ROBOT WARS: LEGAL AND ETHICAL DILEMMAS OF USING UNMANNED ROBOTIC SYSTEMS IN 21ST CENTURY WARFARE AND BEYOND

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

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2008

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
12-12-2008	Master's Thesis	FEB 2008 – DEC 2008

4. TITLE AND SUBTITLE
Robot Wars: Legal and Ethical Dilemmas of Using Unmanned Robotic Systems in 21st Century Warfare and Beyond

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Erin A. McDaniel, Major, US Army

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORG REPORT NUMBER

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

10. SPONSOR/MONITOR'S ACRONYM(S)

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

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution is Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
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The military may also be forced to question an autonomous agent's ability to assess a particular situation during combat before engaging with lethal force. For robotic systems operating autonomously, the inability to distinguish the difference between a lawful and unlawful target remains the overall issue while operating within the confines of the Law of War. Unmanned robotic systems will remain under the control of human operators until the issues of discrimination and proportionality can be resolved.

Unmanned robotic systems possess the ability to abide by the current laws of warfare better than humans.

Laws and Ethics with Unmanned Systems/Weapons, Laws and Ethics of Warfare, Unmanned robot systems,

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. PHONE NUMBER** *(include area code)*
(U)	(U)	(U)	(U)	94	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE
THESIS APPROVAL PAGE

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency (References to this study should include the foregoing statement.)

ABSTRACT

ROBOT WARS: LEGAL AND ETHICAL DILEMMAS OF USING UNMANNED ROBOTIC SYSTEMS IN 21ST CENTURY WARFARE AND BEYOND by Major Erin A. McDaniel, 94 pages

This thesis assumes that the United States will continue to utilize unmanned combat robotic systems in the current operational environment (COE).

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ACKNOWLEDGMENTS

I would like to offer the utmost gratitude to my thesis committee: Lieutenant Colonel Prisco R. Hernandez, Ph.D (Committee Chairman); Ralph O. Doughty, Ph.D.; and Mr. Dirk Blackdeer for their unwavering patience and valuable insight during this long and tedious process. I could not have done this without them. Their professionalism is incredible. Additionally, I would like to express my appreciation to Lieutenant General William B. Caldwell IV, Commanding General of the U.S. Army Combined Arms Center, for his dedicated support of the Master’s of Military Art and Science (MMAS) program and the flexibility of critical thinking and strategic communication to the officers attending the Command and General Staff College.

I want to also show my sincere appreciation of the support of my family. The warmest thank you to my mother and father for their enormous encouragement and interest in my life, career, and achievements. Lastly, to my wife and best friend Patti who has continuously encouraged me to finish this project and has fully tolerated my past nine months of solitude and strict confinement to “the little room in the basement” as I finish this assignment. I could not have asked for anything better.

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INTRODUCTION

> I dream always very much the same dream, Dr. Calvin. Little details are different, but always it seems to me that I see a large panorama in which robots are working. Robots, Elvex? And human beings also? I see no human beings in my dream, Dr. Calvin.

—Isaac Asimov, *Robot Dreams* 1986

Background

The utilization of unmanned combat robotic systems will generate many profound questions in the Laws of Land Warfare as robots become increasingly more advanced. Currently, the United States alone has over 6,000 deployed unmanned robotic systems in Iraq and Afghanistan that are supporting United States troop missions during Operations Iraqi Freedom and Enduring Freedom (Sharkey 2007, 1). Unmanned aerial systems, such as the Global Hawk and Reaper, have already become highly effective instruments for reconnaissance missions, air-ground surveillance, air to ground munitions delivery, and aerial photography that assist military commanders in making rational and intelligent decisions. Unmanned ground based robots, such as the Talon, have become highly useful in detecting and destroying improvised explosive devices, performing ground reconnaissance, conducting ground surveillance, and clearing adversaries out of highly dangerous infrastructure complexes. Additionally, research continues on the use of maritime underwater robots for the purpose of locating explosives designed to disable United States warships. As technology develops, options for the use of unmanned robotic systems appear to be unlimited.

Before continuing this study, it is appropriate to mention that it is not within the scope of this paper to illustrate all the potential impacts that unmanned robotic systems will have on future United States or western military doctrine. The purpose of this study is to examine the impacts that unmanned systems may have on the current laws of warfare. Technology possesses the potential to change the practice and functions of war. As technology changes, revisions to the current laws of warfare will become necessary.

Historically, advances in technology have increasingly separated humans from the worst aspects of lethal conflict. The development of the crossbow, gunpowder, and the atomic bomb are some of the innovations that have significantly changed the concepts of war. Nonetheless, it is not how much technology a nation has; it is how a nation applies it. In his book *War Made New,* Max Boot alludes to several themes regarding man's failure to exploit existing technology through critical moments in history (2006, 91). First, technology is not necessarily the most important variable in winning wars. The concentration of tactics, training, leadership, industry, human spirit, and popular support of the war effort are paramount in order to establish military supremacy. Second, nations that understand the importance of industrial advances will profit from them. Those who do not will falter. Third, societies must understand the limitations of their new technology and not overestimate it. Fourth, technology can be duplicated and modified making one's system obsolete and the enemy's better. Last, new technologies eventually become financially cheaper and more accessible as time goes on (Boot 2006, 92).

The principles listed above provoke profound thoughts on the utilization of technology, including unmanned robotic systems. If new technology is not exploited by the United States, it is expected that others will do so. Extraordinary capabilities will follow the development of weapons such as the V2 rocket and the jet engine aircraft employed by Germany during World War II. One may possess the technology but may sometimes fail in maximizing its full potential or simply lacks the necessary resources to optimally gain from it.

Before reviewing the full potential of unmanned robotic systems used on the battlefield, it is important to clearly define what exactly characterizes a robotic system or "robot." According to the Fiscal Year 2005 Joint Robotics Master Plan, the Department of Defense defines a robot as a "machine or device that works automatically or operates by remote control." There are three basic command modes that mechanically influence a robot. The first mode is fully autonomous--a robot that operates in a fully autonomous mode functions without human intervention. The robot operates through a series of programs and algorithms. An autonomous robot possesses the ability to make its own decisions consistent with its mission without requiring direct human authorization, including the decision to use lethal force (Arkin 2007, 6). The second mode is semiautonomous. Semiautonomous operation allows a robot to operate without human intervention until certain critical decision points are reached; then, human intervention is required. Critical points in missions that mandate human judgment may be diverted to the control of the operator. The robot would act as an extension of a human soldier under the direct authority of a human, including the authority over the use of lethal force (Arkin 2007, 7). The third mode is remote control. A robot operated by remote control functions through a wireless modem or Internet controlled by a human. Presently, most combat robots operate by the remote control mode. However, rapid advancements in technology have greatly accelerated the ability for robots that are used in combat to function in fully autonomous mode.

Removing humans from the battlefield may change a society's understanding of war and how it may be conceptualized. Unmanned robotic systems replacing humans in acts of conflict conveniently suits the American intolerance of casualties during violent conflict. In addition, further removing humans from the process of war may give the appearance that war is an impersonal activity that does not physically or emotionally burden the populace. Conceptually, humans would be removed from immediate danger by remote control or computers. Additionally, the American public is not likely to become overly concerned if armies of expendable robots are destroyed instead of their nation's sons and daughters. Casualties inflicted by unmanned robotic systems against the adversary may shape a society that has become desensitized to the violence of human death. Such patterns may encourage a culture that indulges in a "kill and forget" philosophy. Removing humans from armed conflict further disconnects humans from war, thus making it easier to wage war.

The issues associated with the increasing use of unmanned robotic systems in war present one with difficult questions. In this thesis, one will consider whether the increased use of unmanned robotic systems utilized for combat present significant challenges to the current laws of warfare. To address this question, one must also consider whether unmanned combat robotic systems should be permitted to autonomously apply lethal force and whether autonomous unmanned combat robotic systems could operate under the laws of warfare better than humans.

Significance

As unmanned combat robotic systems are more deliberately incorporated into the United States military, the need to adjust the Law of War will undoubtedly become more pressing. Historically, laws of war normally change when the methods of conducting war change. As has been shown, the advancement of technology has gradually removed humanity from the essential brutality of armed conflict revealing new methods in waging war and new legal challenges questioning the ethical institution of how society defines the rules of war. Punishments employing torture devices such as the iron maiden, "the rack," or burning at the stake may have been ethically acceptable over four hundred years ago; however, in the twenty first century these methods are deemed to be cruel and not acceptable in civilized societies. The use of firebombs against the Japanese during World War II and the use of napalm during the Vietnam War may not have seemed to be overly controversial for the time (Van Creveld 1991, 280). However, the use of such weapons today is considered to be a harsh act of brutality according to a vast majority of human beings. Firebombs and napalm violate the principle of proportionality according to the current interpretation of the Law of War (globalsecurity.org 2008). The change in societal norms that determine right from wrong, compel the change in the process of making war.

It is relevant to note how drastically the body of generally accepted norms that one knows as Law of War has changed throughout the course of history. The modern Law of War concept was originally an attempt by Christians to come to terms with the reality of war "in the real world." Early Christian theology scholars such as, Augustine of Hippo (354 A.D. to 430 A.D.) and St. Thomas Aquinas (1225 to 1274) originally played a significant role in defining the basic principles of lawful violence in order to help preserve and protect the Christian faith (O'Donnell 2001). The Law of War has evolved through five fundamental developmental periods that were mainly based on the current technology of that era. The first period is the Just War Period (335 B.C. to 1800 A.D.). For the first time in history the responsibility for the laws of warfare was passed from the church to the lawyers. During this period, a Dutch philosopher by the name of Hugo Grotius (1583 to 1645) produced the most relevant and comprehensive work titled, *On the Law of War and Peace* (Department of the Army, Pamphlet 27-1 1956). Grotius' work is based heavily on Christian doctrine and is regarded as the starting point for codifying and standardizing the rules of modern war (*Law of War* 2005, 8). The second period is known as The War as Fact Period (1800 to 1918). War as Fact introduced concepts of avoiding war by implementing legal guidelines that discouraged war such as treaties and policies. The third is *Jus Contra Bellum* (1918 to 1945), which translates to "prohibiting aggression and admitting self-defense." During the *Jus Contra Bellum*, world leaders found it difficult to give meaning to wars of unprecedented carnage and destruction. The Law of War for the era supported conclusions that aggressive use of force must be outlawed (*Law of War* 2005, 10). The fourth period is the Post World War II Period (1945 to 1946). The Post World War II philosophy focused on reconstruction and the legal situations that may occur in conjunction with the use of nuclear weapons. This period also focused on the concept of "war crimes." Crimes committed during World War II were subjected to ethical examination and legal analysis. In essence, the laws of warfare were under revision due to the devastation that was brought on civilians. The last period is the United Nations Charter Period (1946 to present). The United Nations Charter Period continues the trend to ultimately ban war. As stated earlier, unmanned robotic systems are variables that will likely provoke changes to the legal conventions governing future war.

