft. The AWS can track up to 100 targets at a distance of more 190 kilometres and provide in-flight guidance to its missiles. The AWS, along with the Phalanx and the Mark 41 Vertical Launch System, are subordinate weapon systems that are integrated into the ACS.

In terms of autonomy, as Singer tells us, the ACS is designed to operate in one of four operational modes to be determined by the human operator:

> 1. **Semi-Automatic**: In which humans work with the system to judge when and at what to shoot;
> 2. **Automatic Special**: In which human controllers set the priorities, such as telling the system to destroy bombers before fighter jets, but the computer decides how to do it;
> 3. **Automatic**: In which data goes to human operators in command but the system works without them; and
> 4. **Casualty**: In which the system just does what it calculates is best to keep the ship from being hit.[380]

Thus, depending on the mode that it is set to, the ACS can conceivably function as a HITL, HOTL or HOOTL system. The Automatic and Casualty operating modes are meant for wartime,

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[378] *Ibid*.
[379] Wikipedia, "Aegis Combat System," last accessed 18 February 2021, https://en.wikipedia.org/wiki/Aegis_Combat_System.
[380] Singer, "In the Loop? Armed Robots and the Future of War."

as once they are activated, the ACS will engage incoming threats without any additional human input. One could argue regardless of the mode that the ACS is set to, it remains a HOTL system as humans can intervene at any point. That said, the autonomy provided by those two wartime modes does mean that there may not be enough time for a human operator to intervene and prevent an "inappropriate engagement" if the ACS malfunctions.[381]

Although the ACS does offer significant benefits, one incident during its operational history does highlight the tragic risks that it can pose and requires recounting here: the downing of Iran Air Flight 655 on 3 July 1988 by the *USS Vincennes*. On this day, while patrolling in the Persian Gulf, the *USS Vincennes* detected Iran Air Flight 655, an Airbus passenger jet, via its ACS. The airliner's course and speed was consistent with a passenger jet and it was broadcasting a radar and radio signal that showed it to be civilian - all of this was information that was readily available to the crew of the *USS Vincennes*.[382] Despite this, the ACS, which was in Semi-Automatic mode at the time, designated the jet as a much smaller Iranian F14 fighter to its human operators. Not critically questioning this designation, the crew of the *USS Vincennes* authorized the engagement. As a tragic result, the airliner was shot down, killing all 290 passengers and crew including 66 children.[383] This incident clearly demonstrates two things: systems like the ACS can sometimes be incorrect and that human operators can sometimes outsource their better judgment to algorithms as result of "automation bias," placing too much trust in their accuracy.[384]

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[381] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I."
[382] Shane Harris, "Autonomous Weapons and International Humanitarian Law Or Killer Robots are here. Get used to It," *Temple International and Comparative Law Journal* 30, no. 1 (2016): 80, https://heinonline.org/HOL/P?h=hein.journals/tclj30&i=85.
[383] Singer, "In the Loop? Armed Robots and the Future of War."
[384] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability"..., 769.

Iron Dome

Working in close cooperation with the US, Israel developed and then deployed the Iron Dome system in April 2011. It protects Israel from ground-to-ground weapons fired into its territory. It has been deployed specifically near Eilat and Israel's Gaza border. The Iron Dome consists of three components: the Detection and Tracking Radar, the Battle Management and Weapon Control, and Missile Firing Unit.[385] The Iron Dome uses radar to identify inbound rockets and artillery shells. After the incoming threat is detected, the Iron Dome sends a recommended threat response to a human operator; they must immediately decide whether or not to neutralize said threat by firing a Tamir interceptor missile. In terms of operational record, the Iron Dome has proven to be 90% effective in terms of intercepts and has substantially outperformed the older PAC-3 Patriot System used by the US and other nations.[386] At their core, both systems do integrate elements of autonomy in their targeting decisions. As Horowitz outlines, the autonomous characteristics of the PAC-3 Patriot System "proved too brittle for the real ambiguities of combat, and operators trusted the sensors too much," as the system was responsible for shooting down two friendly aircraft during the US-led invasion of Iraq in 2003.[387] The factors behind these two fratricides are "complex" as Scharre notes, but "a lack of complete human understanding over the functionality of the weapon was a major factor."[388] No one was ultimately held responsible for this incident, as Horowitz and Scharre tell us, because it "resulted from poor operator training, complex system design, and a real-world environment that wasn't anticipated."[389]

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[385] Wikipedia, "Iron Dome," last accessed 10 March 2021, https://en.wikipedia.org/wiki/Iron_Dome.
[386] Dremliuga, "General Legal Limits of the Application of the LAWS..."..., 116.
[387] Horowitz, "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability"..., 773.
[388] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part II."
[389] Horowitz and Scharre, "The Morality of Robotic War"..., 7.

Robotic Sentries - Sentry Tech, Super aEgis II And SGR-Al

In the land domain, a number of nations have developed and deployed semi-autonomous systems to serve in highly-scripted, defensive contexts as robot sentries or border guards in prohibited, demilitarized or 'no-go' zones. Israel's Sentry Tech and South Korea's Super aEgis II and SGR-Al are three notable examples of these types of systems. Israel's Sentry Tech system is deployed along its 60 kilometre border with Gaza. It is designed to detect movement along this border: namely, people attempting to breach the frontier or conduct sniper or mortar attacks nearby. If movement is detected, the Sentry Tech then alerts a control station, wherein human operators evaluate the threat warning and decide whether or not to engage it. Each Sentry Tech is armed with a 12.7 mm machine gun and a Spike-LR missile; the former has a kill zone of 1-1.5 kilometres, while the latter has a range of 4,000 metres.[390] Presently, the Sentry Tech is employed as a HITL system; however, the Israel Defence Forces (IDF) has suggested that this could change.[391]

Similarly, South Korea's Super aEgis II is an automated gun turret that is currently employed along the 250 kilometre-long and 4 kilometre-wide Korean Demilitarized Zone (DMZ) and is depicted in Figure A2.2.

[390] Wikipedia, "Spike (Missile)," last accessed 21 February 2021, https://en.wikipedia.org/wiki/Spike_(missile).
[391] HRW and IHRC, *Losing Humanity: The Case Against Killer Robots...*, 15.

Figure A2.2: The Super aEgis II.
Source: DoDaam Systems Ltd., "Super aEgis II - Remote Control Weapons Station: Datasheet."[392]

It can be mounted either with 12.7 mm machine gun or a 40 mm automatic grenade launcher. It can find and lock onto a human-sized target at a distance of up to 2.2 kilometres, irrespective of weather. The Super aEgis II system is employed as a HITL system; however, it was originally designed by its manufacturer, DoDaam, to include "an auto-firing system" until safeguards were requested to be implemented by South Korea.[393] Besides South Korea, the Super aEgis II system is also presently used by the United Arab Emirates and Qatar.

Finally, South Korea has also deployed Samsung Techwin's SGR-Al, a semi-autonomous sentry robot, at the DMZ. In contrast to the Super aEgis II, the SGR-Al is also capable of voice recognition and issuing commands to surrender. Although not publically known, it is also suspected of being capable of operating as a HOTL system if set to that mode.[394] Lastly, it is armed with a 5.56 mm automatic light machine-gun and 40 mm automatic grenade launcher.

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[392] DoDaam Systems Ltd., "Super aEgis II - Remote Control Weapons Station: Datasheet," last accessed 23 February 2021, http://www.dodaam.com/eng/sub2/menu2_1_4.php#.
[393] Morris, "A Four-Phase Approach to Developing Ethically Permissible Autonomous Weapons"..., 2.
[394] Evans, "At War with the Robots: Autonomous Weapon Systems and the Martens Clause"..., 705.

X-47B And Taranis

In the air domain, nations are developing armed UAVs which have greater autonomy. For example, the US Navy commissioned Northrop Grumman to design the X-47B, a low-observable, autonomous, unmanned combat aerial vehicle (UCAV) demonstrator for aircraft carrier-based operations as depicted in Figure A2.3.

