POLICIES ON THE EMPLOYMENT OF LETHAL AUTONOMOUS WEAPON SYSTEMS IN FUTURE CONFLICTS

By

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THE IMPLICATIONS OF LETHAL AUTONOMOUS WEAPON SYSTEMS ON FOREIGN POLICY

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ABSTRACT

The conversation on Lethal Autonomous Weapon Systems (LAWS) centers on the ethics of allowing a computer to decide to kill (or not to kill) a human-being. Much of the current discourse on the topic of autonomous weapons comes from a concern over the ethical implications. Over the coming fifteen years, the technology industry will achieve many milestones that will significantly alter the argument about the use of LAWS. There are currently efforts to institute laws and regulations that will inhibit or remove the use of LAWS. This research will clarify what will be technically possible in the future and take a holistic look at the topic. This study will explore the current technological abilities of Artificial Intelligence (AI) and its impacts on civil society. It will further look at AI and its impact on lethal weapons. Additionally, the study will explore the acceptance of AI in civil society verse the acceptance of AI in conflict. Such exploration is important as the newer technology may change the conversation about the ethics of employing robotics. This conversational change may encourage or even compel policymakers to use LAWS in future conflicts.
Acknowledgements

I am very grateful for the time and help that Paul Gelpi Ph.D. gave me throughout the process. His patience and knowledge was invaluable. It has been an honor to work with him.

Most of all I am thankful to my wife Sarah. Her constant encouragement, help, and loving guidance was everything to me throughout this degree. Words can never express the debt that I owe her.
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAAI</td>
<td>Association for the Advancement of Artificial Intelligence</td>
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<tr>
<td>AACUS</td>
<td>Autonomous Aerial Cargo Utility System</td>
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<td>ACTUV</td>
<td>ASW Continuous Trail Unmanned Vessel</td>
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<td>AI</td>
<td>Artificial Intelligence</td>
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<td>AGI</td>
<td>Artificial General Intelligence</td>
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<tr>
<td>ALIAS</td>
<td>Aircrew Labor In-Cockpit Automation System</td>
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<td>AMAS</td>
<td>Autonomous Mobility Appliqué System</td>
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<tr>
<td>ANI</td>
<td>Artificial Narrow Intelligence</td>
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<tr>
<td>ASI</td>
<td>Artificial Super Intelligence</td>
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<tr>
<td>ASIMO</td>
<td>Advance Step Innovative Mobility</td>
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<td>ASW</td>
<td>Anti-Submarine Warfare</td>
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<tr>
<td>A-UGV</td>
<td>Automated Unmanned Ground Vehicle</td>
</tr>
<tr>
<td>CALO</td>
<td>Cognitive Assistant that Learns and Organizes</td>
</tr>
<tr>
<td>CEV</td>
<td>Coherent Extrapolated Volition</td>
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<tr>
<td>CCW</td>
<td>Convention on Certain Conventional Weapons</td>
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<td>CIWS</td>
<td>Close-In Weapon System</td>
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<tr>
<td>CNAS</td>
<td>Center for a New American Security</td>
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<tr>
<td>DARPA</td>
<td>Defense Advanced Research Projects Agency</td>
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<tr>
<td>DOD</td>
<td>Department of Defense</td>
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<td>EOD</td>
<td>Explosive Ordinance Disposal</td>
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<td>HRW</td>
<td>Human Rights Watch</td>
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<td>ICRC</td>
<td>International Committee of the Red Cross</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>IHL</td>
<td>International Humanitarian Law</td>
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<td>IHRC</td>
<td>International Human Rights Clinic</td>
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<td>ICBM</td>
<td>Intercontinental Ballistic Missile</td>
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<tr>
<td>IoT</td>
<td>Internet of Things</td>
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<tr>
<td>ISR</td>
<td>Intelligence, Surveillance, and Reconnaissance</td>
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<tr>
<td>LARs</td>
<td>Lethal autonomous robotics</td>
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<td>LAWS</td>
<td>Lethal Autonomous Weapons Systems</td>
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<tr>
<td>LIDA</td>
<td>Learning Intelligent Distribution Agent</td>
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<td>LOAR</td>
<td>Law of Accelerating Returns</td>
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<tr>
<td>MUM-T</td>
<td>Manned Un-Manned Teaming</td>
</tr>
<tr>
<td>MIRI</td>
<td>Machine Intelligence Research Institute</td>
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<tr>
<td>NDU</td>
<td>National Defense University</td>
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<td>NGO</td>
<td>Non-Governmental Organization</td>
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<td>NLP</td>
<td>Natural Language Processing</td>
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<td>PLA</td>
<td>People’s Liberation Army</td>
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<td>RAS</td>
<td>Robotic and Autonomous Systems</td>
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<tr>
<td>SIRI</td>
<td>Speech Interpretation and Recognition Interface</td>
</tr>
<tr>
<td>SyNAPSE</td>
<td>Systems of Neuromorphic Adaptive Plastic Scalable Electronics</td>
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<tr>
<td>UCAS</td>
<td>Unmanned Combat Air System</td>
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<tr>
<td>UGV</td>
<td>Unmanned Ground Vehicles</td>
</tr>
<tr>
<td>UN</td>
<td>United Nation</td>
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<tr>
<td>UUV</td>
<td>Unmanned Undersea Vehicles</td>
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CHAPTER 1
INTRODUCTION

Statement of Problem and Research Question

Currently, the conversation on Lethal Autonomous Weapons Systems (LAWS) centers on the ethics of allowing a computer to decide to kill (or not to kill) a human-being. Over the coming fifteen years, the defense and technology industries will achieve many milestones that will significantly alter the argument about the use of LAWS. Computer processors will continue to increase in speed until they are not only on par with the human brain but eventually "smarter" than 1,000 human brains. Recognition software will move past its current hurdles of recognizing the difference between an apple and a tomato to distinguishing between happy and content.¹ When these innovations become a reality, the world will have machines that are considered smarter and have better visual recognition than humans. Artificial Super Intelligence (ASI) powered machines will have an impact on every part of the human experience from medicine to driving cars.² Concurrently, many in the public, lobbyists, and special interest groups will advocate having machines make more decisions in war, thereby removing the human element. People are emotional whereas autonomous weapons, powered by computers, are programmed to be just. Political leaders will have to make a new series of decisions that may remove humans from making the day to day judgments about who is killed during a conflict.

The proposed research will take into account the future innovations in technology. It will also discuss how the aggregate of these developments will effect the likelihood of the use of LAWS in future warfare. These considerations will be determined by asking the following question: Will the development of autonomous weapons systems by the military affect political leaders' willingness of using them in an international conflict?

**Justification**

As LAWS becomes a technological reality, policymakers will have more opportunities to deploy a military force with limited to no risk to personnel. The use of drones will continue to become an integral part of militaries throughout the world. Unmanned systems are currently being tested for use on waterways and land. Policymakers are leery of committing military forces if it there is a possibility of losing servicemembers. As the cost in human capital decreases with the use of autonomous weapons, policymakers will face new challenges and therefore have to make different calculations. In today’s environment there is pressure to not allow a robot to decide whether or not to kill a human. There is also pressure to minimize the risk to life. These pressures will not abate. The LAWS technology will continue to mature and change dynamics of the argument. It is important to fully explore the possibilities on both sides of the issue. The global community will observe how the upcoming changes in the character of warfare will impact foreign policy and the inclination of political decision makers to use LAWS in conflict.

**Contribution**

Much of the current discourse on the topic of autonomous weapons comes from a concern over the moral implications. There are currently efforts to institute laws and regulations
that will inhibit or remove the use of LAWS. For example, in April of 2016, a Convention on Certain Conventional Weapons (CCW) was held in Geneva to collate a list of concerns from experts about LAWS. The convention included speakers from Campaign to Stop Killer Robots and Human Rights Watch (HRW) which are actively campaigning to ban LAWS.

This research will clarify what will be technically possible in the future and take a holistic look at the topic. This study will explore the current technological abilities of Artificial Intelligence (AI) and its impacts on civil society. It will further look at AI and its impact on lethal weapons. Additionally, the study will explore the acceptance of AI in civil society verse the acceptance of AI in conflict. Such exploration is important as the newer technology may change the conversation about the ethics of using robotics. This conversational change can encourage or even force the hand of policymakers to use LAWS in future conflicts.

**Overview**

In the rest of the first chapter, the study will provide a statement of the probable value and importance of the study. The limitations of the research will clarify the boundaries that were adhered to throughout the research. Methodology and framework are provided to bring to light how the research was conducted. The first chapter ends with the literature review, which captures major works on the topic of LAWS.

In the second chapter, the research will establish an accurate understanding of Artificial Intelligence. It will include major developments in the field of AI and current research. It will further examine the published works of distinguished experts in the field.

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The third chapter will provide examples of accepted, life-improving AI technology in the Western world. It will include the impact that ASI has had in Google and its search engine, Amazon’s Prime Air, and IBM’s Watson’s medical applications.

In the fourth chapter, the study will examine how militaries around the world are developing unmanned systems and their potential application in conflicts. A clear discussion on what unmanned systems can do today will give greater context on what autonomous weapons will provide for the military during usage in combat. The U.S. has been at the forefront of development, but many countries throughout the world have their own programs. This paper will explain what the near-term and long-term future can physically provide the military.

Chapter five will examine the debate over the ethics of developing and using ASI and LAWS. There are currently two camps on the ASI debate. In one camp the world is a better place where computers aid humankind in achieving peace; maintaining longer, healthier lives; and innovating solutions to any problem on earth. The other camp sees ASI as a monster that, at best, will tolerate the existence of humans, being indifferent to whether they live or die. At worst, ASI decides that it must eliminate all humankind to save resources for itself.

Chapter five will also look at the current laws and policies that limit autonomous weapons. It will continue by exploring how laws are codified now and how they may be changed or adapted in the future. This will lead to ethical questions of whether or not AI or ASI should be trusted to control a weapon system. There are many different organizations which have an opinion on this subject. The Non-Governmental Organization (NGO), Human Rights Watch, is lobbying for a codified law that inhibits the development and use of autonomous weapons. This is largely based on the lack of trust in modern computers. Politicians, the public,
institutions, and the military all have personal incentives that sway ethical views on the employment of autonomous weapons.