Before examining the ethical and legal implications regarding the use of deadly force by autonomous agents, it is helpful to understand the categories of law that seek to regulate the conduct of war. The Department of Defense defines the Law of War as being "the part of international law that regulates the conduct of armed hostilities" (Department of Defense, 2006). The Law of War or "Law of Armed Conflict" is the "customary and treaty law applicable to the conduct of warfare on land and the relationships between belligerents and neutral states" (FM 27-10 as amended 1976, paragraph 1). It "requires that belligerents refrain from employing any kind or degree of violence which is not actually necessary for military purposes and that they conduct hostilities with regard for the principles of humanity and chivalry" (FM 27-10 as amended 1976, paragraph 3). As illustrated in figure 1, the Law of War is part of the broader body of law known as International Law. International Law is defined as "rules and principles of general application dealing with the conduct of states and of international organizations and with their relations inter se (between them), as well as some of their relations with persons, natural or juridical" (*International Law Volume II 1962*, 5-40).

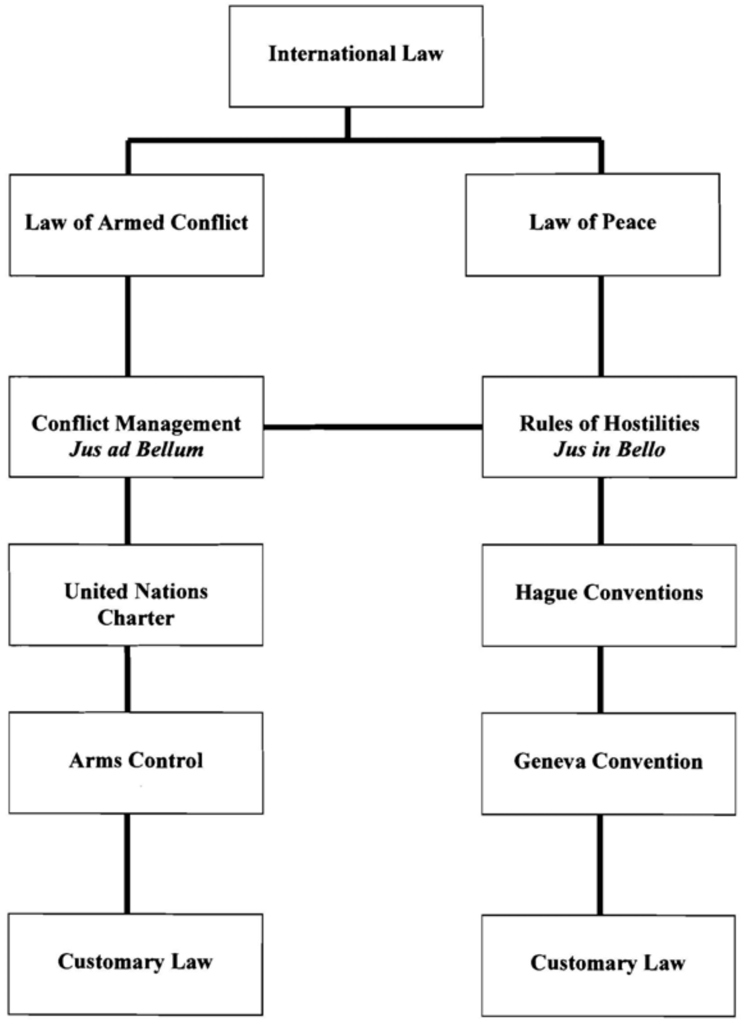

Figure 1. Laws, Charters, and Conventions that Prevent or Regulate Armed Conflict
Source: International & Operational Law Department, *Law of War Handbook* (Charlottesville, VA: The Judge Advocate Generals School, 2005).

The content of Law of War has evolved over time based on the actions and beliefs of nations or coalitions. It is possible to debate endlessly about the legal definition of "war" (Pictet 1952, 47). The international legal definition states that war is "a contention between at least two nation states wherein armed force is employed with intent to overwhelm" (*Law of War* 2005, 4). Some nations have asserted that the Law of War does not necessarily apply to all instances of armed conflict. In this view, the applicability of the Law of War would depend upon the classification of the conflict. After World War II, official political recognition of a state of war is no longer required to trigger the applicability of the Law of War. Instead, the Law of War is generally applicable to any international armed conflict (*Law of War* 2005, 3).

There are two categories that help define the Law of War; *Jus ad Bellum* and *Jus in Bello*. *Jus ad Bellum* (Conflict Management) examines whether or not to engage in a specific war is permissible and just. A "Just War" is defined as "one that has a reasonable chance of success, and the end being proportional to the means" (Encyclopedia of Philosophy 2008). As depicted above, the boundaries within Just War are very extensive. The flexibility for one to wage war by "having a just cause" may be used to justify any nation's decision to declare war because they believe that their particular reason for going to war is acceptable. The military's increased implementation of unmanned robots on the battlefield increases the prospect of nations going to war due to the flexibility of *Jus ad Bellum.*

When examining *Jus ad Bellum*, it is important to recognize the variety of specialized laws and charters that attempt to regulate future conflict. Laws and efforts such as the United Nations Charter and arms control treaties address how states initiate or forbid armed conflict. Additionally, these laws also determine the circumstances of when the use of military power is legally and morally justified (*Law of War* 2005, 5).

The United Nations Charter maintains international peace and security by taking collective measures for the prevention and removal of any threat that may lead to the breach of peace. Additionally, the United Nations Charter serves as a guideline to the members of the United Nations in order to "harmonize the actions of nations in the attainment of common ends” (Encyclopedia United Nations Charter 2006, 3). While examining the rapid advancement of military technology, it is evident that the laws of warfare struggle to keep pace with current technology. Laws do not set the parameters for technology to follow. Within the United Nations Charter, Articles 45, 46, and 47 methodically outline the basic policies that encourage mutual respect between nations before and during the act of war. However, according to the charter, these principles are much more applicable to old technology; not the latest technology. Alternate means of modern warfare, such as cyber attack or the use of unmanned robotic systems are not addressed in the United Nations Charter. Furthermore, the word “robot” is not mentioned even once.

Arms control is meant to mitigate the world security dilemma. Mutual security between partners and overall stability tends to remain the primary purpose behind attempts to limit the quantity and type of armaments available to nations. Many of the articles outlining the current arms control treaties focuses on the methods to stop the spread of certain military technologies such as nuclear weapons, biological weapons, or long-range lethal delivery systems in return for assurances that potential developers will not threaten others with such technologies (Center for Arms Control and Non Proliferation 2006). Arms control treaties can be seen as effective ways to reduce the high costs of developing weapons that make war so costly that only the wealthiest nations could possibly prevail.

The control of arms is significantly different than disarmament. The regulation of weapons development and weapons possession takes a “peace with weapons” approach verses a “peace without weapons” approach (Disarmament Insight 2008). Arms control treaties and agreements assess many types of weapons that may be viewed as direct threats to national security. Missiles are the most common systems addressed throughout most worldwide treaties and agreements. Unmanned robotic systems are never mentioned in any substantial detail.

The lack of treaties and protocols governing the use of unmanned robots on the battlefield may present opportunities for more conflict. The ability to make the decision to go to war easier presents potential changes in the Law of War principle of proportionality. Since war is easier, at least for those nations with advanced technologies, there may be more wars. Conversely, if our enemies are capable of duplicating our technology, they may use our own technology against us making it counterproductive to wage war. No one would ever win and there would never be any losers. Unmanned robotic systems would act as force equalizers for anyone who possesses them. The Cold War between the United States and the former Soviet Union is an example of a state of strategic balance. Equality of nuclear capability and technology theoretically prevented war; equality in robotic technology might do the same.

Operation Iraqi Freedom demonstrated the execution of Just War under the United Nations Charter and arms control provisions were clearly demonstrated. The United States led a coalition attack on Iraq in the search of weapons of mass destruction. However, in the United Nations Charter, there was no provision for a pre-emptive self-defense attack. In retrospect, this example demonstrates how easily nations can justify war under *Jus ad Bellum* (Cowan 2007, 9). Unmanned robotic systems may make the decision to use war as a solution to intractable problems easier to wage war thus inviting the possibility of more wars; particularly wars of "choice." Ultimately, the use of unmanned robotic systems tends to make war less taxing on humans--at least in principle.

Jus in Bello regulates conduct during war. Additionally, it defines what actions are legal and what actions are not legal during war. Unmanned robotic systems are likely to have an impact on the concept of *Jus in Bello*. The technology for an unmanned combat system to determine friend from foe is beyond current artificial intelligence capabilities. The ability to distinguish a small boy playing with a toy gun from an adult carrying a fully loaded AK-47 automatic assault rifle is an ethical dilemma that Soldiers currently face. Will technology be able to solve this problem? The ability to distinguish the difference between legal or non-legal targets remains a difficult challenge. Human intervention may always be required before lethal force is initiated in order to prevent unintended lethality.

The Hague Convention and the Geneva Convention are international protocols that regulate conduct during war (*Jus in Bello*). The Hague Convention defines the qualifications of belligerents, acceptable methods of engaging the enemy with proportionate force and the prohibition of pillage within seized territory as a result of war. Additionally, it serves as an international treaty that focuses on the common interest of nations on the protection of cultural heritage in the event of armed conflict. The Hague Convention reinforces the need to safeguard of architecture, art, history, archaeological sites, manuscripts, books, and other objects of historical interest, as well as scientific collections of all kinds regardless of their origin of ownership (Hague Convention for the Protection of Property in the Event of Armed Conflict 2008, 1). After reviewing a number of bylaws relative to the Hague Convention, it is conceivable that unmanned systems may be capable of demonstrating better “judgment” that is more precise and consistent than a human’s during violent conflict. Inevitably, no human soldier ever makes faultless wartime decisions due to the carnage of war. During extreme violence, decisions are usually altered by the emotions of the participants. Unmanned robotic systems are incapable of experiencing emotions that may cloud judgment.