Figure A2.3: The X-47B.
Source: Wikipedia, "Northrop Grumman X-47B."[395]

The X-47B can fly pre-programmed missions in response to a few mouse clicks and does not have to be actively piloted by remote control. During its testing from 2012-2017, the X-47B was able to autonomously complete the following tasks: take off and land on an aircraft carrier by

[395] Wikipedia, "Northrop Grumman X-47B," last accessed 24 February 2021, https://en.wikipedia.org/wiki/Northrop_Grumman_X-47B.

day and night, carry out aerial refueling, and fly across the continental US.[396] Although the X-47B was not armed during testing, it does have two weapon bays with a total payload capacity of 2000 kilograms of ordinance.

Similar to the X-47B, BAE Systems has also developed the Taranis as a low-observable, autonomous UCAV demonstrator for the UK's Royal Air Force (RAF) as depicted in Figure A2.4.

Figure A2.4: The Taranis.
Source: BAE Systems, "Taranis."[397]

Flying its first test flight in 2013, the Taranis has been designed to autonomously fly intercontinental missions in medium-to high-threat combat zones, carry weapons in two internal missile bays, and be able to attack both aerial and ground targets.[398] As demonstrators, both the Taranis and X-47B are prototypes meant to investigate and validate technologies that will be

[396] Northrop Grumman, "X-47B Unmanned Combat Air System: Datasheet," Northrop Grumman Systems Corporation, San Diego, CA, USA (2015), https://www.northropgrumman.com/wp-content/uploads/UCAS-D_Data_Sheet.pdf.
[397] BAE Systems, "Taranis," last accessed 22 March 2021, https://www.baesystems.com/en/product/taranis.
[398] Wikipedia, "BAE Systems Taranis," last accessed 17 February 2021, https://en.wikipedia.org/wiki/BAE_Systems_Taranis.

used in next-generation combat aircraft. Comparable demonstrators that have been tested in the last decade include the Dassault nEUROn (France), EADS Barracuda (Germany/Spain), Boeing X-45 (US), DRDO AURA (India), Mikoyan Skat (Russia) and Sukhoi Okhotnik (Russia).[399]

Sea Hunter

In the sea domain, from 2016-2018, the Defense Advanced Research Projects Agency (DARPA) of the US DoD conducted experimental sea trials of the *Sea Hunter*, an American autonomous unmanned surface vehicle (USV) built by Vigor Industrial and depicted in Figure A2.5.[400]

Figure A2.5: The *Sea Hunter*.
Source: Wikipedia, "Sea Hunter."[401]

The *Sea Hunter* is a 40 metre trimaran designed to conduct autonomous anti-submarine and counter-mine tasks.[402] It has enough fuel onboard to be able to conduct a 70-day patrol without

[399] Wikipedia, "Dassault nEUROn," last accessed 15 February 2021, https://en.wikipedia.org/wiki/Dassault_nEUROn.
[400] Wikipedia, "Sea Hunter," last accessed 26 February 2021, https://en.wikipedia.org/wiki/Sea_Hunter.
[401] *Ibid*.
[402] Thurnher, "No One at the Controls - Legal Implications of Fully Autonomous Targeting"..., 79.

need for refueling; thus, it can autonomously scout the high seas for enemy with no one onboard for months at a time.[403] The *Sea Hunter* is a HOTL system, wherein a human in a distant control station observes its operation and intervenes if necessary but does not pilot the ship. Instead, it is driven by onboard AI, which leverages optical sensors and radar to avoid hitting other vessels and obstacles while deployed.[404] During its initial trials, weapons were not mounted on or tested on the *Sea Hunter*; however, these could be added in subsequent trials. In 2018, DARPA handed over future testing of the *Sea Hunter* to the US Navy's Office of Naval Research. In September 2020, a photo of an unnamed Chinese People's Liberation Army Navy's (PLAN) equivalent of the *Sea Hunter* - which appears to be a near-identical copy - was posted to Weibo.[405]

THeMIS Combat And Type X Combat

In the land domain, the Estonian defence contractor Milrem Robotics is currently developing two unmanned ground vehicles (UGV): the Tracked Hybrid Modular Infantry System (THeMIS) Combat UGV and Type X Robotic Combat Vehicle (RGV) as depicted in Figures A2.6 and A2.7.

[403] Coker, "Artificial Intelligence and the Future of War"..., 57. https://doaj.org/article/32b4f8c15c2b41fbb6bfd845f3db7e31.
[404] Wikipedia, "Sea Hunter."
[405] H.I. Sutton, "New evidence of China's Copy of U.S. Navy *Sea Hunter* USV," *Covert Shores*, 25 September 2020, last accessed 21 March 2021, http://www.hisutton.com/Chinese-Navy-Sea-Hunter-USV.html.

Figure A2.6: The THeMIS Combat UGV with Protector RWS.
Source: MILREM Robotics, "THeMIS Combat UGV."[406]

Figure A2.7: The Type X RGV.
Source: MILREM Robotics, "Type X RGV."[407]

[406] MILREM Robotics, "THeMIS UGV-Combat," last accessed 22 March 2021, https://milremrobotics.com/defence/.
[407] MILREM Robotics, "Type X RCV," last accessed 22 March 2021, https://milremrobotics.com/type-x/.

The THeMIS Combat consists of a mobile base which has small tank treads mounted on it; it can be weaponized with the installation of one of several in-service remote weapon stations (RWS) on the base. A variety of weapons can be mounted on these RWSs including light or heavy machine guns, 40 mm grenade launchers, 30 mm auto-cannons or anti-tank missile systems.[408] The heavier Type X Combat is designed to "support mechanized units and act as a wingman to main battle tanks." It can be armed with 25 mm to 50 mm auto-cannons.[409] Both platforms can be used as HITL systems, controlled by a human operator through tele-operation. As well, using their onboard DL AI, both platforms have some limited autonomous functionality, as they can navigate and complete missions in accordance with pre-programmed parameters. The functionality to swarm or follow friendly forces remains under development by Milrem. To date, nine nations have acquired the THeMIS Combat UGV.

Harpy

Developed in the early 1990s, Israel's Harpy is one of two LAWS platforms currently in service and is depicted in Figure A2.7.

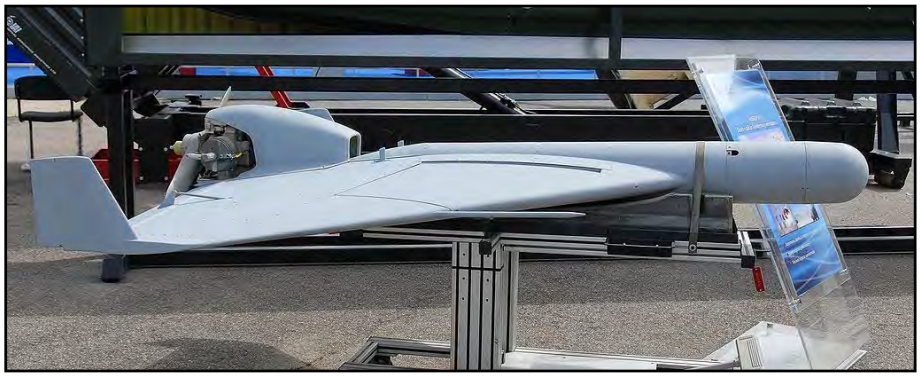

Figure A2.8: The Harpy.
Source: Wikipedia, "IAI Harpy."[410]

[408] MILREM Robotics, "THeMIS UGV-Combat."
[409] MILREM Robotics, "Type X RCV."
[410] Wikipedia, "IAI Harpy," last accessed 23 February 2021, https://en.wikipedia.org/wiki/IAI_Harpy.