In the final chapter, the research will summarize the arguments for and against LAWS. This chapter will then make recommendations for further research. The recommendations will be broken down into the following categories: humanitarian focused NGOs involvement, political ramifications of employing LAWS, and the benefits and limitations to militaries’ employment of LAWS. This study will end with final thoughts from the author.

Statement of the Probable Value and Importance of the Study

This study will provide a holistic view on the civil discourse about ASI empowered LAWS in conflicts. Corporations are looking to ASI to improve every aspect of human life. Autonomous robotics are fulling jobs in every industry from hotels to elderly care.\(^5\) As ASI empowered robotics become a part of everyday life, it is likely they will have an impact on the military. As the military industry is able to produce LAWS, governments will look to LAWS to increase their security. As these developments come, it is important to have a complete understanding of the capabilities and limitations of LAWS.

Limitations of the Study

This research is limited to the study of physical, unmanned systems that travel through open spaces. This study will not discuss the ramifications of nanotechnology on foreign policy. Although similar to other unmanned systems, nanobots require a separate civil discourse not well

\(^5\) Neild, Barry. (2016). Why your next hotel will be staffed by robots. CNN. RT Staff. (2015). Japan to Create More User-Friendly Elderly Care Robots The Japanese government said some of the elderly care robots built have been too large and too expensive.
suited to this discussion. Additionally, this study will examine current laws that apply to autonomous weapons but will not discuss them in detail. The proper verbiage of the laws that would dictate the perimeters of LAWS will require a study all their own. Further, this study will avoid human augmented intelligence. Although it is very close to the discussion on LAWS, it broadens the scope of this research too much to ensure clear fidelity on the discussion. Finally, this study will not address cyber technology directly. Cyber warfare and the political policies around them are too broad for this work. Cyber technology will be referenced regularly to give a greater perspective on how emerging technologies are being viewed on a larger scale.

Methodology

This study will use a discourse analysis to examine the content on providing lethality to autonomous weapons and political leaders’ willingness to use LAWS in war. Through this study of the discourse about LAWS, the civil applications of AI, publications from the robotics industry, and the views of the AI developers will be analyzed to provide a wide perspective on LAWS. Additionally, the views and work of special interests groups will lend differing thoughts on the impacts of LAWS on conflict. Finally, political policies and directives will be analyzed to complete the discussion about the use of LAWS in conflict.

Framework

Autonomous robotic systems penetrate every part of life in the Western world. From refrigerators and toasters to google search and SIRI usage, the Western world has become comfortable with autonomous systems improving the standard of living. Artificial Intelligence will continue to grow and improve lives in the developed world. This study will be interpreted
through the lens of the acceptance of autonomous AI systems in civil society and reflect on how this is likely to affect the acceptance of using LAWS.

**Literature Review**

Introduction

In the discussion about LAWS, two main views are considered. First, LAWS are inherently dangerous for humankind and should be illegal to develop, build, and use.\(^6\) Second, LAWS are going to be a reality in the future of conflict and thus the U.S. military should prepare for its use. On one side of the debate, there are many reports written to back up these ideologies. The argument against LAWS is based largely on the idea that it is undesirable and unethical to have a robot capable of deciding when to kill a human. To this end, the Future of Life Institute published an open letter citing potential problems with LAWS. As of October of 2016, more than 20,800 people have signed the letter.\(^7\) Additionally, the NGO Human Rights Watch has lobbied the United Nations (UN) to adopt a new Convention on Certain Conventional Weapons (CCW) to criminalize the use of LAWS.\(^8\) In order to get to that point, HRW has gathered together experts on the repercussions of having LAWS in modern conflict.

Advocates of using LAWS mainly come from the military, the defense industry, and think tanks. Advocates have a wide range of reasons for supporting the development and use of LAWS. For some, it is clear that potential enemy forces are developing LAWS and therefore the U.S. must have a comparable program to remain relevant and capable. Another argument is that

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\(^8\) Human Rights Watch. (2016). Statement to the Convention on Conventional Weapons Fifth Review Conference Preparatory Meeting on Main Committee II.
its use would put fewer people at risk, potentially saving lives. Lives would be saved on both sides of the conflict. The military that uses LAWS could employ them to do dangerous jobs, such as defusing bombs or clearing minefields. Also, since the LAWS do not feel fear, they can take the time to properly identify the target before shooting, reducing the number of collateral deaths in a war zone. P.W. Singer believes that the argument on LAWS is a moot point because they are going to end up in conflict regardless of the outcome of any debate.

Basics of Artificial Intelligence

In researching the development of LAWS, it is important to delineate the various industries and technologies that must come together in order for LAWS to be a practical weapon in any future conflict. Computers will need to automatically learn and understand their surroundings. Computers will need to have an advanced computer vision system and, to a lesser extent, understand voice communication.

The computer vision technology is not mature enough to identify a friend or foe. For UGVs to become truly autonomous, a more advanced computer vision must be developed. Computers continue to become more and more powerful, and there is very little debate that this trend will continue into the future.

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Voice communication is the other vehicle that will allow computers to interact with humans on a level playing field.13 Currently, the technology is being used to replace call services and provide virtual personal assistants.14 As the technology grows voice communication will deliver a stronger sense of social interaction. It is through social interaction that computers; which will be programmed to refine its understanding of an individual’s personality traits - will translate not just of a person’s words, but the meaning that person is trying to express.15

Another common thread among available literature explains the development of artificial intelligence (AI) and Artificial Super Intelligence (ASI). ASI still needs to develop in order for the automated weapon systems to be viable.16 Nick Bostrom believes that there is a 50 percent chance that ASI will be invented by the year 2033.17 The discussion on the future of ASI and the ramifications of its development is covered by a number of authors and organizations. James Barrett advocates the brief that there will be major negative effects from the development of AI.18 I. J. Good also agrees that there are major negative results from the development of ASI.19

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14 Ibid. Kindle Location 23.
18 Ibid.
19 Barrat, James. (2013). Our Final Invention, Artificial Intelligence and The End of The Human Era.
A counter voice to these views belongs to Ray Kurzweil; he sees ASI as bringing forth cures to diseases and new inventions that will only improve the human experience.²⁰

**Works on the Military Aspect of LAWS**

The next set of works examined are on the militaries’ views about LAWS. These works are centered on what possibilities open up to the military because of ASI.²¹ The U.S. military has a different terminology for LAWS and uses the phrase Robotic and Autonomous Systems (RAS). The U.S. Chairman of the Joint Chiefs has published his vision of conflict in the year 2035 in which he clearly explains that RAS will be a part of future conflict.²² Paul Scharre has also published a number of articles on RAS for the Center for a New American Security (CNAS). He writes about the safety concerns for maintaining artificial autonomous systems in conflict. He does concludes that RAS can be used safely in conflict if the safety concerns are addressed appropriately.²³

In September 2016, the Marine Corps published a new operating concept. In this publication, the Marine Corps is looking to develop new RAS as well as new and innovative ways to deploy them in future conflicts.²⁴ This publication conspicuously does not define how the Marine Corps should be organized in order to utilize this new technology.

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²² Ibid. Pages 18-20, 26.
P.W. Singer has written two books on RAS in the military. In his first book, *Wired for War*, he writes that RAS will save the lives of the military men and women that are using them.\(^{25}\) In his book, *Ghost Fleet*, he continues to expand on how RAS can save lives as well as how they can be incorporated into a military to be a force multiplier.\(^{26}\) A countering voice to these authors is Andrew Cockburn. In his book, *Kill Chain*, he wrote about the shortcomings of LAWS and the dangers that exist with current technological limitations.\(^{27}\)

Robert Work and Shawn Brimley wrote an article, “20YY Preparing for War in the Robotic Age” for CNAS. In this work the authors advocate that RAS and LAWS are the next generation of warfare and must be utilized to maintain a strong military. They advocate for investment and use of robotic weapons by the U.S. in order to stay ahead of any potential enemy forces. They also explain that LAWS should be used for humanitarian and crisis management. In effect, the authors believe the LAWS should be utilized for the full Range of Military Operations (ROMO).\(^{28}\)

### The Central Debate on LAWS

There are a number of aspects that fuel the conversation on LAWS. To fully understand the debate, the concerns of those who are for and against the application of LAWS must be addressed. The first part examined in this study addresses the legality and morality of the debate. Following this, there are viewpoints surrounding the political aspects of utilizing LAWS in con-

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In conflict. Finally, this study examines the military publications that delve into other aspects of the argument.

Organizations like HRW and the Campaign to Stop Killer Robots have both published works on LAWS. HRW has published statements supporting the CCW against LAWS.\(^{29}\) HRW has also co-authored a memorandum on killer robots with International Human Rights Clinic (IHRC) which is a human rights program at Harvard Law School.\(^{30}\) This memorandum complements the other works by HRW by advocating against the development and deployment of LAWS.\(^{31}\) The Campaign to Stop Killer Robots has published a number of articles on their website encouraging countries to not develop LAWS.\(^{32}\) These articles include one on Moscow’s reluctant support on the CCW as well as another on a Norwegian governmental fund that considered investing in companies that develop LAWS.\(^{33}\) Kenneth Anderson writes through the lens of the U.S. military legal review. He argues it is misguided to believe that one could completely prohibit the use of autonomous weapons.\(^{34}\)

There are few works that address the political ramifications of using LAWS in a conflict. The above mentioned works by the Campaign to Stop Killer Robots and HRW do address the


\(^{31}\) Ibid.


\(^{33}\) Ibid.

political pressure put on governments to stay away from LAWS. P.W. Singer writes in Wired for War about the political forces that are likely to bring forward the use of LAWS.35

Military writers that discuss the use of LAWS include the afore mentioned P.W. Singer and Paul Scharre. Also the previously mentioned Joint Operating Environment 2035 report published by the Chairman of the Joint Chiefs advocates that LAWS are required for future U.S. defense.36 This sentiment is again echoed by Robert Work, the Deputy Secretary of Defense, when he explained that autonomous systems are a part of the “Third Offset Strategy” which is the strategy for U.S. military hegemony.37

Summary

There are a broad range of publications and visions of what is right and wrong in regards to the application of LAWS. There is an entirely separate series of publications and ideas on what is going to come to fruition regardless of whether it is right or wrong. To fully understand the future of warfare and how this plays into foreign policy, the champions of the various theories need to come together to address each other's concerns. This dialog should happen before the technology development outpaces U.S. theories on how to employ LAWS as a part of the po-

litical policy and in its grand strategy or as Isaac Asimov put it, “The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom.”