The Geneva Convention is basically a series of rules that protect vulnerable and defenseless individuals during conflict. They are based on the idea that human dignity must be respected at all times. International humanitarian laws serve as an integral foundation of the Geneva Convention. Assuming that the tides of war will forever change the lives of civilians, unmanned combat systems will be expected to abide by seven basic principles of the Geneva Convention. As illustrated in table 1: (1) attackers must be capable of distinguishing from the civilian population and combatants. Neither the civilian population as whole nor individual civilians will be attacked. (2) Attacks are to be made solely on military targets. Individuals who can no longer take part in hostilities are entitled to respect from their attackers. (3) It is strictly forbidden to kill or wound an adversary who surrenders. (4) Weapons or methods of warfare that inflict unnecessary suffering or destruction are forbidden. (5) Wounded combatants and the sick combatants must be cared for as soon as possible. (6) Combatants must be able to distinguish the universal Red Cross or Red Crescent on a white background. All combatants are forbidden to engage objects thus marked. (7) Captured combatants and civilians must be protected against all acts of violence. Historically, total abidance of the Geneva Convention has remained highly challenging for humanity as a whole. It is inevitable that the challenge will even be more significant for unmanned combat machines (International Committee of the Red Cross 2004, 1).

Table 1. Seven Principles of the Geneva Convention

• Attackers must be able to distinguish from combatants and civilians
• Attackers attack military targets only
• Combatants who surrender will be spared from harm
• Weapons or methods that inflict unnecessary human suffering or physical destruction are forbidden
• Wounded combatants and the sick require immediate medical attention
• Combatants must be able to distinguish the universal Red Cross or Red Crescent. Combat engagements of facilities or vehicles displaying these universal symbols are forbidden
• Captured combatants and civilians must be protected against acts of violence

Source: International Committee of the Red Cross (ICRC), *History of International Humanitarian Law*: *The Essential Rules*, 2004, http://www.icrc.org/Web/Eng/siteeng0.nsf/html/5ZMEEM (accessed 28 November 2008).

Unmanned robotic systems will have grave impacts on *Jus in Bello* under the concepts of "Distinction and Proportionality." The concept of Distinction is defined in Article 48 in the Geneva Convention (Cowan 2007, 9). Article 48 states that "in order to ensure respect for and protection of the civilian population and civilian objects, the Parties to the conflict shall at all times distinguish between the civilian population and combatants and between civilian objects and military objectives." Fully autonomous unmanned robotic systems are then bound to be capable of distinguishing a legal from an illegal target. As of today, in order to abide by Article 48, unmanned robots must remain under semi autonomous control (remote control) where the person controlling the robot makes the ultimate decision to fire. Proportionality is outlined in Article 51 of the Geneva Convention. Article 51 states that “an attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated is forbidden.” Again, in order to stay within the confines of Article 51 and avoid the possibility of a functional mishap, humans will continue to remain in the decision process during a system’s assigned task.

The integration of unmanned autonomous robotic systems into combat is a legal problem for the military and society alike. Dr. Robert Arkin, Professor of Artificial Intelligence at Georgia Technical Institute, has previously raised the topic concerning autonomous cars on the highways that may likely create significant issues for the future. He has stated that it is not the autonomous cars that will create the issues; it is the mixture of human operated vehicles and autonomous vehicles sharing the same roads that will inherently become extremely difficult to manage (Cowan 2007, 10). In summary, a human operator must be part of an unmanned system’s decision-making process until we overcome the problem of distinction and proportionality. The shortage of laws concerning unmanned robots becomes even more evident in the case of a tragedy. Currently, one may have a difficult time in determining who exactly is at fault after a fatal incident. Liability issues must be studied in depth before the increased use of unmanned robotic systems takes their roles in future conflict (Cowan 2007, 10).

It is difficult to discuss the laws of warfare without considering how various ethical issues will impact the use of unmanned combat systems. The perception of a conflict of “man against the machine” has caused considerable debate among many scholars including social scientists, politicians, and prominent religious leaders throughout the academic community. In most debates, the underlining issue is usually based on the question of “who is at fault if something goes wrong?” Depending on one’s point of view blame may be cast on a variety of plausible variables; the programmer, the operator, or even the machine itself (see figure 2). Inevitably, this ethical debate will not be solved before we will be able to fully understand how unmanned robotic systems will be integrated into the battlefield of the future (Cowan 2007, 12).

During the fog of war it is difficult enough for humans to effectively distinguish whether or not a target is legitimate. In order to address this dilemma, it is appropriate to ask whether these systems perform better at ethical decision making than human soldiers. In response to this question the following may be contended:

1. Unmanned systems possess the ability to act conservatively. They do not need to protect themselves in cases of uncertainty or poor target identification.

2. Advances in technology will allow unmanned systems to be equipped with better sensors than human soldiers currently possess.

3. Unmanned systems do not possess emotions that cloud judgment or result in anger.

4. Unmanned systems can process more information from a vast number of sources more quickly and accurately than human soldiers before responding with lethal force.

5. Unmanned combat systems are capable of accurately reporting during stressful combat situations without emotional exaggeration, distortion, or contradiction.

6. While working with human soldiers, they can objectively monitor ethical behavior on the battlefield and report any ethical violations that might be observed. (Arkin 2007, 6)

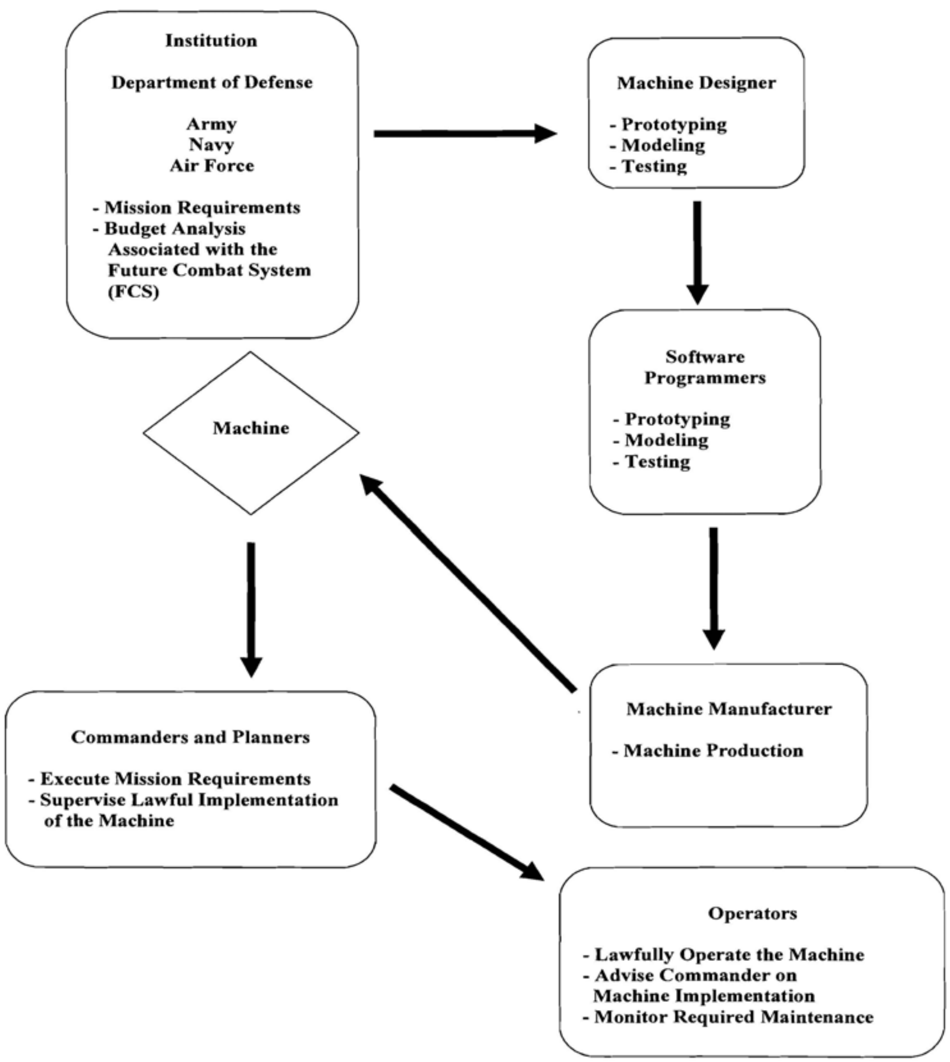

Figure 2. Legal Chain of Responsibility

A recent report published from the Surgeon General's Office in 2006 supports the argument that unmanned combat systems may undoubtedly play a vital role in enforcing many of the ethical challenges that occur during combat. According to the report, appropriate ethical behavior among Soldiers and Marines deployed in Operation Iraqi Freedom and Operation Enduring Freedom appear to be questionable at best. The following findings have been extracted directly from that report (Arkin 2007, 7).

1. Approximately 10 percent of Soldiers and Marines report mistreating noncombatants such as, purposely damaging or destroying civilian property when not necessary or hit/kicked a noncombatant when not necessary.

2. Only 47 percent of Soldiers and 38 percent of Marines agreed that noncombatants should be treated with dignity and respect.

3. Over one-third of Soldiers and Marines reported torture should be allowed in order to save the life of a fellow Soldier or Marine or to obtain important information pertaining to the enemy.

4. 45 percent of Soldiers and 60 percent of Marines did not agree that they would report a fellow Soldier or Marine if he had injured or killed an innocent noncombatant.

5. Only 43 percent of Soldiers and 30 percent of Marines agreed that they would report a unit member for unnecessarily damaging or destroying private property.

6. Less than one-half of Soldiers and Marines would report a team member for an unethical behavior.

7. 28 percent of Soldiers and 31 percent of Marines reported ethical dilemmas in which they did not know how to respond.

8. Immediate loss of a fellow Soldier or Marine during extreme violence was associated with an increase in ethical violations.

Other possible explanations for the propensity of war crimes by Soldiers and Marines include:

1. High numbers of friendly deaths has a tendency to lead to revenge. "Clouded emotions."

2. Dehumanization of the enemy through the use of inaccurate cultural stereotypes. "Killing becomes psychologically easier."

3. No clear identification of the enemy. "Fog of War."

4. The absence of orders or unclear orders may lead to misinterpretation with legal ramifications. "Problems of communication and interpretation."

Academic debate that argues against further research of unmanned systems seems to be mostly based on fears of the unknown. No one really knows what technology may look like in the future. Most societies conceptualize the future through years of typical science fiction fantasies. The media commonly portrays robots as humanoid-like machines that become independent, self-determining entities that seek to establish their own society or seeks to eliminate humankind. As a result, it is not surprising to find why many people are afraid of robots.