The Harpy is designed to attack radar systems. It is a wide area, anti-radiation, autonomous, loitering munition. The Harpy is not recoverable. After it is launched, the Harpy flies over a designated area, loiters, and searches for a particular radar emission using its electromagnetic sensors. If said radar is detected, the Harpy can autonomously select it as a target and destroy it with its explosive payload by dive-bombing into it.[411] The Harpy is a HOOTL system; the only things that a human operator must provide to it is the pre-programmed search area and the target radar emission - the Harpy does everything else. The human operator does not know which, if any, radars will eventually be engaged by the Harpy. As a result of the fact that the Harpy executes lethal force against a typically manned target, which has not been selected specifically by a human operator, it can be considered to be a LAWS.[412] This type of crude targeting is highly problematic because of its lack of discrimination. As Noel Sharkey has noted, the Harpy is unable to differentiate between a radar station placed out in the open and radar that has been placed, for example, on top of a school.[413] Both locations would have a substantially different collateral damage estimate (CDE). The Harpy has been sold to and is also used by Azerbaijan, China, India, South Korea and Turkey.[414] After Harpy sales to China were halted at the insistence of the US, the Chinese reverse-engineered the Harpy to build their own anti-radiation loitering munition in 2017, the ASN-301, which is a near-identical copy.[415]

The Israel Aerospace Industries' successor to the Harpy is the Harop. Developed in the 2000s, the Harop is different from the Harpy in that it is larger and low-observable, has visual and infrared sensors, has a longer loiter time, and can be used as a HITL system.[416] When used

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[411] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I."
[412] Lucas, "Lethal Autonomous Weapons Systems: Issues for Congress"..., 9.
[413] Sharkey, "The Evitability of Autonomous Robot Warfare"..., 788.
[414] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I."
[415] Wikipedia, "IAI Harpy."
[416] Hammes, “Autonomous Weapons Are Coming, This is How We Get Them Right.”

as a HITL system, the Harop can engage a wider range of targets and be used as a 'suicide' drone. Operationally, Azerbaijan has used the Harop as a HITL system to destroy Armenian troop-carrying buses and tanks during the Nagorno-Karabakh conflict of 2016 and war of 2020.[417] Azerbaijan's use of the inexpensive Harop and Turkey's STM Kargu in the 2020 Nagorno-Karabakh war as 'suicide' drones and the vulnerability of land forces to them has caught the attention of militaries around the world.

Encapsulated Torpedo Mines

Besides the Harpy, the other weapon system in service that autonomously selects and engages targets is the encapsulated torpedo mine. Mines in general tend to be excluded from discussions on LAWS as they are simple devices that detonate when criteria are met (E.g.: adequate weight on a pressure plate). Encapsulated torpedo mines are different from traditional contact mines because they are smart and discriminate between combatant and non-combatant vessels through the use of onboard sensors and decision modules.[418] Also, because they are moored to the bottom of the sea, when a target vessel enters into range, they do not explode directly into the target as a traditional mine would but a capsule on the mine opens up and releases a torpedo that instead tracks onto and engages the surface vessel target.[419] There is absolutely no human operator involved in the selection and engagement of the target. Currently, Russia and China use the PMK-2 encapsulated torpedo mine. The US did have a large inventory of MK60 CAPTOR encapsulated torpedo mines but retired them in 2001 following the end of

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[417] Thomas Gibbons-Neff, "Israeli-made kamikaze drone spotted in Nagorno-Karabakh conflict," *The Washington Post (Online),* Washington, DC, USA: 5 April 2016, https://www.washingtonpost.com/news/checkpoint/wp/2016/04/05/israeli-made-kamikaze-drone-spotted-in-nagorno-karabakh-conflict/; *The Economist*, "The Azerbaijan-Armenia conflict hints at the future of war," London, United Kingdom: 8 October 2020, https://www.economist.com/europe/2020/10/08/the-azerbaijan-armenia-conflict-hints-at-the-future-of-war.

[418] Hammes, "Autonomous Weapons Are Coming, This is How We Get Them Right."

[419] Scharre, "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I."

the Cold War.[420] The US Navy is currently developing the Hammerhead encapsulated torpedo mine. Publicly-available details on this system are limited but it is believed to differ significantly from the MK60 CAPTOR as Hammerhead mines will be networked, will be used primarily as an autonomous anti-submarine weapon, will be able to be activated by friendly submarines, and be able to be covertly emplaced by Unmanned Underwater Vehicles (UUVs).[421]

[420] *Ibid*.
[421] David Hambling, "With Hammerhead Mine, U.S. Navy Plots New Style Of Warfare To Tip Balance In South China Sea," *Forbes (Online)*, New York, NY, USA: 22 October 2020. https://www.forbes.com/sites/davidhambling/2020/10/22/us-navys-hammerhead-mine-aims-to-tip-balance-in-south-china-sea/?sh=11d232c87df7.

GLOSSARY OF TERMS

Algorithm: An algorithm is a clear sequence of computer-implementable instructions or code that is used to solve a type of problem or to complete computations.

Artificial General Intelligence (AGI): AGI is the capacity of an engineered system to demonstrate the same rough sort of general intelligence as humans. AGI is not tied to a highly specific set of tasks. AGI is sometimes referred to as strong AI, full AI, or general intelligent action.

Artificial Intelligence (AI): AI is the ability of a computer or machine to mimic the capabilities of the human mind and demonstrate intelligence. AI heavily leverages algorithms.

Artificial Neural Networks: An artificial neural network is composed of artificial neurons or nodes. It is used for solving problems via AI.

Automation Bias: Automation bias is the tendency for humans to accept suggestions from automated decision-making systems and to disregard contradictory information made without automation, even if the former is wrong and the latter is correct. In short, automation bias is said to occur when humans place too much confidence in the correct operation of an autonomous machine.

Deep Learning (DL): Deep learning is a type of machine learning method based on artificial neural networks with representation learning.

Machine Learning (ML): Machine learning is a type of AI based on computer algorithms that improve automatically through the use of data and by experience.

Mala In Se: *Mala in se* is the Latin phrase meaning 'wrong or evil in itself'. It refers to conduct that is inherently wrong by nature and not governed by regulations of conduct.

***Mens Rea*:** *Mens rea* is the Latin phase meaning 'guilty mind'. It refers to a person's intention to commit a crime, or their knowledge that action or inaction would result in a crime being committed.

Organized Irresponsibility: A system wherein individuals can cumulatively contribute to risks but avoid individual culpability.

Software: A collection of instructions or programs that tell a computer to perform specific tasks.

Third Offset Strategy: Announced in November 2014, the US DoD's Third Offset Strategy seeks to outmaneuver advantages of primary adversaries (E.g.: Russia and China) through the incorporation of advanced technology into US warfighting. This strategy will leverage promising areas of technological development such as: robotics, autonomous systems, AI, miniaturization, big data, and advanced manufacturing.

BIBLIOGRAPHY

Acheson, Ray. "CCW Report: Civil society perspectives on the CCW Group of Governmental Experts on Lethal Autonomous Weapon Systems, 27-31 August 2018." *Reaching Critical Will - CCW Report* 6(11). Edited by Ray Acheson. New York, NY, USA: (4 September 2018). Last accessed 14 March 2021. https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/reports/CCWR6.11.pdf.

Acheson, Ray. "CCW Report: Civil society perspectives on the CCW Group of Governmental Experts on Lethal Autonomous Weapon Systems, 20–21 August 2019." *Reaching Critical Will - CCW Report* 7(6). Edited by Ray Acheson. New York, NY, USA: (21 August 2019). Last accessed 14 March 2021. https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2019/gge/reports/CCWR7.6.pdf.

African Group. "Statement by the African Group." Statement to the GGE on LAWS of the CCW. Geneva, Switzerland: 9-13 April 2018. https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/statements/9April_African-Group.pdf.

Akimoto, Daisuke. "International Regulation of "Lethal Autonomous Weapons Systems" (LAWS): Paradigms of Policy Debate in Japan." *Asian Journal of Peacebuilding* 7, no. 1 (2019): 311-332. https://search-proquest-com.cfc.idm.oclc.org/docview/2469264950.

Allenby, Braden R. and Wendall Wallach. *The Applied Ethics of Emerging Military and Security Technologies*. London: Taylor & Francis Group, 2015. http://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=4758577.