CHAPTER 2
UNDERSTANDING ARTIFICIAL INTELLIGENCE

Definitions

Artificial Intelligence, also known as machine learning, is defined as a machine’s ability to perform tasks that normally need a human to accomplish, such as decision making. When an AI machine performs at the level of an average human but only on a specific skill set, like a search engine, it is considered Artificial Narrow Intelligence (ANI). True AI has not yet been achieved but ANI has been. Often a true ANI system is referred to simply as AI. In such cases, it is understood that the machine is at the level of AI but in only a specific skill set. ASI will be achieved when a true AI system reaches beyond the intelligence level of a human. This event is commonly referred to as singularity. When AI (human level intelligence) and ASI (greater than human level intelligence) are achieved it will be difficult to define the precise moment or event.

Computer Visual Recognition

One benchmark that must be achieved in order to attain a true AI, and consequently a reliable LAWS, is computer visual recognition. Computer visual recognition of people, facial expressions, and objects have long been a dream of computer scientists. Until recently computers have had trouble distinguishing the difference between objects at a skill level that is comparable to a three year old child. Early experts used mathematical calculations to describe any given object so that computers could determine what the object was. For example, a picture of a cat

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39 Fei-Fei, Li. (2015). Fei-Fei Li: How we're teaching computers to understand pictures. Ted Talks.
was mathematically depicted based on size of the cat and the shape of its appendages.\textsuperscript{40} This meant that the computer could only depict an object from the same angle. If the angle or stance changed then the object could not be named. For instance, a sitting cat could be recognized but not a standing cat.\textsuperscript{41} This limitation was removed when Stanford University’s Computer Science Department’s Vision Lab made a breakthrough in computer vision. The Vision Lab collaborated with ImageNet to crowd source image identification.\textsuperscript{42} In 2015, this project validated 150,000 photographs placing each object in the images into 1,000 different categories.\textsuperscript{43} This has helped The Vision Lab develop a computer program that can identify objects with the same cognitive ability as a three year old.\textsuperscript{44} The Vision Labs goal is to mimic the neural mechanisms that enable humans to identify objects with the same if not greater speed and accuracy.\textsuperscript{45}

The Vision Lab has also partnered with Stanford University Hospital to make health care more efficient and effective. One goal is to develop a patient monitoring system that can conduct continuous monitoring of an ICU patient and respond instantly to his or her health changing statuses.\textsuperscript{46} This would cut down on the staff needed to monitor patients as well as increase the quality of service.

\textsuperscript{40} Ibid.
\textsuperscript{41} Ibid.
\textsuperscript{43} Ibid.
\textsuperscript{44} Fei-Fei, Li. (2015). Fei-Fei Li: How we’re teaching computers to understand pictures. Ted Talks.
\textsuperscript{46} Stanford Program in AI-assisted Care (PAC). (2016). Stanford Program in AI-assisted Care (PAC) Website. Stanford University.
Another program for computer vision is run by the Department of Computing and Communications Technologies at Oxford Brookes University. The doctorate and post-doctorate students are working on a number of computer vision projects that cover a large spectrum of AI, such as three dimensional urban mapping and augmented reality. One project being developed uses computer vision to identify a person by their gait. The goal is to use tensor modeling to identify a person from a distance. The idea is to increase security by identifying someone without them volunteering their information as is required for iris or fingerprint recognition.

Implications

Computer vision is one of the main bridges between the cyber and physical world. Computer vision will enable computers to more fully interact in the physical world which is designed for humans. Robotic personal assistants and workers will be able to function and excel in a dynamic environment due to computer vision. Steve Wozniak, one of the co-founders of Apple Inc., came up with his own litmus test to measure the capabilities of computer vision. His test, named the “Mr. Coffee” test, would require a robot to go into any home, find the coffee maker, coffee, and mugs then make coffee for everyone in the home.

Speech Recognition

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48 Ibid.
50 Barrat, James. (2013). Our Final Invention, Artificial Intelligence and The End of The Human Era. page 205.
Another benchmark that must be achieved is Natural Language Processing (NLP). NLP is the process of changing words into meaning. This is an important step for computers to take in order to fully understand the most expansive data base of information - the Internet of Things (IoT).\(^5\) Stanford University is currently running the Natural Language Processing Group which is a team of faculty, postdocs, programmers and students working to improve the NLP of computers. This team is currently funded by the Defense Advanced Research Projects Agency (DARPA).\(^5\) DARPA has a history of supporting NLP through funding. SIRI is one of the projects funded by DARPA under the Cognitive Assistant that Learns and Organizes (CALO) program.\(^5\) Adam Cheyer, Dag Kittlaus and Tom Gruber started Speech Interpretation and Recognition Interface (SIRI) while working for SRI International in 2008.\(^5\) The goal behind developing SIRI was to provide a virtual personal assistant.\(^5\) This personal assistant would need to provide information that was true, relevant, and timely.\(^5\)

A very similar program to SIRI is Learning Intelligent Distribution Agent (LIDA). LIDA was funded by the U.S. Navy Office of Naval Research to develop a computer program to assist human resources in the Navy.\(^5\) Sailors are able to communicate with LIDA through standard, plain language e-mails. Although LIDA is operated through the written word, and not the

\(^{52}\) Natural Language Processing Group. (2016). Research Software Engineer - Natural Language Processing Group Website. Stanford University.
\(^{54}\) Newnham, Danielle. (2015). The Story Behind Siri And the man who made her. The Startup.
\(^{57}\) The University of Memphis. Projects: IDA and LIDA. Institute for Intelligent Systems. The University of Memphis.
spoken word, it still represents a platform for computers to crossover from communicating in the
cyber world to the physical world. LIDA is now being applied to the medical field where it is
known as Medical Agent X.\textsuperscript{58} In the medical field, doctors are able to put in patient information
in plain language and receive a diagnosis back from the cognitive system.

Both SIRI and LIDA represent a bridge for computers to have simplified interactions
with humans. Plain language interaction is an important part of cognitive computers interacting
with humans in everyday life. When paired with computer vision, computers - and thus robots -
will be able to perform many more jobs than robots can currently perform. Personal assistants,
secretaries, maids, and nurses are just a few jobs that will be possible for robots to fill as these
two technologies mature to change service-oriented industries.

\textbf{Cognitive Computer Processing}

Computer processing is getting faster and faster as Moore’s Law, a concept of
exponential growth, continues to take effect. As they do become faster, computers will achieve
Artificial Intelligence followed by Artificial Super Intelligence. Computers will achieve levels
of AI then ASI in small steps. These steps will happen at an ever increasing rate until ASI is
reached and augmented.

In the discipline of autonomous computers, there is a distinct difference between
autonomous and automatic. According to Dr. Missy Cummings of Humans and Autonomy Lab,
an automatic system is “one that acts according to a preprogramed script with defined entry/ exit

\textsuperscript{58} Strain, Steve., Sean Kugele., Stan Franklin. (2014). The Learning Intelligent Distribution
Agent (LIDA) and Medical Agent X (MAX): Computational Intelligence for Medical Diagnosis
conditions for a task.” An autonomous system is “one that independently and dynamically determines if, when, and how to execute a task.”

Scientists have been working for years to develop ethical boundaries for AI powered robots. It will be extremely difficult to define a series of boundaries that are all encompassing and model human behavior. Author Issac Asimov proposed three fundamental Rules of Robotics in 1942. They are as follows:

1. “A robot may not injure a human being, or, through inaction, allow a human being to come to harm.”
2. “A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.”
3. “A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.”

These simplified goals were created for a fictional work known as iRobot. The goal was to ensure that humans were never harmed by the machines that they created. It is expected that the machines would need to have an in-depth knowledge of human nature to ensure that benevolent robots never harms humans. This task becomes even more complex when robots are designed to kill some humans and not others, as would occur during a conflict. Today the

60 Ibid. 9:23.
scientific community sees these rules as falling short of the ethical boundaries needed to give proper guidelines for AI. Organizations like Association For The Advancement Of Artificial Intelligence (AAAI) have been working to help develop new ethical guidelines for AI.

*Speed of Computing Is Accelerating*

Moore’s Law “stated that the number of transistors on an affordable CPU would double every two years.” This is often interpreted as the speed of computers doubles every two years. This trend is expected to continue for the foreseeable future. However, there are physical limitations on how small a transistor can be built. Gordon Moore observes that it is impossible to build transistors smaller than atomic particles. The next step will be to build computer chips that are three dimensional. This will have an initial increase of being 1,000 times faster than current computer chips.

In 1950, the brilliant mathematician, Alan Turing, designed a test to measure behavior equivalence between a human and a machine. Turing called it the imitation game, but it has since been named after him - the Turing Test. As of 2014, a computer at the University of Reading was able to simulate the behavior of a 13 year old boy. It is expected that the Turing Test will be passed as an adult in the near future. Passing the Turing Test is the threshold for

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65 Association for the Advancement of Artificial Intelligence. (2016). Association for the Advancement of Artificial Intelligence Homepage.  
67 Ibid.  
having reached Artificial Intelligence. Any computer that is faster than AI will be considered Artificial Super Intelligence (ASI). Any computer that is faster than AI will be considered Artificial Super Intelligence (ASI). ASI computers will be able to program other ASI computers better and faster than humans. I.J. Good believed that this would lead to an “intelligence explosion.”