The fallacy illustrated above may likely become irrelevant by researching the possibility of programming unmanned systems with a code designed to ensure that their actions are ethical. Possessing the right of refusal in the case of an unethical order or incorporating parameters within a system's program outlining existing laws such as the Geneva Convention, Rules of Engagement, and Codes of Conduct may prevent such concern. Computational implementation of an ethical code or an “artificial conscience” within an autonomous system may provide enforceable limits on acceptable behavior during combat. Drawing on ethical precepts extracted from sources such as the Geneva Convention and other related protocols, enables an unmanned system to consider, in real time, the consequences of its actions (Arkin 2007, 61).

As technology continues to improve robots, it is imperative to remember that giving a machine the complete authority to eliminate human life significantly changes the foundations of our existence. Unmanned robotic systems that operate autonomously are prone to change the way one rationalizes the justification for going to war and how one defines its success in war. Ethical decision making within a machine is only as good as the human who programs it and the state of technology that exists at the time. Therefore the humans behind the technology are ethically liable.

Assumptions

This thesis assumes that the United States will continue to utilize unmanned combat robotic systems in the current operational environment. For now, unmanned robotic systems will continue to depend on human intervention that influences the overall performance of the robot. However, as technology progresses and targeting systems become faster, the United States military will eventually allow unmanned robotic systems to autonomously employ lethal force. The laws of warfare will need refinement and new laws will have to be created.

CHAPTER 2

LITERATURE REVIEW

> Law Number 1: A robot may not injure a human being or, through inaction, allow a human being to come to harm.
>
> —Isaac Asimov, "Three Laws of Robotics" 1942

This chapter will examine several writings pertaining to the latest functions, theories, and legal issues regarding the role of unmanned robotic systems during wartime. There are three separate views in the existing literature that warrant review while examining unmanned robotic systems in their entirety. These thoughts are discussed below.

First, studies summarizing the current capabilities and limitations of air, ground, and maritime systems have been annotated throughout this research in order to understand the margins of an unmanned robotic system's overall performance. Second, parameters that govern legal and ethical violations according to the Law of War have not been scrupulously examined by the nations who use them. In addition, legal issues are never analyzed without reverting back to a basic set of principles that defines what is normally "right" and what is normally "wrong." Put simply, ethical considerations generally parallel existing law. Third, it is important to realize that it is within the confines of reason that technology will one day allow unmanned robotic systems to function with zero human intervention. Not surprising most writings that examine the possibility of full autonomy regarding unmanned robotic systems lie in the realms of science fiction. However, present day theorists working in the field of artificial intelligence have published many credible studies that have helped explain the prophecies of future machines that are able to function and “think” on their own. Many experts agree that all machines will require less human interface as technology and societies becomes more sophisticated. Diverse views on these topics expressed by various authors are studied throughout the following text.

Ronald Arkin is a leading researcher regarding the ethical impacts of autonomous unmanned robotic systems. He is a professor at the Mobile Robot Laboratory, College of Computing at the Georgia Institute of Technology. Recently, Arkin published a technical report titled “Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberate/Reactive Robot Architecture.” The article examined the possibility of programming an autonomous unmanned robotic system with a series of commands that would govern the system’s decision cycle. Arkin’s technical report drafts future design recommendations that may be used to imprint moral reasoning. Additionally, Arkin explains that an ethical reasoning formula may be used to ensure that a system abides by the current Law of Land Warfare and the specific Rules of Engagement during violent conflict. He also concludes that keeping a human in the decision-making loop before applying lethal force during combat is a safety consideration rather than an issue of morality (Arkin 2007, 4).

Newsweek war correspondents John Barry and Evan Thomas published the article, “Up in the Sky, An Unblinking Eye” in June of 2008. Barry and Thomas explain that the evolution of unmanned aerial systems dates back as far as 1944. Initially, most unmanned aerial systems were used as target drones supplementing anti-aircraft exercises. Twenty years later, modifications were added that allowed additional capabilities such as photo imagery and data recording. Today, the unmanned aerial system is capable of projecting live footage from the air to the ground; giving commanders the tools they need to make the most accurate decisions regarding the mission at hand. Barry and Thomas do not expand on the legal or ethical dilemmas that may affect autonomous unmanned aerial systems. Conversely, they state that unmanned robotic systems should remain as instruments or extensions of human capabilities to ensure that controllers continue to receive measurable flight time credit and operating experience. This is career protection for unmanned aerial system “pilots.” Additionally, the authors illustrate a clear example of how it may be relatively simple for an enemy to duplicate and improve the capabilities of an unmanned robotic system in the case of a possible capture. As an example, in 1968, the United States began using target drones called Chukars. After a United States naval exercise, a single Chukar crashed into the ocean and washed up on an Israeli beachhead just south of Tel-Aviv. Less than one year later, Israel produced an improved system based on the crashed Chukar that ultimately led to Israel’s own unmanned aerial system program. The program quickly surpassed every nation around the globe and succeeded in causing significant national security concerns. The examination of this scenario may additionally pose the question “to what degree will the laws of warfare change if one nation mass produces hundreds of improved systems?” Overall, Barry and Thomas state that human intervention will always be present while operating unmanned robotic systems. In the future, serving as a “virtual” pilot for an unmanned aerial system will be as prestigious as being an actual pilot today. Overall, the authors show concern with the impact of unmanned aerial systems on “pilot culture” self-esteem.

In September 2002, Lieutenant Colonel Anthony Lazarski published an article that was printed in the *Aerospace Power Journal* titled “Legal Implications of the

Uninhabited Combat Aerial Vehicle." The article reviewed a series of short case studies that revealed a collection of legal parameters ultimately responsible for aborting a number of target engagements during Operation Enduring Freedom in Afghanistan. Lazarski explains that during the early years of Operation Enduring Freedom, many lucrative target engagements were cancelled because several legal debates were taking place at the Pentagon. Such debates have motivated Lazarski to urge the United States military to begin refining the legal foundations that outline the future employment of unmanned aerial vehicles. Lazarski states that the accelerated development of unmanned combat systems has significantly overtaken the current Law of War protocols. Additionally, as more unmanned aerial systems begin flexing their capability while operating in international airspace, the need to establish rules and regulations will become more critical. The creation of such rules will inevitably prevent disasters that may involve other aircraft or densely populated areas. Taking matters further, Lazarski implies that a number of present day researchers have concluded that the future of military aviation will belong to unmanned aircraft (Lazarski 2002, 1). Undoubtedly, unmanned robotic technology will continue to advance followed by the delayed refinement of the laws of warfare. Looking forward, artificial intelligence and complete autonomy will become the military's definitive goal. However, the author explains that human intervention will remain vital in the targeting process for years to come.

The March 2008 *Popular Mechanics* article, "Ultimate Fighting Machines" by Erik Sofge, introduces four types of unmanned ground vehicles with a summary defining the basic capabilities for each system. Sofge explains that the process used to implement unmanned ground vehicles is several years behind unmanned aerial systems due to the nature of the land war. For years, unmanned aerial systems have been the subject of research as far back as the early 1950s. Unmanned ground vehicles are destined to function in highly complex surroundings that will require a more intricate navigation and sensory systems capable of engaging targets in every direction. Armed unmanned aerial systems operate in an open space free of nearly every imaginable obstacle while delivering munitions in one general direction.

According to Sofge, the Special Weapons Observation Remote Direct Action System has been historically used as a tool of human extension. The system operates by remote control and has been implemented for close quarter observation and missions requiring the investigation of improvised explosive devices. Since the year 2005, Special Weapons Observation Remote Direct Action System has been the first armed unmanned ground system to ever enter Iraq and Afghanistan (Sofge 2008, 59). To this day, it has never fired a shot during combat.

The Modular Advanced Armed Robotic System is designed and programmed to function very similar to Special Weapons Observation Remote Direct Action System. In comparison, Modular Advanced Armed Robotic System is 35 pounds heavier than the 90-pound Special Weapons Observation Remote Direct Action System and more maneuverable. The author expresses that the most unique feature of Modular Advanced Armed Robotic System is that the system is programmable to no fire zones in order to prevent fratricide. However, full implementation of this program during war has not occurred. The Warrior X700 is the first unmanned ground system that possesses the structural integrity and power to carry heavier gun systems and equipment. The Warrior X700 is capable of carrying 150 pounds and can move up to 10 miles per hour. Currently, the system is still under construction and not due to make an appearance until early 2010. Lastly, the Multifunction Utility/Logistics and Equipment vehicle has been defined as the zenith of all current unmanned ground systems. Equipped with a highly advanced remote control system, the Multifunction Utility/Logistics and Equipment vehicle is defined by some as the world's biggest "toy car" (Sofge 2008, 60). Currently, autonomous technology only allows the Multifunction Utility/Logistics and Equipment vehicle to determine direction and speed. The development of future upgrades will eventually transform the Multifunction Utility/Logistics and Equipment vehicle into a system more independent from human control.

Sofge illustrates, that unmanned ground systems have made substantial technological progress throughout the past four to five years. Ground based robots acting as human extensions are perhaps the only current logical methods of implementation. The process of identifying a legal target challenges technical advancements that may allow an autonomous agent to apply lethal force. Currently, the necessary sensory systems that are required to successfully execute such elaborate tasks have not yet been developed. Some advances, however, has been achieved, such as the incorporation of basic navigational and motor systems that regulate speed and direction. Regardless, Sofge concludes that the future implementation of unmanned robotic systems will always warrant a "human in the loop." Despite these advances, the technology required for an unmanned robotic system to autonomously implement lethal force in accordance with today's laws of warfare does not exist.

In summary, the four articles discussed above depict obvious technological advances pertaining to unmanned robotic systems. In general, most authors agree that unmanned systems will remain under the control of a human; perhaps for the next several decades. In the article, “Up in the Sky, An Unblinking Eye,” unmanned aerial systems are still tied to human decision making before lethally engaging a target. The Air Force remains interested in preserving the importance of training and flight hours for pilots. In addition, current policies and technology mandate the appropriate pilot qualifications. The *Popular Mechanics* article, “Ultimate Fighting Machines” by Erik Sofge, illustrates vast accomplishments regarding unmanned ground systems. However, the nature of the ground war presents highly challenging aspects for an autonomous system to positively identify a valid target. According to the author, remote control by a human will supplement the technology required to determine “friend” from “foe.” Lazarski’s article, “Legal Implications of the Uninhabited Combat Aerial Vehicle,” describes that even if future technology brings one to the point of being able to autonomously engage a target; the current laws of warfare will call for significant restructure that clearly outlines the protection of non-combatants. Lastly, Ronald Arkin projects that lethal engagements inflicted by autonomous unmanned systems will undoubtedly become a reality in the distant future. However, “ethical programming” within a system’s decision-making process will allow an unmanned robotic system to function under the prescribed Rules of Engagement. As an overview, all authors concur that current technology has only allowed one simply to explore the possibility of autonomous lethal engagement.