Altmann, Jürgen and Frank Sauer. "Autonomous Weapon Systems and Strategic Stability." *Survival: Global Politics and Strategy* 59, no. 5 (2017): 117-142. https://doi-org.cfc.idm.oclc.org/10.1080/00396338.2017.1375263.

Anderson, Kenneth and Matthew Waxman. "Law and Ethics for Robot Soldiers." *Policy Review (Washington, D.C.)* 176, no. 4 (Dec 2012): 35-49. https://search-proquest-com.cfc.idm.oclc.org/docview/1239260811.

Arkin, Ronald C. "Ethics and Autonomous Systems: Perils and Promises [Point of View]." *Proceedings of the IEEE* 104, no. 10 (2016): 1779-1781. https://ieeexplore-ieee-org.cfc.idm.oclc.org/document/7571204.

Arkin, Ronald C. "Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberative/Reactive Robot Architecture Part I: Motivation and Philosophy." *Proceedings of the 3rd Association for Computing Machinery/Institute of Electrical and Electronics Engineers (ACM/IEEE) International Conference on Human Robot*

Interaction. March 2008. https://ieeexplore-ieee-org.cfc.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=6249424.

Arkin, Ronald C. *Governing Lethal Behavior in Autonomous Robots*. Boca Raton, FL, USA: CRC Press Taylor & Francis Group, 2009.

Arkin, Ronald C. "Lethal Autonomous Systems and the Plight of the Non-Combatant." In *The Political Economy of Robots: Prospects for Prosperity and Peace in the Automated 21st Century*, edited by Ryan Kiggins. London, UK: Palgrave Macmillan, 2018, 317-326. https://link-springer-com.cfc.idm.oclc.org/book/10.1007%2F978-3-319-51466-6.

Arkin, Ronald C. "The Case for Ethical Autonomy in Unmanned Systems." *Journal of Military Ethics* 9, no. 4 (2010): 332-341. https://www-tandfonline-com.cfc.idm.oclc.org/doi/full/10.1080/15027570.2010.536402.

Arkin, Ronald C., Patrick Ulam and Brittany Duncan. *An Ethical Governor for Constraining Lethal Action in an Autonomous System*. Technical Report GIT-GVU-09-02. Atlanta, USA: Georgia Institute of Technology - Mobile Robot Lab. 2009. https://apps.dtic.mil/dtic/tr/fulltext/u2/a493563.pdf.

Asaro, Peter. "On Banning Autonomous Weapon Systems: Human Rights, Automation, and the Dehumanization of Lethal Decision-Making." *International Review of the Red Cross (2005)* 94, no. 886 (2012): 687-709. https://search-proquest-com.cfc.idm.oclc.org/docview/1370609149.

Asimov, Isaac. *I, Robot*. New York, NY, USA: Bantam Dell, 2008.

Atherton, Kelsey D. "Are Killer Robots the Future of War? Parsing the Facts on Autonomous Weapons." *New York Times (Online)*, 2018. https://search-proquest-com.cfc.idm.oclc.org/docview/2133334363.

BAE Systems. "Taranis." Last accessed 22 March 2021. https://www.baesystems.com/en/product/taranis.

Bergen, Peter L. and Daniel Rothenberg. *Drone Wars: Transforming Conflict, Law, and Policy*. Edited by Peter L. Bergen and Daniel Rothenberg. Cambridge: Cambridge University Press, 2014. https://www.cambridge.org/core/books/drone-wars/91FDD7D22B527B7116A021516EA42F88.

Berman, Eli, Joseph H. Felter, Jacob N. Shapiro and Vestal McIntyre. *Small Wars, Big Data: The Information Revolution in Modern Conflict*. Princeton, N.J: Princeton University Press, 2018.

Bode, Ingvild. "Norm-making and the Global South: Attempts to Regulate Lethal Autonomous Weapons Systems." *Global Policy* 10, no. 3 (2019), 359-364. https://onlinelibrary-wiley-com.cfc.idm.oclc.org/doi/full/10.1111/1758-5899.12684.

Boulanin, Vincent, Neil Davison, Netta Goussac, and Moa Peldan Carlsson. *Limits on Autonomy in Weapons Systems: Identifying Practical Elements of Human Control*. Report. Stockholm, Sweden: Stockholm International Peace Research Institute: 1 June 2020, 1-41. http://www.jstor.org/stable/resrep25354.8.

Bourke, Joanna. *An Intimate History of Killing*. New York, NY, USA: Basic Books, 1999.

Campaign to Stop Killer Robots (CSKR). "About." Last accessed 19 March 2021. https://www.stopkillerrobots.org/about/.

Canada. Department of National Defence. *D2-386/2017E, Strong, Secure, Engaged (SSE)*. Ottawa, CA: 2017. Last accessed 9 November 2020. http://dgpaapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf.

Canada. Office of the Prime Minister. *Minister of Foreign Affairs Mandate Letter*. 13 December 2019. Last accessed 13 January 2021. https://pm.gc.ca/en/mandate-letters/2019/12/13/minister-foreign-affairs-mandate-letter.

Carvin, Stephanie. "Getting Drones Wrong." *The International Journal of Human Rights* 19, no. 2 (2015): 127-141. https://www-tandfonline-com.cfc.idm.oclc.org/doi/full/10.1080/13642987.2014.991212.

Carvin, Stephanie and Michael John Williams. *Law, Science, Liberalism, and the American Way of Warfare: The Quest for Humanity in Conflict*. Cambridge, UK; New York: Cambridge University Press, 2015.

Castelvecchi, Davide. "Can We Open the Black Box of AI?" *Nature (London)* 538, no. 7623 (2016): 20-23. https://www.nature.com/news/polopoly_fs/1.20731!/menu/main/topColumns/topLeftColumn/pdf/538020a.pdf.

Clarke, Roger. "Asimov's Laws of Robotics: Implications for Information Technology - Part II." *Computer* 27, no. 1, 1994. 57-66. https://doi.org/10.1109/2.248881.

Clausewitz, Carl von. *On War*. Eds. J.J. Graham and F.N. Maude. Jersey City, NJ, USA: Start Publishing LLC, 2013. https://cfc.overdrive.com/media/1306062.

Coker, Christopher. "Artificial Intelligence and the Future of War." *Scandinavian Journal of Military Studies* 2, no. 1 (2019): 55-60. https://doaj.org/article/32b4f8c15c2b41fbb6bfd845f3db7e31.

Coker, Christopher. *Future War*. Malden, MA: Polity Press, 2015.

Coker, Christopher. "Still 'the Human Thing'? Technology, Human Agency and the Future of War." *International Relations (London)* 32, no. 1 (2018): 23-38. https://journals-sagepub-com.cfc.idm.oclc.org/doi/pdf/10.1177/0047117818754640.

Coker, Christopher. *Waging War without Warriors: The Changing Culture of Military Conflict*. Boulder, Co: Lynne Rienner Publishers, 2002.

Corn, Geoffrey S. "Autonomous Weapon Systems: Managing the Inevitability of 'Taking the Man out of the Loop'." *Social Science Research Network (SSRN)*. Working Paper: (22 August 2014). Last accessed 14 January 2021. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2450640.

Crootof, Rebecca. "The Killer Robots are here: Legal and Policy Implications." *Cardozo Law Review* 36, no. 5 (2015): 1837-1916. https://heinonline.org/HOL/P?h=hein.journals/cdozo36&i=1943.

Dahm, Werner J. A. "Killer Drones are Science Fiction." *The Wall Street Journal (Eastern Edition)*. 15 February 2012. https://search-proquest-com.cfc.idm.oclc.org/docview/921411133.

"David Ignatius and Pentagon's Robert Work Talk About New Technologies to Deter War." *Washington Post Live* video, 53:20. Posted by *Washington Post (Online)*, 30 March 2016. https://www.washingtonpost.com/video/postlive/david-ignatius-and-pentagons-robert-work-on-efforts-to-defeat-isis-latest-tools-in-defense/2016/03/30/0fd7679e-f68f-11e5-958d-d038dac6e718_video.html.