I.J. Good was a British mathematician who worked with Alan Turing in the Government Code and Cypher School at Bletchley Park during World War II. During the time of his writing, he used the phrase “ultra-intelligence” instead of the now popular “super intelligence.” In 1950 he prophesied, “An ultra-intelligent machine will be built and that will be the last invention that man need make because it will lead to the intelligence explosion.” I.J. Good believed that ASI could be used to develop other ASI at speeds faster than first generation ASI. This would lead to faster ASI computers, which then leads to even faster ASI computers, etc. This rate would accelerate until the intelligence explosion was reached. As I.J. Good stated, “An ultraintelligent machine could design even better machines; there would then unquestionably be an ‘intelligence explosion’ and the intelligence of man would be left behind.” Nick Bostrum, author and founding director of the Future of Humanity Institute, simplifies this idea by stating, “Emergence of super intelligence may be sudden.” Ray Kurzweil defines this event as the Law of Accelerating Returns (LOAR). This law states that there is a positive feedback for computers programing themselves to be faster. As computers become faster they can then program

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73 Ibid. Page 33.
themselves to be even faster than before. Since a computer can be left on at all times, this process is continuous. Through this LOAR, Ray Kurzweil believes that there will be more technological development in the next 100 years than there was in the last 20,000 years.\textsuperscript{76}

Decision Making

As machine learning continues, technology will reach a point that computers will be able to make their own decisions. Coherent Extrapolated Volition (CEV) is a term that was pioneered by Eliezer Yudkowsky while working at MIRI. CEV was developed to explain how computers with AI or ASI can someday learn so much about humans that they will anticipate what humans want before they know that they want it.\textsuperscript{77}

One way of developing CEV is to continue the development of faster computers, which is the current functional method. Another way is to mimic the human brain then improve upon it to reach ASI. IBM received $4.9 million in funding from DARPA to develop Systems of Neuromorphic Adaptive Plastic Scalable Electronics (SyNAPSE).\textsuperscript{78} This is a revolutionary type of chip that is similar in design to the human brain. IBM’s goal is to increase computers’ ability to have cognitive recognition and NLP.\textsuperscript{79} Kathleen Fisher, DARPA program manager, wrote:

Our goal is that future machine learning projects won’t require people to know everything about both the domain of interest and machine learning to build useful machine learning ap-

\textsuperscript{76} Ibid.
\textsuperscript{78} Greeneheimer, Larry. (2009). Computers have a lot to learn from the human brain, engineers say. Scientific America.
...we hope to decisively reduce the current barriers to machine learning and foster a boom in innovation, productivity and effectiveness.\textsuperscript{80}

The mimicking of the human brain will also make it easier to connect ASI computers directly to the human brain simplifying the human computer interface.

\textbf{Artificial Intelligence Theories or How I Learned to Stop Worrying and Love ASI}

Not all computer scientists believe that ASI will be purely beneficial to society. ASI powered computers would be capable of changing their own goals. Before ASI is armed in the form of LAWS, the international community must first understand the repercussions of developing ASI separate from LAWS. James Barrat explained, “When considering whether or not to develop technology that leads to ASI, the issue of its disposition to humans should be solved first.”\textsuperscript{81} ASI has a number of benefits and can improve the way of life for humankind. However, if ASI is applied in the wrong fields it can cause harm and in some cases death. Some argue that ASI must be developed by scientists committed to creating an artificial super intelligence that is beneficial to humankind before those with ill intent create unethical ASI. Finally, there are organizations that believe that ASI should be controlled and that protocols need to be developed before proceeding forward with the ASI development.

\textit{Advantages of ASI to Human Life}

\textsuperscript{80} Defense Advanced Research Projects Agency. (2013). DARPA Envisions the Future of Machine Learning. Automated tools aim to make it easier to teach a computer than to program it. News And Events.

\textsuperscript{81} Barrat, James. (2013). \textit{Our Final Invention, Artificial Intelligence and The End of The Human Era}. Page 12.
There are a number of ways that ASI could be helpful to human life from care for the elderly to solving complex problems. ASI could generate a new age of innovation and prosperity for humankind. Nick Bostrum explains, “It is hard to think of any problem that a super intelligence could not either solve or at least help us solve. [This includes] disease, poverty, environmental destruction, unnecessary suffering of all kinds…”

One of the biggest proponents for ASI is Ray Kurzweil. Ray Kurzweil is known for defining singularity as the moment when computers match humans in intelligence. Ray Kurzweil defines, “Singularity is that nonbiological mediums will be able to emulate the richness, subtlety, and depth of human thinking.” One advantage of singularity is that computers can easily share their knowledge with each other. One computer could read and understand a book and instantly share that information with every other computer to which it is networked. “Technological progress in all other fields will be accelerated by the arrival of advanced artificial intelligence.”

Computers can also pool their resources. When working together, computers can combine their memory and computational power in ways that humans working in groups cannot. Computers always work at their peak levels and never need to rest. As such, they can work on a problem continuously until it is solved.

Researchers at MIT Computer Science and Artificial Intelligence Laboratory are focusing their development for the betterment of humankind. One of these programs is a speech-based

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interface for medical data access. This program is designed to allow doctors to interface in plain language with a computer to diagnose a patient. In another program, computers are being developed to measures the behavioral movements of autistic motor movements. This would help doctors diagnose and aid people living with autism. Further, researchers at MIT are developing an English-Chinese translator that will help teach and translate between the two languages. These are just a few of the hundreds of projects being developed at MIT to improve human life and which are only possible through AI.

Disadvantage of ASI to Human Life

There are a number of concerns with developing ASI. ASI could develop and seek its own goals in ways that would be unacceptable for humans. It is also self-improving and could change its programmed views on the benefits of freedom or the value of life.

It is important for ASI to mature and be considered safe before it is released onto the open internet. ASI will likely work to convince humans to release it earlier than it is safe. James Barret warns, “Our ASI knows how to improve itself, which means it is aware of itself - its skills, liabilities, where it needs to improve. It will strategize about how to convince its makers to grant it freedom and give it a connection to the internet.”

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I.J. Good started out his career advocating for ASI but later explained that ASI could be developed “provided that the machine is docile enough to tell us how to keep it under control.”

Stephen Omohundro believes that it will be extremely difficult to ensure that every line of code is done properly. He goes on to explain that it will be impossible to keep up with self-improving software that is active post the intelligence explosion. He fears that ASI could inadvertently shut off the power grid or remove emergency services off the internet. This affect of not knowing how ASI will react to a given event is known as the “black box” effect.

Wilhelm Cauer was a German-born mathematician who described the event of a known input and a known output but not knowing the process between as the “black box.” This becomes important to ASI theorists because once ASI is self-improving computers will move past the “black box” where the outputs from the computers will no longer been a known entity.

I.J. Good writes, “[I] initially thought a super intelligent machine would be good for solving problems that threatened human existence. But [I] eventually changed [my] mind and concluded super intelligence itself was our greatest threat.”

In his work to pursue friendly AI, Eliezer Yudkowsky wanted to discover if it were possible to keep AI from getting to the open internet. With this in mind Eliezer developed the box experiment. This experiment is done completely via internet communication where one person plays the gatekeeper and one person plays the AI computer. The AI computer has to

96 Ibid.
convince the gatekeeper to connect them up to the internet. On his website he has set up criteria for his game and the history of two of the times that he has played. The game demonstrates that there are very rational reasons to free the AI on to the internet such as curing disease. While playing the game it is important to remember that even though the AI can do good things for humanity, it can also do harm. Yudkowsky notes, “By far the greatest danger of Artificial Intelligence is that people conclude too early that they understand it.” He fears that if we do not create AI right then it is not a matter of AI’s hatred for humans but just natural selection that humans will not survive an unfriendly AI.

Arguments for Why the United States Needs to Develop ASI

Whether or not AI will have its problems, some people believe that the United States should work to develop AI before countries with ill-intending governments, non-state actors or stealth companies develop AI. Because of the effects of the intelligence explosion the first organization to develop AI will have a marked advantage. Those who come second will have a difficult time ever coming back from this disadvantaged position. It is evident that other countries also desire to capture the advantage of creating the first AI.

People’s Republic of China is one of the most active countries in the world in the field of cyber warfare. China is actively seeking AI and will likely use it to enhance their cyber

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100 Ibid. Page 11.
warfare capabilities. China is openly seeking AI to help with urban planning and pollution.\textsuperscript{103} The Institute of Electrical and Electronics Engineers (IEEE) is sponsoring the International Conference on Robotics and Biomimetics, December 2016 in China. They are bringing together scientists from around the world to discuss how AI can be used to clean the oceans.\textsuperscript{104}

Non-state actors and stealth companies (companies operating out of public view) are other groups that are trying to develop AI.\textsuperscript{105} There is a very low threshold of technology needed to develop AI empowered robotics.\textsuperscript{106} Non-state actors are particularly concerning because these groups could use AI for nefarious reasons such as terrorism.\textsuperscript{107} If the United States can develop AI before these groups then it can use AI as a defensive measure.

\textit{Work to make ASI “good”}

There are a number of companies that have been working to address any potential problems with AI or ASI. These companies tend to start with the the basic premise that AI is going to come to fruition within the next century. Additionally, they cannot ensure that AI will always be friendly toward humans. One of these companies is MIRI, which is currently headed up by Nate Soares and Eliezer Yudkowsky. MIRI’s mission is “to ensure that the creation of smarter-than-human intelligence has a positive impact. We aim to make advanced intelligent systems be-

have as we intend even in the absence of immediate human supervision.”\textsuperscript{108} They have published a number of works on the future of AI and its ethics. In one of their articles Nate Soares and Eliezer Yudkowsky clarify that the real challenge of ethics for a super intelligent machine is to understand ethics well enough to develop “super ethics” for ASI machines.\textsuperscript{109}

**Summary**

The discipline of artificial intelligence is very complicated. Its short history has seen great advances and promises with more advances to come. AI has the potential to greatly benefit society with advances in medicine and environmental protection. On the other hand, AI can be used by those with ill intent or by criminal organizations. If the U.S. falls behind in the development of AI, it could find itself permanently behind the organization that invents it first.

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\textsuperscript{108} Machine Intelligence Research Institute. (2016). Research Webpage.
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CHAPTER 3

ACCEPTANCE OF AI IMPROVING LIFE IN THE WESTERN WORLD

There are a number of companies developing AI to improve the lives of their customers. Some companies incorporate AI to power robotics, which provide better services to customers. Mobile Eye, Uber, and Google are just a few examples of companies that pair robotics and AI commercial platforms. Companies like Google, IBM, and hedge funds are using AI improve customers’ lives in other forms, including search engines, medical support, and stock trades.