In the Richard Epstein book, *The Case of the Killer Robot*, Epstein presents a fictitious case study where a factory worker that is accidentally murdered by a new assembly line robot. In the book, the worker happened to be the robot’s operator who was unfamiliar with the functionality of the robot and the control panel that commanded the robot. As a result, a blow to the head caused by an unexpected movement from the system's arm killed the worker. This scenario shows that even though an unmanned combat system can out perform a human being even in abiding by the current laws of warfare and Rules of Engagement, the robot is in fact simply a machine susceptible to error. Epstein identifies issues of accountability and responsibility when software systems fail. Factors such as the number of individuals assisting in the creation of the robot's software, the quality of training designed to educate the robot's operator, and the increased complexity involved in constructing the robot's programming may collectively increase the probability of severe malfunction in the system. Epstein's series of studies present important factors that challenge the question of whether or not unmanned robotic systems can truly abide by the current laws of warfare better than humans.

Noel Sharkey, an artificial intelligence professor at the University of Sheffield, is a leading advocate against allowing unmanned machines to operate as independent and autonomous entities. Sharkey's article published in the 2007 *Computer Journal*, "Automated Killers and the Computing Profession," expresses that the proposed ethical codes applied to the artificial intelligence of unmanned autonomous agents remains totally irrelevant within most legal communities due to the fact that such concepts are mere science fiction. Sharkey characterizes the possibility of how the increased application of unmanned robotic systems can change the nature of society; and how society may view war. The reduction of prices involving mechanical parts and the simplicity required to duplicate unmanned robotic systems may make conditions easier for going to war and or discourage war. Sharkey summarizes that the possibility of future autonomous robotic armies may lead to a society that is disconnected or removed from the violence of war. In general, Sharkey fears how technology may shape the future.

In February of 2008, John Wiseman wrote an unusual article from his "Lemonodor" Blog titled "Ethics in Lethal Robots." Wiseman anticipates that future autonomous combat robots may be capable not only of out performing humans in physical ability, but also of out performing humans when making ethical decisions during combat. Furthermore, Wiseman states that future autonomous unmanned robotic systems will be able to abide by the current laws of warfare and Rules of Engagement significantly better than humans due to several advantages. These advantages will ultimately allow optimal responses with the most ethical method of engagement. Advantages include, enhanced sensors used for superior battlefield observation and lethal engagement; the elimination of counterproductive human emotions such as, fear, anger, and guilt which may lead to war crimes; the ability to report criminal activity committed by Soldiers; accurately record and monitor human ethical behavior during routine combat operations; maintain superior battlefield momentum as a result of the inability to experience mental or physical exhaustion; and lastly, they will possess the capacity to react with lethal force more accurately and more quickly than any human soldier. Wiseman concludes that in the future, autonomous unmanned robotic systems will be highly successful in abiding by international law. Additionally, unmanned robotic systems are more likely to become as successful as humans due to their inability to think about self-preservation and their inability to self-sacrifice.

In summary, Epstein and Sharkey clearly address a number of questions that can be viewed as ethical taboos regarding the autonomy of unmanned robotic systems. Both convey that superior performance does not always ensure superior obedience under the current laws of warfare. Mishaps and oversights do happen. Epstein illustrates that as the technology of systems becomes more elaborate, the more likely it becomes that something could go wrong. As a result, a gross malfunction could lead to a wrongful death. Additionally, Epstein also explains that as more robotic parts and software programs are built, the preponderance of software assembly industries will become abundant. The concept of an unmanned robotic system becoming manufactured in several different plants is highly probable. Epstein believes that this process leads to a greater probability of mistakes by various manufacturers. Noel Sharkey warns that the increased use of unmanned systems will ultimately change society and condition humans to become more desensitized to the violence of war. Additionally, the author emphasizes that the expectation of totally relying on an unmanned robotic system to perform combat missions without expecting a single violation under the current laws of warfare is foolishly unrealistic. Computers and machines are not perfect. Wiseman concludes that unmanned robotic systems will be capable of abiding by the current laws of warfare and Rules of Engagement better than humans due to their inability of experiencing emotions that has historically distorted rational judgment among humans during violent conflict.

In his book, *The Geeks of War*, John Edwards, a business-technology journalist who covers emerging trends for a wide variety of publications such as, *The New York Times*, *The Washington Post*, and *Wireless Week*, forecasts a variety of uses and improvements that unmanned combat robotic systems may bring to future war. The complexity of future warfare will not only require precision targeting but also precision intelligence collection. As technology progresses toward the future, the utilization of highly sophisticated robotic sensors will be implemented in order to seek out targets. The vision of futuristic robotic aircraft and land vehicles that are capable of detecting targets in buildings, caves, and bunkers is quickly becoming a reality (Edwards 2005, 30). In theory, the new sensory systems would acquire electrical signatures emitting from distant communication devices and reactively trace the signals back to the points of origin. The author proposes this method as a primary means of target location that could commonly be used in the future in order to locate enemy positions. Such practices may be applied by the United States combat patrols in areas with substantial enemy activity. Edwards illustrates that the most practical role outlining an unmanned robotic system's position in war is the collection of detailed intelligence that will be exploited against the adversary. As a result, one may think of this process as the groundwork for precision targeting. Unmanned robotic systems, both air based and ground based, are becoming smaller in size in order to become less visible, less detectable, and less noticeable to the eyes of the enemy. Overall, the future prescribes very small and subtle "ghostly" systems, which will be capable of entering small places with immense sensory capability and substantial firepower.

The June 2008, *U.S. News and World Report*, titled "Targeting the Enemy" by Anna Mulrine, has defined that in the future, the appropriate role of unmanned robotic systems will remain as an extension of human senses. Mulrine briefly examines the likely challenges of future warfare. As battlefields begin to evolve from the steppes of Eastern Europe to more heavily populated cities with thousands of residing non-combatants, the needs for precision targeting will become more critical. Mulrine intricately describes the roles of the unmanned aerial combat systems as valuable instruments capable of identifying targets twice as effectively as humans. The technological milestones responsible for viewing real time footage originating from the unmanned aerial system to the controller on the ground has given the United States Air Force more precision and flexibility before and during an attack. The author accentuates that the Air Force labels this process as “putting warheads on foreheads.”

Tony Rogers, writer for the *Defense Review Magazine*, published an article titled “New Military Robots Violate Isaac Asimov’s First Law” in March of 2006. Rogers defines the most likely possibilities regarding the various weapon systems that may be installed on unmanned ground vehicles of the future. Additionally, Rogers illustrates that the Special Weapons Observation Remote Direct System can easily be fitted with everything from a M249 machine gun, the M136 antiarmor weapon, the M141 Bunker Defeat Munitions, the M72 thermobaric weapon system, or the DREAD/Multiple Projectile Delivery System. The author explains that unmanned ground vehicles will become more prevalent in future combat operations due to increased opposition from the American public protesting against members of the United States Armed Forces loosing their lives on foreign soil. The increased use of unmanned combat robotic systems during war could perhaps mitigate such opinions. Rogers states that the United States Army Stryker Brigades have already begun the process of fielding the new Special Weapons Observation Remote Direct Action System unmanned ground vehicle as an integral addition to the Stryker community. The process of implementing unmanned ground systems into the missions together with human soldiers has already begun.

Dr. Lawrence Hinman, Director of the Values Institute at the University of San Diego, delivered a set of briefings in August of 2008 that clearly summarizes the human basis on moral decision-making. Hinman's study characterizes applicable theories that help explain the human rationalization regarding the increased use of technology that may be employed during war. According to Hinman, The Ethics of Duty Theory and The Utilitarianism Theory provide the theoretical framework that best describes how the current Law of War and philosophy of ethics define the virtue of using unmanned robotic combat systems during violent conflict. The Ethics of Duty Theory states that individuals must always do what is right for the benefit of other individuals or the state. The principles of reasoning and professional duty defines that unmanned robotic systems are the most logical weapons of choice during warfare in order to support the existence of an institution and its people. In other words, using unmanned systems in place of humans during war mitigates the consequences of war or the unnecessary loss of human life. The Utilitarian Theory claims that the purpose of morality is to make the world a better place. Utilitarianism demands a high degree of self- sacrifice and seeks to reduce suffering and increase happiness. The application of unmanned robotic systems during armed conflict may prevent the burden on humans participating in war; but will undoubtedly imply self-sacrifice due to the process of technological improvement and increased ridicule from poorer nations that do not possess such technology. In summary, Hinman explains that technological advancement and research will always take precedence over any ethical consideration or rule of law. In all cases, laws and ethics are forced to keep up with technology. Nothing is ever considered unethical until something goes wrong (Hinman 2008, 2-9).

In conclusion to this chapter, it seems evident that the various views expressed by the authors depicted above are divided into two general categories. The first category is a series of views that finds positive benefits in autonomous weapons research and supports the programs associated with such programs. The second category is a series of views that either discourages autonomous weapons research or believes that human intervention will always be necessary while implementing unmanned robotic systems. Authors such as, Ronald Arkin, John Edwards, Lieutenant Colonel Anthony Lazarski, and John Wiseman, express the beliefs that the advancement of technology will call for increasingly more autonomy as the contemporary environment progresses. Variables such as ethical programming, the equality of unmanned aerial system operator credentials verses those of the conventional pilot, and the abidance of the laws of warfare better than humans are all aspects worthy of acknowledgement as technology progresses. Authors such as Richard Epstein, Lawrence Hinman, and Noel Sharkey address that unmanned robotic systems will undoubtedly become more sophisticated over time. However, these authors express that it is important to acknowledge fundamentals such as, software programmer training, software testing, continuous assessment of current law relevant to the latest technology, and issues associated with humans becoming too dependent on current technology. These matters are easily overlooked or forgotten until something happens that warrants such attention.