Davis, Daniel L. "Who Decides: Man or Machine?" *Armed Forces Journal*, (1 November 2007). Last accessed 13 January 2021. http://armedforcesjournal.com/who-decides-man-or-machine/.

Del Monte, Louis A. *Genius Weapons: Artificial Intelligence, Autonomous Weaponry, and the Future of Warfare*. Amherst, NY: Prometheus Books, 2018. https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5893704#.

DoDaam Systems Ltd. "Super aEgis II - Remote Control Weapons Station: Datasheet." Last accessed 23 February 2021. http://www.dodaam.com/eng/sub2/menu2_1_4.php#.

Dreifus, Claudia. "Toby Walsh, A.I. Expert, is Racing to Stop the Killer Robots: A Conversation With." *New York Times (Online)*, 30 July 2019. https://search-proquest-com.cfc.idm.oclc.org/docview/2266245933.

Dremliuga, Roman. "General Legal Limits of the Application of the Lethal Autonomous Weapons Systems within the Purview of International Humanitarian Law." *Journal of Politics and Law* 13, no. 2 (2020): 115-121. https://heinonline.org/HOL/P?h=hein.journals/jpola13&i=297.

du Picq, Charles-Jean-Jacques-Joseph Ardant. *Battle Studies: Ancient and Modern Battle*. Project Gutenburg EBook of Battle Studies. Trans. John N. Greely and Robert C. Cotton. 1921. Last accessed 21 March 2021. https://www.gutenberg.org/files/7294/7294-h/7294-h.htm.

The Economist. " The Azerbaijan-Armenia conflict hints at the future of war." London, United Kingdom: 8 October 2020. https://www.economist.com/europe/2020/10/08/the-azerbaijan-armenia-conflict-hints-at-the-future-of-war.

Egeland, Kjølv. "Lethal Autonomous Weapon Systems Under International Humanitarian Law." *Nordic Journal of International Law = Acta Scandinavica Juris Gentium* 85, no. 2 (2016): 89-118. https://heinonline.org/HOL/P?h=hein.journals/nordic85&i=97.

Evans, Tyler D. "At War with the Robots: Autonomous Weapon Systems and the Martens Clause." *Hofstra Law Review* 41, no. 3 (2013): 697-733. https://heinonline.org/HOL/P?h=hein.journals/hoflr41&i=729.

Forsberg, C.J. "Future Battlespace: Is there a place for Autonomous Weapons?" Joint Command and Staff Programme (JCSP) 42 - Exercise SOLO FLIGHT Paper, Canadian Forces College, 2016. https://www.cfc.forces.gc.ca/259/290/318/305/forsberg.pdf.

Fugger, Keith. "How should the RCAF adopt Autonomous Weapons Systems?" Joint Command and Staff Programme (JCSP) 46 - Service Paper, Canadian Forces College, 2020. https://www.cfc.forces.gc.ca/259/290/22/192/Fugger.pdf.

Future of Life Institute (FLI). "Autonomous Weapons: An Open Letter from AI and Robotics Researchers." Letter. 28 July 2015. Last accessed 21 March 2021. https://futureoflife.org/open-letter-autonomous-weapons.

Future of Life Institute (FLI). "An Open Letter on the United Nations Convention on Certain Conventional Weapons." Letter. 21 August 2017. Last accessed 21 March 2021. https://futureoflife.org/autonomous-weapons-open-letter-2017/.

Garamone, Jim. "Work Details Multidomain Battlefield of the Future." *US Department of Defense News*. 4 October 2016. Last accessed 19 February 2021. https://www.defense.gov/Explore/News/Article/Article/963806/work-details-multidomain-battlefield-of-the-future/.

Gibbons-Neff, Thomas. "Israeli-made kamikaze drone spotted in Nagorno-Karabakh conflict." *The Washington Post (Online)*. Washington, DC, USA: 5 April 2016. https://www.washingtonpost.com/news/checkpoint/wp/2016/04/05/israeli-made-kamikaze-drone-spotted-in-nagorno-karabakh-conflict/.

Grossman, Dave. *On Killing: The Psychological Cost of Learning to Kill in War and Society*. Revised Ed. New York: Back Bay Books, 2009.

Haider, Andre. “Autonomous Weapon Systems in International Humanitarian Law.” JAPCC Journal 27, (2018): 48-49. https://www.japcc.org/autonomous-weapon-systems-in-international-humanitarian-law/.

Hambling, David. "With Hammerhead Mine, U.S. Navy Plots New Style Of Warfare To Tip Balance In South China Sea." *Forbes (Online)*. New York, NY, USA: 22 October 2020. https://www.forbes.com/sites/davidhambling/2020/10/22/us-navys-hammerhead-mine-aims-to-tip-balance-in-south-china-sea/?sh=11d232c87df7.

Hammes, T.X. “Autonomous Weapons Are Coming, This is How We Get Them Right.” *The National Interest.* 2 December 2018. https://nationalinterest.org/blog/buzz/autonomous-weapons-are-coming-how-we-get-them-right-37532.

Hammond, Daniel N. "Autonomous Weapons and the Problem of State Accountability." *Chicago Journal of International Law* 15, no. 2 (2015): 652-687. https://search-proquest-com.cfc.idm.oclc.org/docview/1651730428/fulltextPDF/3061E16E19234C1FPQ/1?accountid=9867.

Harris, Shane. "Autonomous Weapons and International Humanitarian Law Or Killer Robots are here. Get used to It." *Temple International and Comparative Law Journal* 30, no. 1 (2016): 77-84. https://heinonline.org/HOL/P?h=hein.journals/tclj30&i=85.

Hauptman, Allyson. "Autonomous Weapons and the Law of Armed Conflict." *Military Law Review* 218, (2013): 170-195. https://heinonline.org/HOL/P?h=hein.journals/milrv218&i=178.

Heyns, Christof. "Annual Report of the Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions: Lethal Autonomous Robotics and the Protection of Life." Report: A/HRC/23/47. United Nations General Assembly. New York, NY, USA: 9 April 2013. http://www.icla.up.ac.za/images/un/hrc/Thematic%20report%20-%20LARs%20A-HRC-23-47_en.pdf.

Horowitz, Michael C. "When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability." *Journal of Strategic Studies* 42, no.6 (2019), 764-788. https://www-tandfonline-com.cfc.idm.oclc.org/doi/full/10.1080/01402390.2019.1621174.

Horowitz, Michael C. "Why Words Matter: The Real World Consequences of Defining Autonomous Weapons Systems." *Temple International and Comparative Law Journal* 30, no. 1 (2016): 85-97. https://heinonline.org/HOL/P?h=hein.journals/tclj30&i=93.

Horowitz, Michael C. and Paul Scharre. "Artificial Intelligence: What Every Policymaker Needs to Know." *Center for a New American Security*. Report. Washington, DC, USA: (June 2018). https://www.cnas.org/publications/reports/artificial-intelligence-what-every-policymaker-needs-to-know.

Horowitz, Michael C. and Paul Scharre. "The Morality of Robotic War." *The New York Times*, 27 May 2015. 7. https://search-proquest-com.cfc.idm.oclc.org/docview/1683108359.

Human Rights Watch (HRW). *Stopping Killer Robots: Country Positions on Banning Fully Autonomous Weapons and Retaining Human Control*. Report. (10 August 2020). https://www.hrw.org/sites/default/files/media_2020/08/arms0820_web_0.pdf.

Human Rights Watch (HRW) and the International Human Rights Clinic (IHRC), Harvard Law School. *Advancing the Debate on Killer Robots: 12 Key Arguments for a Pre-emptive Ban on Fully Autonomous Weapons*. Report. (8 May 2014). https://www.hrw.org/sites/default/files/supporting_resources/advancing_the_debate_8may2014_final.pdf.

Human Rights Watch (HRW) and the International Human Rights Clinic (IHRC), Harvard Law School. *Losing Humanity: The Case Against Killer Robots*. Report. (19 November 2012). https://www.hrw.org/report/2012/11/19/losing-humanity/case-against-killer-robots.