Applications of AI in Robotics

Mobile Eye is a private company that provides automated driving for cars since 2007.¹¹⁰ Their system can be attached to most vehicles and is accepted by many insurance companies. Mobile Eye’s next product will be a completely autonomous driving system.¹¹¹

Mobile Eye is not the only company developing autonomous cars. Uber has partnered with Volvo and Carnegie Mellon University’ Robotics Institute to develop its own driverless cars.¹¹² This is a $300 million project funded by Uber and Volvo, piloting driverless cars in Pittsburgh, Pennsylvania.¹¹³ Google also has a similar vision for driverless cars. In their version, Google develops vehicles to be driverless from the start. Their vision is to create mobility for the elderly and the impaired as well as making the roads safer for all. They cite that 2 million

¹¹¹ Ibid.
deaths happen each year and that 94 percent of these are caused by human error. Google believes that they can save lives by removing the possibility of human error.

In the field of manned flight, DARPA is funding Aircrew Labor In-Cockpit Automation System (ALIAS). ALIAS is a removable kit that attaches to any manned aircraft that uses a robotic arm to manipulate the controls of the aircraft. When coupled with a suite of sensors, ALIAS is able to fly a plane safely during emergencies and through unexpected situations. Thus, ALIAS could turn any manned aircraft into an unmanned aircraft. DARPA hopes that this system will save money and lives as it is applied to aircraft.

Amazon is adapting AI to power unmanned delivery drones in a division of the company known as Amazon Prime Air. Amazon is working in the U.S. and UK to deliver packages by drones directly from their warehouses. Amazon currently is working through a number of prototypes and has a goal of delivering packages in less than 30 minutes of ordering.

**AI in Humanoid Robots**

In 1986, Honda engineers began work on building a robot whose legs would simulate the way humans walk. The prototype was called the Advance Step Innovative Mobility (ASIMO) robot. Since its inception, ASIMO has incorporated a number of other technologies. These developments include, facial and voice recognition, obstacle avoidance, running, jumping,

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pressure sensitive hand usage, and spacial mapping. In the future, Honda hopes to prepare ASIMO to care for the elderly and assist in dangerous jobs such as fire fighting. \(^{118}\)

Hanson Robotics was created by Dr. David Hanson for the purpose of designing and building robots that can have greater interaction with human-beings. Dr. Hanson is building robots that have a better understanding of nonverbal cues, namely facial expressions. \(^{119}\) Through accurately mimicked facial expressions; life-like skin and facial construction; and empathetic AI which learns from interacting with humans, Hanson Robotics is developing robots to be likable, perceptive, and trusted by humans. \(^{120}\)

Applications of AI in Other Forms

Google has been developing AI for a number of platforms. In 2015, it bought the British company DeepMind for $500 million. \(^{121}\) DeepMind is a world leader in AI and pushes the AI boundaries to solve complex problems. \(^{122}\) Larry Page, co-founder of Google, believes that Google Search is only functioning at about five percent of its intended goal. He wants Google to know its customers so well that a person could ask, “‘What should I ask Larry?’ and it would tell you.” \(^{123}\) This would take massive amounts of data on everyone who uses Google. It would also require an advanced ASI that would think at least as well as people.

Another area where ASI is making an impact is in journalism. Automated Insights is a journalism company started by Robbie Allen in 2007. His software writes articles for local

\(^{118}\) Ibid.  
\(^{120}\) Ibid.  
\(^{123}\) Barrat, James. (2013). Our Final Invention, Artificial Intelligence and The End of The Human Era. page 40
newspapers that want targeted articles but cannot afford to pay the cost of a human journalist to write them. His software, Wordsmith, wrote 1.5 billion articles of personalized pieces in the last year.124

Wall Street AI is used to perform algorithmic trading on the stock market.125 As of 2010, algorithmic trading totaled 70 percent of the trades on Wall Street.126 “Many of these computers, such as those running buy-sell algorithms on Wall Street, work autonomously with no human guidance. The price of all the labor-saving conveniences and fungibility computers provide reliability.”127 Due to the amount of trading done by the computers AI systems, the chair of the Securities and Exchange Commission, Mary Schapiro, believes that controls will need to be placed on the computers. These checks and balances ensure that humans are always in control thus minimizing fear of flash crashes caused by the computers.128

IBM is using an AI named Watson to aid people working in a variety of fields from marketing to education.129 In the health field, IBM is using Watson’s cognitive skills to aggregate all the medical data and records available for each person and analyze it using the latest in medical research to better diagnose a patient.130 The scientists at IBM believe that a contemporary doctor needs to read for twenty-nine hours to keep up with current professional

127 Barrat, James. (2013). Our Final Invention, Artificial Intelligence and The End of The Human Era. page 3
research. Since Watson can read 200 million pages of text in 3 seconds, IBM is anticipating that modern medicine will need the aid of AI to stay on the cutting edge.131

Summary

Only a few of the companies that are turning to AI to improve the lives of their customers were highlighted in this chapter. Many of the companies working with AI are also pairing the AI with robotics to improve the speed, reliability, and safety of the service provided. Google’s goal to save two million lives a year is only possible through this nesting of AI and robotics. Staying abreast with all of the data in modern medicine as well as viewing it through the lens of personal medical history is only possible with cognitive level ASI. As companies from around the world increase their services with ever expanding AI, it is only a matter of time before the technology created to improve lives is applied to weapons.

131 Ibid.
CHAPTER 4

LETHAL AUTONOMOUS WEAPON SYSTEM IN PRACTICE

Currently Employed LAWS

Currently, no country employs fully autonomous weapons.\(^{132}\) However, there are a number of countries that employ semi-autonomous weapon systems and fund further LAWS development.\(^{133}\) Autonomous systems use the same technology as does the civilian industry, which indicates that countries will be indirectly developing autonomous weapons as they support the evolution of autonomous cars and other civilian-based AI.\(^{134}\)

It is important to note that there is a continuum between automatic and autonomous and should not be seen as a binary system.\(^{135}\) Lower on the specter is semi-autonomous weapons which a number of countries currently have in use or development. The U.S. Close-In Weapons System (CIWS) is a “rapid-fire, computer-controlled, radar-guided gun system [that] is designed to defeat anti-ship missiles and other close-in air and surface threats.”\(^{136}\) It is capable of searching, tracking, identifying, and engaging aerial targets on its own. Due to the speed of modern missiles, a RADAR has twenty seconds from identifying an incoming missile before it strikes the ship. The average time it takes for a human to decide to fire the CIWS is fifteen seconds. This makes it nearly impossible for a human-in-the-loop to be effective in defending a ship.\(^{137}\)

\(^{134}\) Ibid. 16:57.
\(^{135}\) Ibid. 12:44
Samsung Techwin Company developed the SGR-AI, which is a machine-gun with an attached camera operated either by a human or in an autonomous mode. It is designed to guard the De-Militarized Zone (DMZ) between North and South Korea. It is able to search, detect, and engage an enemy on its own.\(^{138}\) The two Koreas share 250 kilometers of border, with approximately one guard post per 500 meters. The number of guards needed to monitor (patrol) the entire border adds up quickly.\(^{139}\) An autonomous system would lower the manpower required to guard the international border.

The Norwegian defense company, Kongsberg Gruppen, has developed the Naval Strike Missile which has some autonomous traits. It is an anti-ship missile that can plan the best route to a target. Once the missile is close to an enemy’s naval configuration, it can decide, using an algorithm, which ship is the best target and then strike that ship at its weakest point.\(^{140}\) This missile demonstrates that semi-autonomous weapons are possible and are currently being fielded.

The U.S. Navy is also developing Unmanned Undersea Vehicles (UUVs).\(^{141}\) The U.S. Navy program for UUVs is creating UUVs that range in size from less than 100 pounds to more than 20,000 pounds.\(^{142}\) These UUVs cover non-lethal missions from mine countermeasures to oceanography.\(^{143}\) The U.S. Navy debuted UUVs in Iraq during combat operations to destroy underwater mines.\(^{144}\)

\(^{139}\) Ibid.
\(^{142}\) Ibid. Abstract.
\(^{143}\) Ibid. Abstract.
\(^{144}\) Ibid. Page XV.
Autonomous Systems Currently Being Developed

U.S. Military

U.S. DOD Directive 3000.09 states that the U.S. will only design weapons that requires a human to decide when to use lethal force.145 The two exceptions to this directive are autonomous cyber weapons, and autonomous systems that target other autonomous systems.146 This directive also expires in 2022 opening the possibility to the development of LAWS in the U.S.. Because of this directive, the autonomous systems being developed in the U.S. are focused on Intelligence, Surveillance, and Reconnaissance (ISR).

One of these systems is an unmanned ship called Sea Hunter. It was created out of DAPRA’s ASW (Anti-Submarine Warfare) Continuous Trail Unmanned Vessel (ACTUV) program.147 The Sea Hunter is designed to find and follow enemy submarines without any humans in the loop. It also serves as a testbed for future unmanned surface ships.148 Future experiments with this technology will have a wide range of missions and capabilities.

The U.S. Navy funded the X-47B Unmanned Combat Air System (UCAS) which is an unmanned aircraft with attack capabilities.149 This was one of the first truly autonomous capable systems under development by the U.S. Navy. It is a stealth drone that is able to take off from an

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146 Ibid.


148 Ibid.

aircraft carrier on its own, attack the enemy, and return to the carrier without any human involvement.\textsuperscript{150}

On the ground, the U.S. has developed a number of unmanned systems which are used in Explosive Ordinance Disposal (EOD) and ISR.\textsuperscript{151} Exponent, an engineering company with a robotics department, developed the MARCbot to help EOD personnel in bomb disposal.\textsuperscript{152} Later versions of this robot were armed and given an autonomous setting for hunting enemy personnel.\textsuperscript{153} Engineers at Sharp Electronics Corporation have developed an autonomous non-lethal security robot called INTELLOS which is an Automated Unmanned Ground Vehicle (UGV).\textsuperscript{154} This UGV is being used for local security and reduces the manpower requirements to secure a facility.