CHAPTER 3

RESEARCH METHODOLOGY

> Law Number 2: A robot must obey orders given to its human beings, except where such orders would conflict with the First Law.
>
> —Isaac Asimov, "Three Laws of Robotics" 1942

Unmanned robotic weapon systems such as, the Patriot Air Defense Weapon System, the Aegis Automatic Special Weapon System, the Tomahawk Anti-Ship Missile System, are all current examples of autonomous like weapon systems capable of lethal effects with little or no human intervention. Each of these systems has been treated in a short case study or dialogue that outlines common operator and design oversights that have been made during fielding and application of those particular unmanned combat systems. In retrospect, programs mandated by law may have prevented many of those oversights. In the cases regarding the Patriot Air Defense System and the Tomahawk Anti-Ship Missile System, it is evident that both systems were used in particular situations, which the weapons were not originally designed. Additionally, matters of operator/ machine interface and outdated software pertaining to the missions at hand are significant variables that inevitably caused the systems not to operate at the optimal level or even caused unforeseen deaths. After a number of fratricide incidents, the Tomahawk-Anti-Ship Missile System was in serious question concerning the dilemmas of target proportionality and discrimination. Initially designed as a "fire and forget" weapon platform, the Tomahawk has been redesigned as a versatile weapon capable of changing target selection during flight. The MQ-9 Reaper and RQ-4A Global Hawk have been examined in order to determine the possibility of any legal scrutiny in the future.

Suggestions of an improved sensor system pertaining to the Reaper and possible safety considerations during a Global Hawk's emergency landing procedure have been discussed in order to ensure legal protocol in the future. Lastly, mines have been worthy of study due to the vast challenges they pose to the principle of discrimination and their potential for the violation of human rights of non-combatants.

During this study, the progression of technology and how that progression will continue to spark a different variety of legal problems that have never before existed have been described. Additionally, as progress in technological brings humans more data faster; the probability that humans become further removed from the machine is highly likely. In order to understand how future laws of warfare may be structured, it was necessary to examine the most current research that is shaping autonomy in unmanned weapon systems. Additionally, defining artificial intelligence and how artificial intelligence may change the course of law as a whole has also been necessary during this examination. The various meanings of Autonomous Control Levels and how they are applied to unmanned weapon systems are explained throughout this work in order to emphasize the vast complexity of future unmanned robotic system command and control nodes. Additionally, due to such vast technological growth, future challenges regarding the current laws of warfare will also be addressed.

Unmanned combat systems may possess the ability to operate under the current law of warfare better than humans during combat. During this study, the laws of warfare under the Rules of Hostility or Conduct During War (*Jus in Bello*) will be analyzed. Conduct during conflict remains to be a significant factor as the United States implements unmanned robotic systems in the contemporary operating environment. The ability to distinguish between a legal and non-legal target remains challenging both scientifically and ethically. Semi-autonomous robotic weapons such as the Patriot Air Defense System and the Global Hawk unmanned aerial system have already been installed with safety abort parameters that may assist a system's operator in preventing lethal accidents. However, as unmanned robotic systems become more complex, legal and ethical controversy may increase during future war.

During the analysis portion of this thesis, major points have been discussed regarding an unmanned robotic system's capacity to perform on the battlefield without experiencing emotional variables that normally affect human beings during traumatic violence. Environments contaminated with toxins such as, chemicals, biohazards, and radiation will not affect a machine's judgment. Historically, human emotions during war have contributed to war crimes and gross misjudgments that have tarnished a nation's reputation during conflict. Unmanned robotic systems may make it easier for a nation to abide within the confines of the Land Law of War and decrease the possibility of criticism from the international community. Additionally, unmanned robotic systems are incapable of struggling with emotions during the fog of war. Emotions such as, hate, anger, revenge, or guilt will not cloud judgment. Combat functions are narrowed to a tangible "targets" or "non targets." While methods of fighting future wars develop, future missions are likely to call for humans and robots to work side by side more often. Unmanned robotic systems may present valuable capabilities that could prevent Soldiers, which inherently represent an entire nation, from making ethically destructive errors during violent conflict.

Lastly, this study reviewed the many intricacies pertaining to software development, testing, and prototyping that lack current lawful guidelines in order to establish sufficient protocols in the case of an incident requiring legal action. As a result, the most likely point to define such protocols is to study a system's development process all the way back to where the software designers actually began their work. The questions of adequate software worker training programs or professional certification requirements may be significant. Additionally, as an unmanned robot's particular stage of development passes, one must begin to consider the degree of influence the human controller has over the system itself. Many believe that this particular issue is based on the phase of development relevant to the proposed human/machine interface procedure. Such problems are normally identified during system prototyping and testing.

This chapter outlined how the effects of developing technology on the current laws of warfare will be analyzed. Future recommendations pertaining to the further study of this thesis will be outlined in the conclusions and recommendations portion in chapter 5. The next chapter (chapter 4) will examine in detail the concepts discussed.

CHAPTER 4

ANALYSIS

> Law Number 3: A robot must protect its own existence as long as such protection does not conflict with the second law.
>
> —Isaac Asimov, "Three Laws of Robotics" 1942

This chapter will consider some of the key variables that may be deemed crucial in order for an unmanned agent to autonomously apply lethal force. Additionally, plausible theories regarding how unmanned robotic systems may conceivably abide by the current laws of warfare perhaps even better than human soldiers will be discussed. As these proposals are examined, it is important to reflect on how the current laws of warfare may be drastically affected by robotic technology. Undoubtedly, there are literally hundreds of requirements that will inherently direct the performance of unmanned robotic systems under the laws of warfare. For the purpose of this paper, requirements that warrant the most obvious attention and that are deemed fundamental in order for a system to perform as legally and ethically as possible on the battlefield will be reviewed. First, some of the contemporary "autonomous like" weapon systems that currently employ lethal force within the legal parameters of the Land Law of War will be examined. Second, assuming that future unmanned systems will eventually be allowed to engage targets without any degree of human intervention, it is relevant to discuss proposed control measures and the necessary technological requirements that would seem logical regarding autonomous target engagement under legal and ethical protocols. Lastly, potential robotic programming, developing, and manufacturing issues that may negatively impact the behavior of an unmanned robotic system during war will be reviewed.

The Patriot Missile System is a United States automated air defense system that was first developed in 1977 and fielded as part of the United States arsenal in 1984. Perhaps the system’s most impressive feature is its ability to accurately engage an incoming missile out to 50 miles away. The Patriot literally intercepts incoming targets beyond the natural senses of a human being. The system activates and engages targets before the targets are even seen or heard. The Patriot’s radar acquires an incoming object and calculates a particular area within assigned air space in which the system should next look for the object. Once the radar begins to track the object, all other data outside this airspace becomes irrelevant. The radar continues to track the incoming target, sends the data to the Patriot’s computer, the computer then sends the command to launch a missile in order to intercept the incoming object (howstuffworks.com, Patriot Missile System, 2008). Historically, the Patriot has performed missions since Desert Storm with remarkable results. However, after a period of continuous operations, the Patriot began to miss targets at a substantial rate. After a series of investigations, it was discovered that most of the Patriot’s software was originally designed in the late 1970s. The Patriot’s radar system was prone to “drift” away from its prescribed search fan after periods of extended use. In essence, the system’s radar and main computer would simply loose search accuracy. This reduction in accuracy would ultimately cause the Patriot’s computer to consistently miscalculate firing data. When this problem was identified, the Patriot was then retrofitted with updated software using the most current technology (General Accounting Office 1992, 2).

It is important to understand that the Patriot Missile System was originally designed to defend against massive and somewhat predictable missile attacks initiated by an army following traditional 1970s Soviet Block doctrine. To counter that doctrine, the Patriot was required to detect and intercept incoming targets with series of short bursts during limited periods of time. During Desert Storm, the Patriot was tasked to search endlessly and continuously for incoming SCUD missiles. Patriot search schedules lasted for several days but the system was designed for searches lasting only several minutes. Launch sequences initiated by the Iraqi Army were simply too unpredictable and required long hours of continuous monitoring by the Patriot system. After reviewing this short case study, it is apparent that the process of software upgrade pertaining to the Patriot Missile System was an oversight before its deployment to Desert Storm. Whether the oversight was simply overlooked, deemed not important, or regarded as a financial burden is not known. Many times, underlying legal issues pertaining to the laws of warfare and technology do not seem to reveal themselves as legitimate until something goes wrong or something does not work the way it is supposed to.

The Aegis Automatic Special Weapon System was first developed in 1973. Originally intended as a blue water warfare enabler, the Aegis was capable of defending a warship against multiple air, surface, and sub surface targets. The level of autonomy regarding the system's target engagement process could be increased or decreased according to the threat and circumstances (Zwanenburg 2008, 3). Additionally, once it detects a target, the Aegis can assess the selected target and reengage it if necessary. By the middle of the 1980s, a significant number of the United States naval warships were equipped with the Aegis; it was considered a perfect solution against any current Soviet naval threat. Similar to the Patriot Missile System scenario illustrated above, the Aegis was conceptualized to defend against massive and overwhelming missile strikes launched from multiple systems.

On 3 July 1988, the *USS Vincennes*, a Ticonderoga Class cruiser equipped with the Aegis system, was engaged in a skirmish with several small Iranian speedboats in the Persian Gulf. The *USS Vincennes* was in the area in order to protect American interests from the effects of the war between Iraq and Iran. While engaging the Iranian speedboats, the ship's radar system detected an inbound aircraft identified as an Iranian F-14 aircraft advancing toward the *USS Vincennes*. The aircraft was identified as hostile and immediately destroyed. Later, it was determined that the aircraft was a civilian Iranian passenger jet carrying roughly 290 passengers. There were no survivors (Zwanenburg 2008, 2). Afterwards, a number of investigations revealed that the crew on the *Vincennes* was indeed tracking what they truly believed to be an F-14 because the Aegis' computer clearly displayed data outlining the characteristics of an F-14 fighter jet. However, it was discovered that the data was previously captured by the Aegis' computer system based on a past scenario pertaining to a grounded F-14. The Aegis Identification Friend or Foe computer was still displaying data pertaining to an F-14; not a civilian aircraft. A procedural oversight that required the Aegis operators to "reset" the system before initiating a new search pattern was omitted and the result was a tragedy and a serious international crisis.

The Aegis system which had been designed to defend against multiple threats at one time was not found to be effective while engaging a single target in the crowded context of the Persian Gulf populated with a confusing assortment of military and civilian vessels and aircraft of various nationalities (Zwanenburg 2008, 4). Prototype based testing will continue to become more vital as technology advances and begins to require less human intervention. Careful and thorough testing of all aspects of a prototype system may avoid the likelihood of system failure or operator error mistakes in the future.