Human Rights Watch (HRW) and the International Human Rights Clinic (IHRC), Harvard Law School. *Making the Case: The Dangers of Killer Robots and the Need for a Pre-emptive Ban*. Report. (December 2016). https://www.hrw.org/sites/default/files/report_pdf/arms1216_web.pdf.

Husain, Amir. *Hyperwar: Conflict and Competition in the AI Century*. Austin, USA: SparkCognition Press, 2018.

Hynek, Nik and Anzhelika Solovyeva. "Operations of Power in Autonomous Weapon Systems: Ethical Conditions and Socio-Political Prospects." *AI & Society* 36, no. 1 (2021): 79-99. https://search-proquest-com.cfc.idm.oclc.org/docview/2492787143.

International Committee of Robot Arms Control (ICRAC). "About ICRAC." Last accessed 19 March 2021. https://www.icrac.net/about-icrac/.

International Committee of the Red Cross. "Ethics and Autonomous Weapons Systems: An Ethical Basis for Human Control?" Report. Geneva, Switzerland: (3 April 2018). https://www.icrc.org/en/download/file/69961/icrc_ethics_and_autonomous_weapon_systems_report_3_april_2018.pdf.

International Committee of the Red Cross. "A Guide to the Legal Review of New Weapons, Means and Methods of Warfare: Measures to Implement Article 36 of Additional Protocol I of 1977." Guide. Geneva, Switzerland: (January 2006). https://www.icrc.org/en/doc/assets/files/other/icrc_002_0902.pdf.

International Committee of the Red Cross. "Report of the ICRC Expert Meeting on Autonomous Weapon Systems: Technical, Military, Legal and Humanitarian Aspects." Summary Report. Geneva, Switzerland: (26-28 March 2014).

https://www.icrc.org/en/doc/assets/files/2014/expert-meeting-autonomous-weapons-icrc-report-2014-05-09.pdf.

International Court of Justice. *The International Court of Justice Handbook*. 7th Edition. Mauberge, France: Triangle Bleu, 31 December 2018. 1-323. https://www.icj-cij.org/public/files/publications/handbook-of-the-court-en.pdf.

Johnson, Aaron M. and Sidney Axinn. "The Morality of Autonomous Robots." *Journal of Military Ethics* 12, no. 2 (2013): 129-141. https://doi-org.cfc.idm.oclc.org/10.1080/15027570.2013.818399.

Kastan, Benjamin. "Autonomous Weapons Systems: A Coming Legal "Singularity"?" *Journal of Law, Technology & Policy* 2013, no. 1 (2013): 45-82. https://heinonline.org/HOL/P?h=hein.journals/jltp2013&i=51.

Kania, Elsa. "China's Strategic Ambiguity and Shifting Approach to Lethal Autonomous Weapon Systems." *Lawfare*. 17 April 2018. Last accessed 20 March 2021. https://www.lawfareblog.com/chinas-strategic-ambiguity-and-shifting-approach-lethal-autonomous-weapons-systems.

Klein, Ezra. "The Author Behind 'Arrival' Doesn't Fear AI. 'Look at How We Treat Animals." *New York Times (Online) - The Ezra Klein Show*, 30 March 2021. https://www.nytimes.com/2021/03/30/opinion/ezra-klein-podcast-ted-chiang.html?action=click&module=audio-series-bar&pgtype=Article&region=header&showTranscript=1.

Knight, Will. "The Dark Secret at the Heart of AI." *Technology Review* (1998) 120, no. 3 (2017). https://www.technologyreview.com/2017/04/11/5113/the-dark-secret-at-the-heart-of-ai/.

Krishnan, Armin. "Automating War: The Need for Regulation." *Contemporary Security Policy* 30, no. 1 (2009): 172-193. https://doi-org.cfc.idm.oclc.org/10.1080/13523260902760397.

Krishnan, Armin. *Killer Robots: Legality and Ethicality of Autonomous Weapons*. Surrey, UK: Ashgate Publishing Limited, 2009.

Lin, Patrick, George Bekey, and Keith Abney. "Autonomous Military Robotics: Risk, Ethics, and Design." Report prepared for the US Department of Navy, Office of Naval Research. San Luis Obispo, CA, USA: California Polytechnic State University, 20 December 2008. http://ethics.calpoly.edu/ONR_report.pdf.

Lucas, George R.,Jr. "Automated Warfare." *Stanford Law & Policy Review* 25, no. 2 (2014): 317-339. https://heinonline.org/HOL/P?h=hein.journals/stanlp25&i=333.

Lucas, Nathan J. "Lethal Autonomous Weapons Systems: Issues for Congress." *Congressional Research Service (CRS)*. CRS Report. Washington, DC, USA: 14 April 2016. https://crsreports.congress.gov/product/pdf/R/R44466/4.

Marijan, Branka. "Canada's deafening silence on the creation of Autonomous Weapons." *Toronto Star* (Online), 9 October 2020. https://www.thestar.com/opinion/contributors/2020/10/09/canadas-deafening-silence-on-the-creation-of-autonomous-weapons.html.

Marra, William C. and Sonia K. McNeil. "Understanding "the Loop": Regulating the Next Generation of War Machines." *Harvard Journal of Law and Public Policy* 36, no. 3 (2013): 1139-1185. https://search-proquest-com.cfc.idm.oclc.org/docview/1415163546.

Macdonald, Julia and Jacquelyn Schneider. "Battlefield Responses to New Technologies: Views from the Ground on Unmanned Aircraft." *Security Studies* 28, no. 2 (2019): 216-249. https://doi-org.cfc.idm.oclc.org/10.1080/09636412.2019.1551565.

McGinnis, John O. "Accelerating AI." *Northwestern University Law Review* 104, no. 3 (Summer 2010): 1253-1269. https://search-proquest-com.cfc.idm.oclc.org/docview/840560052.

McIntosh, Scott E. "The Wingman-Philosopher of MiG Alley: John Boyd and the OODA Loop." *Air Power History* 58, no. 4 (2011): 24-33. https://search-proquest-com.cfc.idm.oclc.org/docview/914457733.

Mills, Brendon. "Rosa's Dystopia: The Moral Downside of Coming Autonomous Weapons Systems." *Foreign Policy* (18 June 2013). https://foreignpolicy.com/2013/06/18/rosas-dystopia-the-moral-downside-of-coming-autonomous-weapons-systems/.

MILREM Robotics. "THeMIS UGV-Combat." Last accessed 22 March 2021. https://milremrobotics.com/defence/.

MILREM Robotics. "Type X RCV." Last accessed 22 March 2021. https://milremrobotics.com/type-x/.

Moon, A. Jung , Peter Danielson, H.F. Machiel Van der Loos. "Survey-Based Discussions on Morally Contentious Applications of Interactive Robotics." *International Journal of Social Robotics* 4, no. 1 (2012): 77-96. https://search-proquest-com.cfc.idm.oclc.org/docview/2421245172.

Morris, Zachary L. "A Four-Phase Approach to Developing Ethically Permissible Autonomous Weapons." *Military Review* 98, no. 4 (2018): 1-8. https://www.armyupress.army.mil/Portals/7/Army-Press-Online-Journal/documents/Morris-v2.pdf.

Muoio, Danielle. "Russia and China are Building Highly Autonomous Killer Robots." *Business Insider* (15 December 2015). https://www.businessinsider.com/russia-and-china-are-building-highly-autonomous-killer-robots-2015-12.

Noone, Gregory P. and Diana C. Noone. "The Debate Over Autonomous Weapons Systems." *Case Western Reserve Journal of International Law* 47, no. 1 (2015): 25-35. https://search-proquest-com.cfc.idm.oclc.org/docview/1696877899.

Northrop Grumman. "X-47B Unmanned Combat Air System: Datasheet." Northrop Grumman Systems Corporation. San Diego, CA, USA (2015). https://www.northropgrumman.com/wp-content/uploads/UCAS-D_Data_Sheet.pdf.