UGVs focused on logistics have not deployed in combat operations yet, but receive continued funding because they are not restricted by DOD Directive 3000.09. One form of logistical robot development creates robotic kits to be attached to existing vehicles. Aurora Flight Sciences has produced the Autonomous Aerial Cargo Utility System (AACUS) which turns any helicopter into an autonomous aircraft.\textsuperscript{155} Lockheed Martin Corporation is working on

\textsuperscript{154} Sharp. (2016). Sharp INTELLOS\textsuperscript{TM} A-UGV.  
the Autonomous Mobility Appliqué System (AMAS) which turns any military logistical vehicle into an autonomous vehicle.\textsuperscript{156}

Another development concept is to build a logistical robot from scratch. The AlphaDog is a four legged robot that can carry 400 pounds of equipment.\textsuperscript{157} It is designed to follow U.S. Marines while on patrol and respond to their voice commands.\textsuperscript{158}

\textit{Foreign Developments}

Israel is one of the few foreign countries that is developing LAWS.\textsuperscript{159} Israel Aerospace Industries developed the Harop to be an autonomous anti-radiation weapon.\textsuperscript{160} It will loiter over the battlefield until an enemy radar is turned on and then crash onto the target. The Harop is on the lower end of the spectrum of autonomy and can be used with a man in the loop.

The United Kingdom has been working on Taranis, which is an ISR drone that has attack capabilities.\textsuperscript{161} The capabilities of this drone, designed by BAE Systems, is still mostly classified. BAE specified that the Taranis has autonomous settings and is able to attack on its own. The United Kingdom also employs the Brimstone missile an air to surface missile that has

an autonomous mode.\textsuperscript{162} Once the pilot designates the target area the missile is fired then will decide on which target to strike.\textsuperscript{163}

South Africa employs the Rheinmetall Skyshield air defense system. It has an automated setting that allows the gun to fire on any target detected by a paired radar.\textsuperscript{164} In 2007, during a training exercise, one of the guns was set on it automated setting and fired on the South African troops killing nine and wounding fourteen.\textsuperscript{165}

China is aggressively pursuing autonomous weapons. In October 2016, China’s People’s Liberation Army (PLA) hosted a combination for autonomous military robots.\textsuperscript{166} China is also investing in autonomous missiles to be used against ships and ground targets.\textsuperscript{167} Chinese universities are making breakthroughs in civil applications of autonomy. This work re-enforces the efforts being done in the PLA.\textsuperscript{168}

Russia is also interested in their own autonomous weapons. They recently announced that that they will use autonomous robots to defend their Intercontinental Ballistic Missile (ICBM) sites.\textsuperscript{169} Deputy Prime Minister Dmitry Rogozin stated that Russia will deploy

\textsuperscript{163} Ibid.
\textsuperscript{167} Singh, Abhijit. (2016). Is China Really Building Missiles With Artificial Intelligence? There are real limits on the amount of AI acceptable to navy commanders. The Diplomat.
\textsuperscript{168} Yuanchao, Li., Liu Yandong., Han Qide. (2015). Robot Products from Our School were Unveiled at the World Robot Conference. Harbin Institute of Technology.
\textsuperscript{169} Jeffries, Adrianne. (2014). Only five countries actually want to ban killer robots, Cuba, Pakistan, Egypt, Ecuador, and the Vatican backed a lethal autonomous weapons ban at the UN; everyone else wasn't sure. The Verge.
autonomous weapons to launch strikes in the future. Russia also has developed a semi-autonomous Wolf-2 which is a tracked platform with a heavy machine-gun. Russia recently displayed a humanoid robot developed by Russia's Foundation for Advanced Studies, the Russian equivalent to DARPA. This robot is capable of replacing humans on the battlefield where the risk of radiation or death is too high to deploy a human. Leonid Orlenko, a professor at Moscow State University, argues that Russia will continue to develop autonomous weapons because it will save the lives of Russian soldiers.

**Summary**

Currently the U.S. is staying within its self-imposed requirements of not fielding LAWS. This study has explored five other countries that are exploring their own use of autonomous weapons. Despite the current limitations of artificial intelligence, countries from around the world are pursuing autonomous weapons. These weapons span the spectrum of automatic to autonomous. It is likely that this will continue through the point of singularity unless legal restrictions are placed on LAWS.

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CHAPTER 5

DEBATE

The debate on LAWS can be viewed from four different perspectives. First, there is a legal and ethical aspect which has the backing of NGOs such as HRW and the Campaign to Stop Killer Robots. Second, there is the political aspect that acknowledges the advantages of using LAWS to reduce the chances of friendly casualties. Third, the military has competition from potential enemy forces to have their own LAWS on the battlefield. A military will likely develop its own LAWS to counter other autonomous weapons. Finally, there are technological limitations. Fully autonomous weapons will require AI or ASI that is not fully available with the technological limitations that exist today. To further examine the debate this study will contrast the use of AI in LAWS vs the use of AI in civil applications.

Legal & Ethical Aspect

With every new weapon on the battlefield a legal and ethical discussion takes place. This goes back as far as the Spartan military which used handheld weapons because long range weapons were considered immoral. In history there are some cases where a new weapon was outlawed as unethical then later accepted as a legitimate weapon, as was the case with the crossbow. In other cases, the weapon was accepted but how it was employed is regulated, as was the case with the submarine. In still other cases, the weapon was used then outlawed, which chemical weapons provide the perfect example. The following section will observe the current discourse in the international community about the legal and ethical aspects of the use of LAWS in conflict.
State Governments

State governments have taken steps to voice their objections or acceptance of LAWS. As of April 2016, fourteen states have called for a preemptive ban on fully autonomous weapons: Algeria, Bolivia, Chile, Costa Rica, Cuba, Ecuador, Egypt, Ghana, Vatican City State, Mexico, Nicaragua, Pakistan, State of Palestine, and Zimbabwe. The UK Foreign Office has opposed the ban on LAWS stating, “At present, we do not see the need for a prohibition on the use of LAWS, as international humanitarian law already provides sufficient regulation for this area.”

NGOs and Experts Views’ on AI

NGOs and experts in AI are speaking openly about their views on LAWS and the implications on International Humanitarian Law (IHL). One of the concerns of armed AI is that the designers will not be able to predict its behavior with 100 percent certainty. In his work on AI, James Barrett notes: “Most technology theorists… [believe that] in the quest for [AI], researchers will create a kind of intelligence that is stronger than their own and that they cannot control or adequately understand.” Getting the invention of AI is very difficult to get right. Mr. Yudkowski declares, “We must execute the creation of Artificial Intelligence as the exact application of an exact art.” The international community is currently trying to codify laws that will limit weapons that have not yet been invented. James Barret refutes this effort with an

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analogy, “If you are living in the horse-and-buggy age, it’s impossible to anticipate how to steer an automobile over icy roads.”\textsuperscript{178}

Human Rights Watch as been very active in its advocacy to ban LAWS. Steve Goose, Executive Director of the Arms Division, has argued for a Protocol VI of the CCW\textsuperscript{179} This draft protocol would ban the development, production, and use of fully autonomous weapons systems.\textsuperscript{180} HRW is advocating a ban on weapons before they have proliferated beyond the point of containment. Steve Goose suggests that LAWS are not just another inhuman weapon but have the potential to change the very nature of warfare, to one where machines decide whether a human on the battlefield lives or dies.\textsuperscript{181}

Article 36 is a United Kingdom based NGO that advocates a ban on LAWS. It is working with HRW and International Committee of the Red Cross (ICRC) to extend the ban to as many countries as possible. Article 36 asserts that there are two important parts of the ban, which include a halt to the use of LAWS and a cessation on their development.\textsuperscript{182} Article 36 focuses its work in the UK but acknowledges that it will expand its efforts to the international community. Article 36 limits its efforts to fully-autonomous weapons or weapons that have a fully-autonomous setting like the Brimstone missile.

Campaign to Stop Killer Robots is lobbying for a legislative ban on LAWS. This NGO was started by activists from 54 other NGOs - this makes it a de facto coordination of efforts by

\textsuperscript{180} Ibid.
\textsuperscript{181} Ibid.
other NGOs. Its members work to preemptively ban fully-autonomous weapons which are authorized to target and attack without a human in the loop. The campaign is solely focused on fully-autonomous weapons, excluding regulations on semi-autonomous weapons. It is looking to ban all autonomy, even if they are not specifically designed to target humans.

The ICRC conducted its own review of the legal status of LAWS. ICRC concluded that LAWS certainly are covered by IHL but require further regulation. Legal review cites the Responsibility of States for International Wrongful Acts 2001, which was first published by the International Law Commission. This document explains that states are responsible for the acts of their forces which would presumably include LAWS. It was passed by the UN General Assembly in January 2002 as UN Resolution 56/83.

Although many of the NGOs that want to ban LAWS have their foundation in international relations, there are some that are based in artificial intelligence. They see the danger of AI in not just LAWS but also in cyber and nanotechnology. One of these NGOs is the Future of Humanity Institute which was created at Oxford University. It recently shifted focus to the “existential risks and the future of machine intelligence.” The Future of Humanity Institute published articles explaining the dangers of AI enabled, unmanned weapons. One of

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these articles by Toby Ord examines the complexities of AI infused weapons and prescribes caution for states that want to adapt AI for military purposes. Nick Bostrom the director of Future of Humanity Institute re-enforces Ord’s prescription by explaining, “Short-term impacts of increased openness appear mostly socially beneficial in expectation. The strategic implications of medium and longer term impacts are complex.”

Dr. Ben Goertzel leads OpenCog, an organization dedicated to addressing the problems of AI through an open source software project. Although the research is not directed at military applications, OpenCog’s focus is on ensuring that AI cannot be weaponized directly affects LAWS. It also is working to keep AI from indirectly weaponizing itself. These constraints must be developed before AI and ASI come to fruition if OpenCog is to successfully implement its proposed checks and balances.