Fielding of the Tomahawk Anti-Ship Missile began in 1983. After target selection, the missile is launched in the general direction of the target, which may be beyond the horizon and beyond visual range of a ship's launching pad. Once the missile is within vicinity of the target, it begins a serpentine search pattern and emits radar search signals in order to scan for enemy emissions. Once detected, the Tomahawk locks on to the enemy target and engages. The missile is considered "lawful" under "The 2008 Commander's Handbook on the Law of Naval Operations" because it has onboard sensors deemed capable of successful target acquisition and discrimination. The Tomahawk missile is the United States Navy's premier land attack missile. It frequently used during the 1991 Gulf War, Afghanistan in 2001, and the current war in Iraq. The system is of great strategic value since it may be fired at over 1,000 miles from its intended target with high accuracy. However, one of the primary drawbacks is its "fire and forget" capability. Once the missile is launched, its internal navigation system does not allow for redirection. This limitation causes potential redundant demolition of targets as well as the inability to correct the system's flight path if a targeting mistake is discovered during the missile's flight. In addition, once fired, the missile cannot respond to dynamic situations in which, for example, a target has moved, or a more critical target emerges (Cummings 2006, 704). In recent history, the inability to redirect the missile system after initial launch has fatefully resulted in a number of wrongful target engagements such as, the destruction of a British Tornado fighter jet and a number of the United States attack aircraft during more recent incidents in Iraq. In response to these incidents, the United States Navy is in the process of developing a particular version of the Tomahawk called the "Tactical Tomahawk." The Tactical Tomahawk will possess the capability of allowing the launch operator to initiate a "direction override" option once the missile has been launched. The system will be designed to provide battlefield commanders the ability to redirect missiles in flight. Not only will commanders possess the ability to have more flexibility and options, they will also be allowed to engage targets of opportunity as the situation develops. The Tactical Tomahawk will provide the flexibility needed to support both military objectives and operators who must be able to allocate resources through constant targeting updates in a time sensitive environment (Cummings 2006, 705). Compared to the United States military's massive ordnance arsenal that contains numerous air blast bombs with warheads weighing up to 21,000 pounds and a blast radius comparable to that of a nuclear bomb, the Tactical Tomahawk missile is obviously a weapon more in keeping with the just war criteria (Cummings 2006, 706). The Tactical Tomahawk's onboard control interface system is an example of how modern technology can take into account the principle of discrimination in weapons' design.

Perhaps the world's simplest yet most controversial unmanned weapon system is the mine. Mines are autonomous weapons that are normally initiated by pressure, magnetic attraction, or tripwire (http://howstuffworks.com, "How Landmines Work," 2001). Today, more than 450 varieties of mines exist. However, for the purposes of this study, one needs to only consider that mines are normally categorized into three basic types: (1) antipersonnel mines, (2) antitank mines, and (3) maritime mines. Mines occupy every land or sea area of the planet. There are a significant number of international debates over the continued use of mines. This has convinced most nations to simply abandoning their use. Mines are cheap to produce; designed to persist; and after initial emplacement, may lay dormant under the soil of past battlefields for several years. Typically as time passes, even the individuals who have originally planted the minefields forget where they are located. In essence, this becomes an important issue affecting civilian populations living in areas that were previously mined during past wars. Maritime mines are virtually impossible to locate until an unforeseen incident occurs involving a vessel that accidentally drifts into them. Currently, many countries, including the United States, reserve the right to deploy mines. Today, most mines automatically self-destruct after the expiration of an allotted time period once the mine is armed. This particular approach allows certain nations, including the United States, to justify their use while narrowly complying with the current laws of warfare. Regardless of the legality relating to the use of various mine systems or the "fail safe" complexity of many current designs, the mine is an example of an unmanned autonomous weapon that applies lethal force to virtually anyone or anything that encounters it. The principles of legal target cannot be considered once mines are deployed.

The MQ-9 Reaper is an unmanned aerial system has been fielded in the United States arsenal as a "hunter-killer" weapon system. The Reaper is operated by remote control and is capable of projecting vivid imagery to the operator as the system searches for its assigned target. Once the target is acquired, the operator may launch one of the Reaper's onboard Hellfire missiles in order to destroy the target. While the Reaper provides its operators with greater safety than pilots of manned aircraft, the Reaper presents other thought-provoking issues. The most positive aspect of the Reaper is that in the case of a downed aircraft, there is no pilot to take hostage, no pilot to kill, and no pilot to be used as a propaganda tool by a hostile entity. Conversely, one may pose the question, “will the Reaper push the limits when it comes to more risky missions?” As unmanned aerial system become more sophisticated, many questions have come to attention in the scientific and military communities. The concern of other nations using unmanned aerial systems in order to collect military intelligence or conduct military surveillance has been the topic of many legal debates globally. Perhaps one of the most critical issues is that the Reaper is incapable of detecting other aircraft while in flight. The adverse consequences of this dilemma may propose more immediate attention as the Reaper is being used more often in more increasingly active airspaces such as Iraq. Other concerns may warrant the same degree of attention if a Reaper happens to “go astray” from a training area and wonders into the path of other aircraft. Additionally, the Reaper’s lightweight design has many positive advantages; however, the system remains extremely vulnerable to high winds, snow, and rain. In such environments, the Reaper’s operational performance is significantly degraded and it must be grounded. These issues warrant further investigation and must be addressed in any discussion on the laws of warfare (http://howstuffworks.com, Reapers 2008).

The Global Hawk RQ-4A is an unmanned aerial system that has taken over a significant portion of the roles that were once performed by the Lockheed U2 Surveillance Aircraft better known as “Dragon Lady.” The Global Hawk is a high altitude reconnaissance unmanned aerial system capable of conducting missions up to 70,000 feet. In the case of an onboard malfunction, the Global Hawk is capable of executing emergency landings on pre-designated airstrips located along its flight path. This capability is very useful in case of an emergency; however, in many cases the “designated airstrips for emergency landings” have not been cleared with the landowners. Currently, this particular function has not yet caused any known legal issues; but the potential exists. The Global Hawk “lands” and “takes off” in a fully autonomous mode. If the operator is unable to see an unsuspected obstacle located on the airstrip such as a car, another aircraft, or children playing ball on a rural airstrip there may be disastrous consequences before the operator can override the Global Hawk’s “landing function.” Additionally, scientific research defining the combined integration of the Global Hawk and manned aircraft is still an unresolved issue. Currently, a significant amount of research is being done regarding integrated communication between the Global Hawk and manned aircraft. Communication between the Global Hawk and manned aircraft would allow for more integrated operations and more precise control of the Global Hawk’s missions. Currently, this capability does not exist (McGee 2006).

Future unmanned aerial combat systems offer many compelling advantages. Currently, the concept of future unmanned aerial combat systems is to operate in groups or sorties with integrated communication and targeting data. In essence, future systems are projected to show more “onboard intelligence.” More onboard intelligence means less demand for data-link capacity. More data-link capacity invites less dependency on human decision-making. Many experts argue that the roles of the aircraft “pilot” (operators) will be outmatched and rendered obsolete by software programs that will be installed into future unmanned machines. The vast growth in computer power will undoubtedly surpass human reflexes and mental capacity. Current microprocessor chips in transistor counts rival the neuron counts of small mammals. Presumably, it seems likely that microprocessors in the year 2020 will approach the data processing capabilities of the human brain (http://howstuffworks.com, computer 2008). Most academic scientific models indicate that technology is only predictable up to 10 years. Therefore, the capability of future unmanned combat aerial systems is difficult to imagine. An interesting question, which remains to be answered, is whether it would be wise, as well as whether it would be legally or ethically viable to deploy fully autonomous systems in the future. A fully autonomous machine's entire purpose for killing would be significantly different than that of a human. A human is normally motivated to kill in the interest of their family, nation, or fellow Soldiers. The motivation to kill for a fully autonomous and customized would pose serious questions.

An unmanned combat aerial system's vulnerability in a heavily jammed electronic environment suggests an important issue that may be a problem for future systems. In such an environment, the pilots of manned aircraft are able to successfully complete their assigned mission even in cases where an unmanned combat aerial system will more likely abort. Additionally, the full process of mission abortion remains somewhat unclear and lacks tangible legal examination. If a system's performance is so badly affected by electronic jamming and begins to fall from the sky, how will the system avoid crashing into an illegal target? In the case, of a manned aircraft crashing, the situation seems more variable in terms of understanding. The pilot knows that he or she may die and will do everything possible in order to avoid the tragedy itself or any additional unattended deaths. In the case of an unmanned aerial combat system, the machine does not realize that it is about to be destroyed. It will simply crash. There is absolutely no human will associated with the machine in order to prevent any further tragedy or innocent human loss. If the system crashes into someone's home, the question may be asked, "Who is at fault for the innocent deaths?" "How will compensation occur regarding the loss of innocent human lives?"

After briefly reviewing the seven weapon systems depicted above, it is important to recognize the legal facets that are not obvious each time a technological leap is implemented into the military community or into society itself. As stated earlier, laws regularly follow technological innovation. In many cases, it is not typically realized that certain laws may require considerable when technological advances challenge the definitions of what may be considered "ethical."

The above case studies regarding the Patriot Missile System and the Aegis Special Weapon System conclude that both systems were initially weapons designed to engage a massive Soviet Army that followed a regimented attack strategy as outlined by Soviet doctrine. Soviet attacks were envisioned as highly organized surges intended to quickly overwhelm their adversary. Therefore, the United States developed the Patriot and the Aegis in order to defeat such massive attacks. These attacks were projected to occur at such high volumes of fire that human operators would be unable to keep pace with the battle. However, after the collapse of the Soviet Union and the fluid requirements that characterize the current operational environment it became clear that the Patriot and the Aegis would require technological upgrades. The concepts governing the employment of both weapons were restructured in order to "fit" the current threat. Currently, it is difficult to imagine that such sophisticated and expensive systems could possibly represent outdated technology and doctrinal practices. However, as shown in the case studies, something must go wrong before defects become evident which require change.