Owens, Gregory. "Controlled Autonomy: The Limited Future Use of Autonomous Weapons." Joint Command and Staff Programme (JCSP) 44 - Exercise SOLO FLIGHT Paper, Canadian Forces College, 2019. https://www.cfc.forces.gc.ca/259/290/405/305/owens.pdf.

Parasuraman, Raja, Thomas B. Sheridan, and Christopher D. Wickens. "A Model for Types and Levels of Human Interaction with Automation." *IEEE Transactions on Systems, Man and Cybernetics. Part A, Systems and Humans* 30, no. 3 (2000): 286-297. https://ieeexplore-ieee-org.cfc.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=844354.

Paumgarten, Nick. "Here's Looking at You: The World of Surveillance." *The New Yorker* 88, no. 13 (2012). https://search-proquest-com.cfc.idm.oclc.org/docview/1018546507.

Purcell, Richard. "Autonomous Weapons: The Ultimate Military Game Changer?" *The National Interest.* 21 October 2018. https://nationalinterest.org/blog/buzz/autonomous-weapons-ultimate-military-game-changer-33937.

Rasser, Martijn, Megan Lamberth, Ainikki Riikonen, Chelsea Guo, Michael Horowitz and Paul Scharre. "The American AI Century: A Blueprint for Action." *Center for a New American Security*. Report. Washington, DC, USA: (17 December 2019). https://www.cnas.org/publications/reports/the-american-ai-century-a-blueprint-for-action.

Renic, Neil C. "A Gardener's Vision: UAVs and the Dehumanisation of Violence." *Survival: Global Politics and Strategy* 60, no. 6 (2018): 57-72. https://doi.org/10.1080/00396338.2018.1542794.

Rogers, A.S. "Rise of the Machines – Making the Case against a Global Ban on Fully Autonomous Weapons." Joint Command and Staff Programme (JCSP) 41 - Exercise SOLO FLIGHT Paper, Canadian Forces College, 2015. https://www.cfc.forces.gc.ca/259/290/317/305/rogers.pdf.

Rosenberg, Matthew and John Markoff. "The Pentagon's 'Terminator Conundrum': Robots that could Kill on their Own." *New York Times* (Online), 25 October 2016. https://www.nytimes.com/2016/10/26/us/pentagon-artificial-intelligence-terminator.html?mcubz=1.

Rosert, Elvira and Frank Sauer. "How (Not) to Stop the Killer Robots: A Comparative Analysis of Humanitarian Disarmament Campaign Strategies." *Contemporary Security Policy* 42, no. 1 (January 2021): 4-29. https://doi.org/10.1080/13523260.2020.1771508.

Sayler, Kelley M. "Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems." *Congressional Research Service (CRS)*. CRS Report. Washington, DC, USA: 1 December 2020. https://fas.org/sgp/crs/natsec/IF11150.pdf.

Scharre, Paul. *Army of None: Autonomous Weapons and the Future of War*. New York, USA: W.W. Norton & Company. 2019.

Scharre, Paul. "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part I." *Just Security*, Article, New York University School of Law, New York, NY, USA: (9 July 2014). https://www.justsecurity.org/12708/autonomy-killer-robots-human-control-force-part/.

Scharre, Paul. "Autonomy, 'Killer Robots', and Human Control in the Use of Force – Part II." *Just Security*, Article, New York University School of Law, New York, NY, USA: (9 July 2014). https://www.justsecurity.org/12712/autonomy-killer-robots-human-control-force-part-ii/.

Scharre, Paul. "Centaur Warfighting: The False Choice of Humans Vs. Automation." *Temple International and Comparative Law Journal* 30, no. 1 (2016): 151-165. https://heinonline.org/HOL/P?h=hein.journals/tclj30&i=159.

Scharre, Paul. "Killer Apps: The Real Dangers of an AI Arms Race." *Foreign Affairs (New York, N.Y.)* 98, no. 3 (2019). https://heinonline.org/HOL/P?h=hein.journals/fora98&i=557.

Schmidt, Eric, Robert Work, Safra Catz, Steve Chien, Mignon Clyburn, Chris Darby, Kenneth Ford, Eric Horvitz, Andrew Jassy, Gilman Louis, William Mark, Jason Matheny. "Final Report of National Security Commission on Artificial Intelligence (NSCAI)." NSCAI. Washington, DC, USA: 1 March 2021. https://www.nscai.gov/wp-content/uploads/2021/03/Full-Report-Digital-1.pdf.

Schmitt, Michael N. "Military Necessity and Humanity in International Humanitarian Law: Preserving the Delicate Balance." *Virginia Journal of International Law* 50, no. 4 (2010): 795-839. https://heinonline.org/HOL/P?h=hein.journals/vajint50&i=805.

Schmitt, Michael N. and Jeffrey S. Thurnher, "'Out of the Loop': Autonomous Weapon Systems and the Law of Armed Conflict." *Harvard National Security Journal* 4, no. 2 (2013): 231-281. https://harvardnsj.org/wp-content/uploads/sites/13/2013/01/Vol-4-Schmitt-Thurnher.pdf.

Sharkey, Noel. "The Automation and Proliferation of Military Drones and the Protection of Civilians." *Law, Innovation and Technology* 3, no. 2 (2011): 229-240. https://doi-org.cfc.idm.oclc.org/10.5235/175799611798204914.

Sharkey, Noel E. "Comment & Debate: Robot Wars are a Reality: Armies Want to Give the Power of Life and Death to Machines without Reason Or Conscience." *The Guardian (London),* 18 August 2007. 29. https://search-proquest-com.cfc.idm.oclc.org/docview/246677475.

Sharkey, Noel E. "The Evitability of Autonomous Robot Warfare." *International Review of the Red Cross (2005)* 94, no. 886 (2012;, 2013): 787-799. https://search-proquest-com.cfc.idm.oclc.org/docview/1370609152/fulltext/27D748D043804517PQ/1?accountid=9867.

Singer, Peter W. "In the Loop? Armed Robots and the Future of War." *Brookings Institution*, Article, Washington, DC, USA: (28 January 2009). https://www.brookings.edu/articles/in-the-loop-armed-robots-and-the-future-of-war/.

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

Smith, Patrick Taylor. "Just Research into Killer Robots." *Ethics and Information Technology* 21, no. 4 (2019): 281-293. https://search-proquest-com.cfc.idm.oclc.org/docview/2073877858.

Smithers, P.D. "Killer Robots: Employing Lethal Autonomous Robots within *Jus in Bello* and the Requirement for Command Responsibility." Joint Command and Staff Programme (JCSP) 38 - Master of Defence Studies Paper, Canadian Forces College, 2012. https://www.cfc.forces.gc.ca/259/290/298/286/smithers.pdf.

Sparrow, Robert. "Killer Robots." *Journal of Applied Philosophy* 24, no. 1 (2007): 62-77. http://search.ebscohost.com.cfc.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=23774147&site=ehost-live&scope=site.

Sparrow, Robert. "Robots and Respect: Assessing the Case Against Autonomous Weapon Systems." *Ethics & International Affairs* 30, no. 1 (2016): 93-116. https://search-proquest-com.cfc.idm.oclc.org/docview/1771700843.

Springer, Paul J. *Outsourcing War to Machines: The Military Robotics Revolution*. Santa Barbara, Calif: Praeger, 2018. https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5255510.

Sutton, H.I. "New evidence of China's Copy of U.S. Navy *Sea Hunter* USV." *Covert Shores*. 25 September 2020. Last accessed 21 March 2021. http://www.hisutton.com/Chinese-Navy-Sea-Hunter-USV.html.

Thurnher, Jeffrey S. "Means and Methods of the Future: Autonomous Systems." In *Targeting: The Challenges of Modern Warfare*, edited by Paul A.L. Ducheine, Michael N. Schmitt

and Frans P. B. Osinga. The Hague: T.M.C. Asser Press, 2015, 177-199. http://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=4084582.