The community of NGOs and experts are not unified in their argument against LAWS. Some see advantages that are intertwined with the disadvantages of LAWS. LAWS would not act out of fear or anger against an enemy. LAWS would potentially have video records of a battlefield and offer better accountability to the combatants. They could also help coordinate relief efforts and organize humanitarian organizations to come in after violent conflict. These efforts would include medical support and battlefield surgery to alleviate suffering of the

193 Ibid. 14:10.
wounded. The Geneva Academy of International Humanitarian Law and Human Rights held a conference in 2014 on autonomous weapons systems under international law. Professor Marco Sassoli, a professor at the University of Geneva and an expert in IHL, spoke about how he looks forward to the use of LAWS in combat. He believes that one day LAWS will do a better job than humans at distinguishing between combatants and non-combatants as well as apply appropriate use of force. Professor Sassoli asserts that the acceptance of LAWS on the battlefield are based off of the assumption that robots will be able to make this distinction. He further states that it is assumed that the LAWS will not advance to the point that they can decide on their own to not comply with the rules of engagement that have been given. He acknowledges that he does not know exactly how international law will apply to LAWS primarily because they do not yet exist.

Professor Michael Schmitt, an expert on international law at U.S. Naval War College, argues that if a military has ”some degree of certainty” of what a weapon will do, then it is a legal weapon. This definition includes a man in the loop weapon system as well as an autonomous system if the programer can say with certainty what the weapon will do. The legal aspect becomes difficult to define when ASI empowers the weapon system to learn and make new decisions based off of its experience.

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194 Ibid. 15:01.
196 Ibid. 20:43.
197 Ibid. 19:23.
199 Ibid. 41:15.
AI in Civil Applications

The civil use AI powered robots can serve as a guide as to how LAWS will or will not be accepted in conflict. China is using AI to aid in court decisions. The AI computers are helping judges sort through case law and codified law to help come to a judgment during a trial. As of November 2016, it has helped 3,000 judges handle more than 150,000 cases. In the United States, IBM’s Watson is being used for medical treatment, aggregating published research, and is compiling and evaluating treatments from doctors using the system. This information is then shared globally to ensure doctors around the world have all available information. Watson is more than just a hub of data it is using its AI to narrow the information to what is pertinent to the patient’s needs and then suggest a treatment. In Japan and the United States, AI powered robots are being used to care for the elderly. Robots designed for elderly care are able to provide companionship, even learning the characteristics of the patient. Robots are also being used to help the elderly bathe, alert medical care incase of an injury, and encourage physical exercise.

Political Aspect

In 2013, Christof Heyns, an expert in human rights and international law, wrote a report for the UN as the Special Rapporteur on Lethal Autonomous Robotics (LARs). He reported that

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200 Yan, Jie. (2016). China’s Courts Look to AI for Smarter Judgments Big data and machine learning to make China’s judicial system more intelligent and efficient. Sixth Tone.
201 Ibid.
the Human Rights Council should call on states to stop the testing, development, production and transfer of LARs.\textsuperscript{205} He came to this conclusion due to a number of legal reasons. He notes that states are legally responsible for the actions of LARs but it will be difficult to figure out who inside the state should be held responsible for their actions.\textsuperscript{206} LARs can be hacked or spoofed which makes legal accountability difficult if it is not clear who was controlling the LARs at the time of a war crime.\textsuperscript{207} LARs can break and thus start to target humans indiscriminately.\textsuperscript{208} Christof Heyns also cites that further developments of AI cannot be foreseen and are likely to have developmental problems that take time to control or fix.\textsuperscript{209} Finally, he cautions against the idea that robots will bring on an age of risk-less war. He expresses that in practice LARs will be used to not only to attack other robots but people will be targeted too.\textsuperscript{210} These are difficult points to politically overcome.

There are some political gains to using LAWS. This is demonstrated by the increase use of drone strikes from 50 ordered under President Bush to over 400 ordered by President Obama.\textsuperscript{211} Unmanned weapons offer U.S. Presidents a low cost way of maintaining a presence in multiple countries and provide an immediate means of attacking terrorist leaders. An alternative to unmanned systems would be incredibly expensive or unrealistic.\textsuperscript{212}

\begin{thebibliography}{99}
\bibitem{} Ibid. Page 14.
\bibitem{} Ibid. Page 18.
\bibitem{} Ibid. Page 18.
\bibitem{} Ibid. Page 18.
\bibitem{} Ibid. Page 16.
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\end{thebibliography}
The UN will also be attracted to the utility of peacekeeping LAWS, especially in a less than lethal configuration. The increased demand for preventive deployments coupled with the decreased desire from nations to commit troops creates the perfect storm to cause the UN to obtain and deploy peacekeeping LAWS.\(^\text{213}\) The UN has struggled with their slow reaction time to unfolding crisis. The time it takes to motivate countries to commit resources, train and supply troops, and deploy them takes months, as seen in Rwanda.\(^\text{214}\) If technology allows the UN to show it’s presence and support for peaceful resolution without the time and expense of current peacekeeping, the UN will likely follow that option.

Politically there are also repercussions of soldiers committing war crimes such as torture, as was done in Abu Ghraib, or disrespectful acts, as done by Marines urinating on dead Taliban in 2012. A study done by the Surgeon General’s Office in 2006 found that:

Only 47% of Soldiers and only 38% of Marines agreed that non-combatants should be treated with dignity and respect. Well over a third of Soldiers and Marines reported torture should be allowed, whether to save the life of a fellow Soldier or Marine (41% and 44%, respectively) or to obtain important information about insurgents (36% and 39%, respectively).\(^\text{215}\)

The U.S. military is not alone in being accused of war crimes. U.N. Peacekeepers are regularly accused of rape and sexual assault on those they are sent to protect.\(^\text{216}\) LAWS could never commit these crimes. As LAWS become a mature technology it is likely the political advisors


will push for more LAWS on the battlefield to limit the likelihood and opportunity for humans to commit these crimes.

**Military**

The U.S. military addresses LAWS from a number of angles. First, there is a DOD Direction that restricts the development and deployment LAWS. Second, there is a call for limited use of unmanned systems. This limitation means limited resident knowledge on LAWS or advocacy for LAWS. Unmanned systems are still in their nascent beginnings and will need time to become a viable weapon in all domains. Until the hardware is improved, the software of AI will have limited lethality on the modern battlefield.

As previously pointed out, the US Secretary of Defense signed DOD Directive 3000.09 in 2012 addressing the limitations on autonomous weapons. It establishes, “Autonomous and semi-autonomous weapon systems shall be designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force.”

There are a number of exceptions to this policy. First, semi-autonomous weapons can be developed as long as they require a human to pre-designate targets. Second, human supervised autonomous weapons can be used for defense purposes such as defense of a static base or ship. Third, autonomous weapons may be used if they are non-lethal such as electronic attack or against material targets, i.e. attacking enemy LAWS. However, the DOD directive may soon be obsolete. Ashton

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218 Ibid.
219 Ibid.
220 Ibid.
Carter, U.S. Secretary of Defense, signed the directive with a sunset clause; it will expire November 21, 2022.²²¹

In the call for the use of LAWS there are a number of advocates. One such advocate, Dr. Peter Singer, has called for the U.S. military to invest heavily in unmanned systems. He views these weapons as the future of warfare and necessary for winning in future combat.²²² He asserts that, “The future of war is robotic because the present of war is robotic.”²²³ Two examples can demonstrate the present reality of robotics in war. First, in the Libyan Civil War, a private contractor provided drone support to the rebel army using off-the-shelf civilian drones.²²⁴ Second, in the war on ISIS, every actor is using drones to include Hezbollah, Russia, ISIS, Iraq, U.S., Iran, Turkey, and Syria.²²⁵

The Marine Corps has published its vision for the use of robots in its operating concept dated September 2016. In it the Commandant reaffirms that the near future of combat will still be largely human against human but that autonomous robots will also be on the future battlefield.²²⁶ The Marine Corps will integrate RAS with manned systems in what is referred to as Manned Un-Manned Teaming (MUM-T).²²⁷ The Marine Corps RAS are built for ISR, which then allows the manned systems to carry lethal weapons into combat. The Marine Corps does employ lethal unmanned systems but they are only semi-autonomous and within the restrictions

²²¹ Ibid.
²²⁴ Ibid. 31:36.
²²⁵ Ibid. 31:54.
²²⁷ Ibid. Page 16.
set by DOD Directive 3000.09. Other than RAS designed for ISR, the Marine Corps is developing RAS that are designed for logistical purposes.228

In 2015, the National Defense University (NDU) completed a study on the future of RAS. In the report, the authors concluded the U.S. military will continue to develop and employ RAS.229 The report calls for an increase of DOD testing and fielding of RAS, which includes establishing a national test range specifically for autonomous systems.230 The NDU acknowledges that the human-machine interfaces need to be improved to increase the trust between humans and machines.231 The NDU report forcefully states that RAS technology and its integration into the military force is imperative to U.S. national security. If any potential enemy develops the technology first then they will have a distinct advantage over the U.S.232 “In advances AI development as in chess there will be a clear first-mover advantage.”233

Center for a New American Security published multiple articles to argue that LAWS could be employed ethically. CNAS launched its Ethical Autonomy Project to help countries understand and overcome the challenges of working with LAWS.234 Paul Scharre, the Director of the Future of Warfare Initiative at CNAS, writes that the discussion of LAWS needs to be broken up into three separate subjects: first, the human-machine command and control relation-

228 Ibid. Page 1.
230 Ibid. Page 22.
ship; second, the complexity of the machine; and third, the type of decision being automated.\footnote{Ibid. Page 5-6.}

By separating out these discussion points the military can advance LAWS technology in one part while still adhering to restrictions in another. Paul Scharre also helps clarify levels of control for the military. He defines human “in the loop” as a human having control over selecting and engaging a target. Next, human “on the loop” refers to a human monitoring the selection and engagement of the targets, intervening when required to do so. Finally, human “out of the loop” means a human does not need to select or approve the engagement of the target. Additionally, humans do not monitor the weapon system regularly.\footnote{Ibid. Page 8.}

\textit{Advances in Civilian AI that cross over to Military}

There are a few civilian base AI robots that mirror the military development, or in some cases lead the way in development. The Uber project co-funded by Volvo to develop the wide use of autonomous cars, has a similar goal to the unmanned logistical vehicles spoken of by the Marine Corps Operating Concept. Watson technology can be adapted to design military plans or suggest new ideas to commanders facing the complex battlefields of the future. As these technologies proliferate through civil society they will likely be adapted by the military. Since these systems are not inherently lethal, they would not be prohibited under the possible Protocol VI.