Thurnher, Jeffrey S. "No One at the Controls - Legal Implications of Fully Autonomous Targeting." *Joint Force Quarterly* no. 67 (2012): 77-84. https://search-proquest-com.cfc.idm.oclc.org/docview/1271860635.

Ticehurst, Rupert. "The Martens Clause and the Laws of Armed Conflict." *International Review of the Red Cross* 37, no. 317 (1997): 125-134. https://doi.org/10.1017/S002086040008503X.

Tirpak, John A. "Find, Fix, Track, Target, Engage, Assess." *Air Force Magazine* (Online), 1 July 2000. https://www.airforcemag.com/article/0700find/.

United Nations. Office for Disarmament Affairs. "The Convention on Certain Conventional Weapons." Last accessed 19 March 2021. https://www.un.org/disarmament/the-convention-on-certain-conventional-weapons/.

United Nations. *Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I)*. Geneva, Switzerland: 8 June 1977. https://treaties.un.org/doc/Publication/UNTS/Volume 1125/volume-1125-I-17512-English.pdf.

United Nations. *Protocol on Prohibitions or Restrictions on the Use of Mines, Booby-Traps and Other Devices as amended on 3 May 1996 (Protocol II as amended on 3 May 1996) annexed to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which may be deemed to be Excessively Injurious or to have Indiscriminate Effects*. Geneva, Switzerland: 3 May 1996. https://treaties.un.org/doc/Publication/MTDSG/Volume II/Chapter XXVI/XXVI-2-b.en.pdf.

United Nations Office at Geneva (UNOG). "Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects." Final Report: CCW/MSP/2013/10. Convention on Conventional Weapons, Geneva, Switzerland: 16 December 2013. https://undocs.org/pdf?symbol=en/CCW/MSP/2013/10.

United Nations Office at Geneva (UNOG). "Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects." Final Report: CCW/MSP/2019/9. Group of Governmental Experts from Convention on Conventional Weapons, Geneva, Switzerland: 13 December 2019. https://undocs.org/CCW/MSP/2019/9.

United Nations. Institute for Disarmament Research. "Framing Discussions on the Weaponization of Increasingly Autonomous Technologies." *UNIDIR Resources*. No. 1. n.p., 2014. https://unidir.org/files/publications/pdfs/framing-discussions-on-the-weaponization-of-increasingly-autonomous-technologies-en-606.pdf.

United Nations. Institute for Disarmament Research. "The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values." *UNIDIR Resources*. No. 3. n.p., 2015. https://www.files.ethz.ch/isn/190017/considering-ethics-and-social-values-en-624.pdf.

United Nations. Institute for Disarmament Research. "The Weaponization of Increasingly Autonomous Technologies: Concerns, Characteristics and Definitional Approaches." *UNIDIR Resources*. No. 6. n.p., 2017. https://www.unidir.org/files/publications/pdfs/the-weaponization-of-increasingly-autonomous-technologies-concerns-characteristics-and-definitional-approaches-en-689.pdf.

United Nations. Treaty Collection. "Additional Protocol I to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (AP1)." 8 June 1977. Last accessed 23 March 2021. https://treaties.un.org/pages/showdetails.aspx?objid=08000002800f3586.

United States of America. Department of Defense. *Autonomy in Weapon Systems - Department of Defense Directive* No. 3000.09. Washington, DC, USA: 12 November 2012. https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodd/300009p.pdf.

United States of America. Department of Defense. *Unmanned Systems Integrated Roadmap, FY2013-2038*. Government Printing Office. Washington, DC, USA: January 2014. https://apps.dtic.mil/dtic/tr/fulltext/u2/a592015.pdf.

United States of America. Department of Justice. "Boeing Charged with 737 Max Fraud Conspiracy and Agrees to Pay over $2.5 Billion." *Justice News*. Office of Public Affairs. Washington, DC, USA: 7 January 2021. https://www.justice.gov/opa/pr/boeing-charged-737-max-fraud-conspiracy-and-agrees-pay-over-25-billion.

United States of America. Department of State. "Human-Machine Interaction in the Development, Deployment and Use of Emerging Technologies in the Area of Lethal Autonomous Weapons Systems." Working paper to the GGE on LAWS of the CCW: CCW/GGE.2/2018/WP.4. Geneva, Switzerland: 28 August 2018. https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/documents/GGE.2-WP4.pdf.

Useem, Jerry. "At Work, Expertise Is Falling Out of Favor." *The Atlantic* (Online). July 2019. https://www.theatlantic.com/magazine/archive/2019/07/future-of-work-expertise-navy/590647/.

Wagner, Markus. "The Dehumanization of International Humanitarian Law: Legal, Ethical, and Political Implications of Autonomous Weapon Systems." *Vanderbilt Journal of Transnational Law* 47, no. 5 (2014): 1371-1423. https://heinonline.org/HOL/P?h=hein.journals/vantl47&i=1423.

West, Darrell M. and Jack Karsten. "It's time to start thinking about Governance of Autonomous Weapons." *Brookings Institution*, Tech-Tank (blog), Washington, DC, USA: (10 May 2019). https://www.brookings.edu/blog/techtank/2019/05/10/its-time-to-start-thinking-about-governance-of-autonomous-weapons/.

West, Darrell M. and John R. Allen. *Turning Point: Policymaking in the Era of Artificial Intelligence.* Washington, DC, USA: Brookings Institution Press. 2020.

Weiner, Tim, "New Model Soldier Rolls Closer to Battle." *The New York Times (Online)*. 16 February 2005. https://www.nytimes.com/2005/02/16/technology/new-model-army-soldierrolls-closer-to-battle.html.

Wikipedia. "Aegis Combat System." Last accessed 18 February 2021. https://en.wikipedia.org/wiki/Aegis_Combat_System.

Wikipedia. "BAE Systems Taranis." Last accessed 17 February 2021. https://en.wikipedia.org/wiki/BAE_Systems_Taranis.

Wikipedia. "Dassault nEUROn." Last accessed 15 February 2021. https://en.wikipedia.org/wiki/Dassault_nEUROn.

Wikipedia. "Deep Learning." Last accessed 7 December 2020. https://en.wikipedia.org/wiki/Deep_learning.

Wikipedia. "General Atomics MQ-1 Predator." Last accessed 15 February 2021. https://en.wikipedia.org/wiki/General_Atomics_MQ-1_Predator.

Wikipedia. "IAI Harpy." Last accessed 23 February 2021. https://en.wikipedia.org/wiki/IAI_Harpy.

Wikipedia. "Iron Dome." Last accessed 10 March 2021. https://en.wikipedia.org/wiki/Iron_Dome.

Wikipedia. "OODA Loop." Last accessed 4 December 2020. https://en.wikipedia.org/wiki/OODA_loop.

Wikipedia. "Phalanx CIWS." Last accessed 20 February 2021. https://en.wikipedia.org/wiki/Phalanx_CIWS.

Wikipedia. "Sea Hunter." Last accessed 26 February 2021. https://en.wikipedia.org/wiki/Sea_Hunter.

Wikipedia. "Spike (Missile)." Last accessed 21 February 2021. https://en.wikipedia.org/wiki/Spike_(missile).

Wikipedia. "Northrop Grumman X-47B." Last accessed 24 February 2021. https://en.wikipedia.org/wiki/Northrop_Grumman_X-47B.

Useem, Jerry. "At Work, Expertise Is Falling Out of Favor." *The Atlantic*. July 2019. Last accessed 10 April 2021. https://www.theatlantic.com/magazine/archive/2019/07/future-of-work-expertise-navy/590647/.

Vincent, James. "Putin Says the Nation That Leads in AI 'Will Be the Ruler of the World'." *The Verge*. 4 September 2017. Last accessed 18 February 2021. https://www.theverge.com/2017/9/4/16251226/russia-ai-putin-rule-the-world.

Yu, Howard. "Killer Robots: The Risks and Opportunities of AI in Military Operations." Joint Command and Staff Programme (JCSP) 44 - Service Paper, Canadian Forces College, 2018. https://www.cfc.forces.gc.ca/259/290/405/192/yu.pdf.