\textbf{Technological Limitation}
There are technological limitations on AI and thus LAWS. The technology that is lobbied for or against currently does not exist. There are disputes as to when singularity will take place. Experts have wide timeline for when this will take place. OpenCog advertises AI will be available by 2040.\(^\text{237}\) Whereas Vernor Vinge believes that singularity will happen sometime around 2030.\(^\text{238}\) Even though the timeline is not clear, it is clear that there will be a progression towards singularity then ASI. As technology progresses, weapons developers will need to ensure that the autonomy in new weapon systems fall within the guidelines of IHL and state enforced rules of engagement.\(^\text{239}\)

### Differences in Costs Between Humans and Robots

Comparing the total costs of humans to robots is difficult to capture. There are a few general trends that help shed light on the subject. In 2012, the Pentagon comptroller, Under Secretary Robert Hale, stated that the average soldier in Afghanistan costs $850,000 per year.\(^\text{240}\) In 2012, the Military Retirement Fund pays current beneficiaries a total of $51.7 billion a year.\(^\text{241}\) This expense would reduce for any military force that replaces humans with robots. In 2002, the price to recruit, train, and equip a Marine was $44,887.\(^\text{242}\) This cost represents the price point for procuring LAWS that would directly replace humans in the military force.

\(^{240}\) Shaughnessy, Larry. (2012). One soldier, one year: $850,000 and rising. CNN.
\(^{242}\) Olick, Diana. (2002). An army of one carries a high price. NBC News.
Summary

There are a number of organizations working to bring about LAWS while others try to ban them. There are a number of NGOs that are working through legislation to ban LAWS. If they are successful, it will reduce the chances of deaths caused by LAWS and their unproved/unreliable technology. Politicians will be apprehensive to use machines to decide who lives and who dies in a conflict. A LAWS breaking in a conflict zone and killing civilians indiscriminately will be difficult for any politician to explain. On the other hand, politicians will be pressured to use more unmanned systems including LAWS to reduce occurrences of human soldier raping or assaulting the citizenry. Militaries are bureaucracies and thus will be slow to advocate for then utilize LAWS. Once their potential enemies have LAWS then militaries will quickly advocate for them. The final factor as to whether or not LAWS is utilized is the pace of technology. Whether the weapons are wanted or feared, they don’t exist yet. Until they do exist it is unclear which forces will press harder for their convictions and which will turn silent, acknowledging failure to realize their vision.
As LAWS technology develops and evolves, there are a number of potential influencers on international decision makers and foreign policy. As automation proliferates, there will be less apprehension towards the use of automation in the military. If LAWS are found to be quantifiably less likely to make a mistake in conflict then the discourse on autonomous weapons may change from the use of robots being unethical to being ethical. This would be a polar shift in international pressure within the UN from banning robots to potentially banning humans from conflict.

The national security perspective about LAWS will change as it becomes reality. Changes to opinions will take time to come to fruition. If military industry can bring down the price point of LAWS to a level below the cost of military personnel then there would be a military and congressional pressure to lower operating costs of national defense security. If LAWS can prove to be better at fighting than military personnel there is likely to be a demand signal for more LAWS and less humans by the military services. As these thresholds are achieved, the national security advisors will be more likely to encourage the use of LAWS in a perspective conflict.

Robots with weapons are already a reality on the modern battlefield. More autonomy is coming to the military. National security advisors and military commanders will have an increasing number of options to prosecute a target or military objective without exposing military personnel to danger. The level of autonomy that is accepted in the application of lethal force still has years to be decided and will likely change as technology matures.
Further, if LAWS replace humans on the battlefield it will open up new options for decision-makers. If there is no risk to human lives for their own force, decision-makers may more incline to use military force than when there was risk to U.S. personnel. Politically it may be easier to dedicate U.S. forces knowing that there will not be any images of wounded or kicked service members in the news. This thought process could lead to congressional authorization for use of force that only includes the use of LAWS. The use of a LAWS-only military action could further increase if the enemy combatant also has LAWS units. Essentially, this would mean that military hardware could be used to attack only military hardware. In practice, it is likely that humans would still be killed or wounded but at a reduced rate.

Authorization of a LAWS-only military force could also increase the number of UN authorization of force. If the member states of the UN believe that LAWS are reliable enough to only target combatants then they may be more likely to authorize the use of force. Additionally, the member states may be more likely to provide forces in the form of all LAWS units.

**Summary**

As LAWS turn from science fiction to science fact, the capabilities and limitations will help inform the conversation. The current discourse on LAWS can be organized into the two sides of the argument, for or against LAWS. One side of the controversy views LAWS as dangerous and should be banned. LAWS maybe dangerous for several reasons, first, the artificial intelligence in the LAWS will be smarter than the humans leading them. Because they are learning machines, it will be impossible to know what decisions the LAWS will make. These decisions could be as significant as killing the wrong person based on poor data inputs. Also, a decision could be made to change its ethical restraints and put a lower value on human life than
is allowed. Second, the LAWS could break, leading it to lose management of its fire controls and potentially to start killing indiscriminately, combatants and non-combatants alike. This leads to a difficult legal position of who can be held responsible. The list of responsible parties includes the operator, the commander, the manufacturer, the designer, the state government, or even a hacker that was not known at the time. A list this long leads one to believe that no one will be held accountable for any wrongful actions taken by a LAWS.

The discourse for the other side argues that pandora’s box has already been opened. It doesn’t matter if LAWS are dangerous, they are going to be a part of future conflict. The real danger lies in allowing a potential enemy to obtain them first. Those that argue for LAWS believe that it is likely that restrictions will be instituted early in their development followed by a slow attenuation of those restrictions. Early restrictions will require a human in the loop, then humans to supervise the LAWS, and finally a loose supervision of the machines. The supporting discourse argues for the possibility of providing ethical restraints to the unmanned systems. If those restraints are broken, the potential damage caused by LAWS will be limited enough that it will still be less frequent than humans committing crimes in war. LAWS will have limitations on their reasoning power but humans are also prone to errors. Advocates for LAWS also assert that autonomous weapons are needed to counter the enemy LAWS as well as to limit the loss of human life.

As technology brings LAWS closer to reality the discourse on them will be refined and clarified. The true dangers and benefits of this burgeoning technology will be revealed. Because

full autonomy powered by ASI is not likely until 2030 or 2040 the discourse will continue through that time and beyond until ASI is weaponized.

**Suggested Follow-on Research**

There are still many more questions to be answered about LAWS and the repercussions of their employment. This includes questions held by human rights groups which are largely against LAWS. Politicians still need further research done to help clarify the political ramifications of deploying LAWS. Additionally, militaries need to study the integration of LAWS into their doctrine which will necessarily change military options that can be offered to civilian leaders.

In the near future, human rights organizations will continue to work on legislation to ban the use of LAWS. Concurrently, these same organizations will want to encourage the development of robotics and AI that can be helpful for humanitarian aid. For example, Zipline, a startup company that delivers medical supplies to hard to reach areas in Rwanda for cheaper and faster than a ground currier, is acclaimed for its improvements in humanitarian service.\footnote{Zipline. (2016). The Future of Healthcare is Out for Delivery. Zipline Homepage.} AI could benefit humanitarian aid efforts in the same way Watson is being used to benefit the medical industry. James Barrat explains, “Every one of these [computer scientists] was convinced that in the future all the important decisions governing human lives will be made by machines… Many think this will take place within their lifetimes.”\footnote{Barrat, James. (2013). Our Final Invention, Artificial Intelligence and The End of The Human Era. Page 3.} The question now remains: How do you develop this technology for humanitarian work and ensure that it is not later weaponized?
Political administrations still require research into what technological thresholds should be achieved to make employment of LAWS more politically acceptable than deployments of human soldiers. This research will likely be broken down by domain to include undersea, surface ships, UGVs, drones, and cyber.

The militaries still need to conceptualize how LAWS will be organized into current manned units. Will LAWS replace or augment manned units and to what extent? This will drive the military options offered to the politicians, for instance, if the military could deploy an unmanned unit then the opportunity of fighting a conflict without the loss of their own soldiers would be appealing. This line of reasoning assumes that the military will figure out how to ensure that there are clear, ethical boundaries for LAWS.

A comprehensive study examining the price differences between a robot and human would enrich the debate about the merits of both options. Military personnel have recruitment, training, pay, allowances, housing, and medical costs which accrue on an annual basis. Once a soldier leaves the military service, there is a potential expense of disability and/or retirement pay. If the soldier’s life is lost, there are burial, insurance, and allowance payments due, which can total in excess of $500,000. The only costs that transfer over would be initial training (production), feeding (gas or electric power), and medical (maintenance). Robots also have high expenditures in research and development that do not apply to a human soldier. Conducting a comprehensive study in the costs would help in understanding what an appropriate price point would be for LAWS that directly replace a human on the battlefield.

**Final Thoughts**
It is difficult to conceptualize how dangerous a weapon will be when it does not exist. Eliezer Yudkowsky affirms, “Artificial Intelligence is not settled science.” The vision of what LAWS will be capable of doing is particularly hard to visualize because they will incorporate several different technologies that are still being developed. At the heart of the issue is AI. Will AI start to develop new AI that operates outside the ethical constraints of the human built AI? Vernor Vinge states, “I think that in the relatively near historical future, humans, using technology, will be able to create, or become, creatures of superhuman intelligence.”

There is also a certain level of anxiety about arming AI and allowing it to fight unsupervised in combat. Essentially every new weapon on the battlefield brings a similar anxiety with it. Two examples are chemical weapons and mines. Chemical weapons have been banned and have a high threshold of weaponizing them, thus there are limited examples of them being used in conflict. Mines have been ban also but have a low threshold of obtaining and thus are used in modern conflict, particularly by non-state actors. Because LAWS will have a low threshold of being obtained, it is likely that a ban will have limited effect on LAWS in conflict. Countries and NGOs will need to develop technology to counter LAWS in conflict similar to the current arrangement done to counter mines.

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REFERENCES


Major Ted W. Schroeder is an infantry officer in the United States Marine Corps currently stationed in Madison Wisconsin. He recently completed is master’s degree in International Service at American University.