The Tomahawk Anti-Ship Missile System represents a different paradigm than that of the Patriot or the Aegis. The Tomahawk's task and purpose was to cruise toward the general location of the target, begin a search using a specified flight pattern, acquire the target, and engage it. The Tomahawk provides pinpoint target accuracy that unquestionably considers the principles of discrimination and proportionality. However, once the Tomahawk is launched, operators are allotted very few options that allow missile redirection. Such characteristics have unfortunately led to past mishaps involving the engagement of unintended targets. The use of the Tomahawk in the context of today's battlefield has called for improvements of the Tomahawk system. These improvements will give commanders and operators the time needed in order to redirect the missile's flight path due to an aborted mission or a sudden change in target location. In general, this capability provides the flexibility to engage a valuable target in another place or at another time. As an example, let us suppose that a commander may desire to destroy a truck carrying a number of combatants with a Tomahawk cruise missile. The truck is located on the outskirts of a highly populated town. However, from the time the missile is launched, the truck carrying the combatants moves into the town's market square populated with numerous noncombatants. In this particular case, the option to abort the mission or redirect the missile's flight path would be critical. In essence, this flexibility would become invaluable in order to abide by the principle of proportionality and avoid civilian casualties. The technological improvement of the Tomahawk represents a significant improvement of an autonomous weapon systems based on the challenges of the current operational environment.

Unmanned robotic systems such as the MQ-9 Reaper, the RQ-4A Global Hawk, and future unmanned combat aerial systems are subjects that require more detailed analysis regarding future discussion on the Law of War. As these systems are technologically improved, legal matters pertaining to shared airspace, sensors that are capable of detecting other aircraft, legal lines of responsibility, and better emergency contingency plans in the case of a system malfunction, require serious clarification in order to avoid future legal and ethical problems.

As technology races forward and continues to render the current laws of warfare obsolete, it is likely that unmanned systems will eventually become less dependent on the "man in the loop" process. Due to the development of satellite and other sophisticated surveillance systems, information on the battlefield has become more readily available and is delivered at a much faster rate. Massive amounts of data transmitted with remarkable speed can now reach human decision makers with overwhelming speed. Commanders may easily become overwhelmed with enormous quantities of battlefield data that is virtually impossible for any one human to successfully manage. This situation poses the question: "When does battlefield data become too much data?" As battlefield technology becomes more network-centric, it is plausible that the nature of modern warfare among technologically advanced adversaries will continue to change. Invariably, the tempo of war will become faster. Key targets are likely to become acquired and engaged within a matter of seconds resulting in total conflict culmination in a matter of hours. The possibility of minimal human intervention would become very likely.

Conversely, if two nations possess the same level of technology that is depicted above, the logic of justifying war would become easier. Matching technology on both sides may result in a strategic stalemate. Obviously, the theories illustrated above are simply paradigms affected by no outside variables such as terrorism or insurgencies. However, it is useful to acknowledge such possibilities.

Advances in autonomous technology will cause an entirely different set of problems that have never before existed in the history of law and modern war. In the case of a mishap that violates any law concerning conflict management, it would be next to impossible to establish exactly “who or what” is at fault. Blame could be placed (or shared) on the commander, the operator, the programmer, the victims, or perhaps the machine. After considering such a dilemma, it is very difficult to ignore the aspect of artificial intelligence. According to the *Webster’s Universal College Dictionary*, artificial intelligence is defined as “the collective attributes of a computer, robot, or other mechanical device programmed to perform functions analogous to learning and decision making.” Commonly, Hollywood films that have been produced within the past twenty years have greatly contributed to the stereotypical image of what future artificial intelligence would look like. Examples of these stereotypes include famous science fiction films such as, “I Robot,” featuring actor Will Smith and the “Terminator” featuring Arnold Schwarzenegger. Both films depicted “humanoid-like” robots with highly advanced artificial intelligence capabilities that unquestionably exceed current artificial intelligence technology by probably hundreds of years. With those concepts in mind, the complexities of artificial intelligence could vary in capability perhaps as much as natural biological intelligence. As an over-simplified example, both the beetle and the chimpanzee possess some level of intelligence. However, the degree of intelligence displayed by the chimpanzee is obviously more advanced than that of the beetle. One may visualize artificial intelligence capacities in a similar manner.

The overall purpose of autonomy or “artificial intelligence” is for a device to possess the internal ability to reason and react to its environment. As far back as the fifteenth century, objects as simple as the clock, a variety of mechanical toys, and vending machines have portrayed characteristics of such autonomy. Unlike today’s automated technology, these devices required absolutely no electronic interface such as, vacuum tubes, transistors, or computer chips. As simplistic as these automated historical devices may be, they were fully capable of functioning with literally no human intervention. Today, the scope defining autonomy or “artificial intelligence” is as wide as the latest iRobot® Roomba® household vacuum cleaner which is designed to automatically vacuum and navigate through a house using onboard “bump sensors” and infrared receivers all the way to the Defense Advanced Research Project Agency’s (DARPA) Learning Applied Ground Robot (LAGR) which navigates by a sophisticated sonar ranging system and a high optical camera (SRI 2007). Each machine displays a particular degree of artificial intelligence and a specific method to navigate. As stated earlier in this study, the fundamental principle that defines automated weapon systems is the ability to engage the correct target on the battlefield every time. This is also perhaps the greatest challenge concerning the development of proper legal guidelines in the case of an accident. In summary, it is necessary to understand the most basic concepts of how system autonomy or “artificial intelligence” works in order to conceptualize the number of complexities that may be associated with the future legal problems that normally follow autonomous technology.

One of the most important goals of research in autonomous flight and navigation is to reduce the time of flight and the requirement of human operators. The advantage of this is an increased reconnaissance capability at a lower risk and cost in terms of finance. Much research goes into reducing the human / unmanned aerial system ratio, which will eventually decrease the required number of human operators needed to operate unmanned systems. As a result, human decisions could be moved to a higher level of policy and or operation. With the exception of the Global Hawk, all unmanned aerial systems are controlled from remote ground stations. Global Hawk employs a structure of autonomous operation under computer control, supervised by a remote operator, similar to robots used in the automotive industry. Significant effort has been made to develop the automatic takeoff and landing software of the Global Hawk enabling the system to perform these two procedures nearly perfectly every time (Kniskern 2006). The high endurance, high mission reliability, and overall effectiveness of the Global Hawk have resulted in enormous success during recent conflicts such as Operation Iraqi Freedom. According to the February 2004 Defense Science Board Study, the Global Hawk acquired 55 percent of the time sensitive targets scheduled between the periods of March 2003 and April 2003. In 16 missions, the Global Hawk located 13 surface-to-air missile batteries and over 300 tanks. Overall, automation and robotics have been commonly accepted in commercial manufacturing because they have ultimately paid off in terms of efficiency and safety. Thus far, the same has been true for unmanned robotic weapon systems (Hanon 2004, 2).

In order for any unmanned ground combat system to function autonomously, the robot must possess appropriate sensors and systems to successfully navigate through its environment. These sensors and systems are generically categorized in two groups; relative and absolute position measurements. Relative position measurements include odometry and inertial navigation; absolute position measurements include active beacons, artificial and natural landmark recognition, and model matching (Borenstein, Everett, Feng 1996). Presently, autonomous research regarding unmanned ground based robots emphasizes artificial landmark recognition that receives data from reference points placed on the ground. In this method, distinctive artificial landmarks are placed at known locations throughout the robot's environment that "map out" the robot's surroundings. In essence, the robot's sensors detect the landmarks, computes a route, and navigates to its destination. Autonomous unmanned ground systems present a different degree of navigation and weapon engagement challenges than unmanned aerial systems. Autonomous navigation and target recognition on the ground requires what is referred to as "real time" capability. Real time sensory capability is necessary to interpret the environment three dimensionally. Normally, objectives in such an environment are at close distance. The global positioning satellites that are currently used in unmanned aerial systems would simply not be as effective. The lack of pinpoint accuracy provided by global positioning would vary by such margins that the process of delicate and close ranged tasks performed on the ground would become practically impossible.

Future warfare will likely introduce more unmanned robotic systems with greater capabilities for autonomous operations as depicted in figure 3. Currently, there are ten Autonomous Control Levels that have been the under extensive research by the scientific community (see table 2). Each level offers a variety of options pertaining to an unmanned robotic system's functionality. The simplest is Autonomous Control Level 1. Autonomous Control Level 1 directs all control to the unmanned robotic system's operator. Autonomous Control Level 2 is designed to inform the unmanned robotic system's operator of any unexpected system malfunction and allows the operator to initiate a mission override or mission abortion. Autonomous Control Level 3 identifies any internal malfunction that may be present within an unmanned robotic system. Once the malfunction is identified, the unmanned robotic system attempts to fix the malfunction automatically while the unmanned robotic system is in flight. In the case of a malfunction that is too severe to be adjusted in flight, the unmanned robotic system will either automatically abort the mission or automatically execute and emergency landing until recovered by humans. Autonomous Control Levels 4, 5, and 6 automatically diverts control of several unmanned robotic systems to one unmanned robotic system, which serves as the main control node. In essence, the human operator controls the one unmanned robotic system serving as the main control node and the main control node controls multiple unmanned robotic systems that are directed to a particular task or mission. This concept allows up to ten systems to operate under the influence of one human operator. Autonomous Control Levels 7, 8, and 9 function under the same concept as Autonomous Control Level 4, 5, and 6; however, Autonomous Control Levels 7, 8, and 9 allow unmanned robotic systems to engage targets by priority of tactical and strategic importance. This particular concept gives unmanned robotic systems the flexibility to skip targets that are of low importance and engage targets that are deemed to be more tactically or strategically vital. Autonomous Control Level 10 influences multiple unmanned robotic systems by what is called “swarms.” Fully automated swarm technology is modeled after the behaviors of insects such as ants and bees. Swarm intelligence provides insights that can help human controllers manage highly complex systems that range from only several unmanned robotic systems to hundreds of unmanned robotic systems under the supervision of one human operator (nationalgeographic.com 2007).

Current unmanned aerial systems operate at what is called Autonomous Control Level 2, which are capable of an automatic on board systems analysis or “real time health diagnosis.” A health diagnosis is an automatic “systems check” that searches for possible electronic or mechanical failures that may prevent the machine from functioning properly. If the health diagnosis detects a malfunction, the machine’s computer will shut down the robot and abort the mission. In essence, the health diagnosis serves as a safety override in order to prevent a potential mishap. Global Hawk incorporates automatic takeoff and landing and some internal reconfiguration to adapt to subsystem failures, which approaches Autonomous Control Level 3. Future unmanned combat aerial systems, now referred to as joint unmanned combat aerial systems, are scheduled to reach Autonomous Control Level 6; with on board coordination measures and planning programs while unmanned combat aerial robots are designed to approach Autonomous Control Level 9 (Hanon 2004, 4).

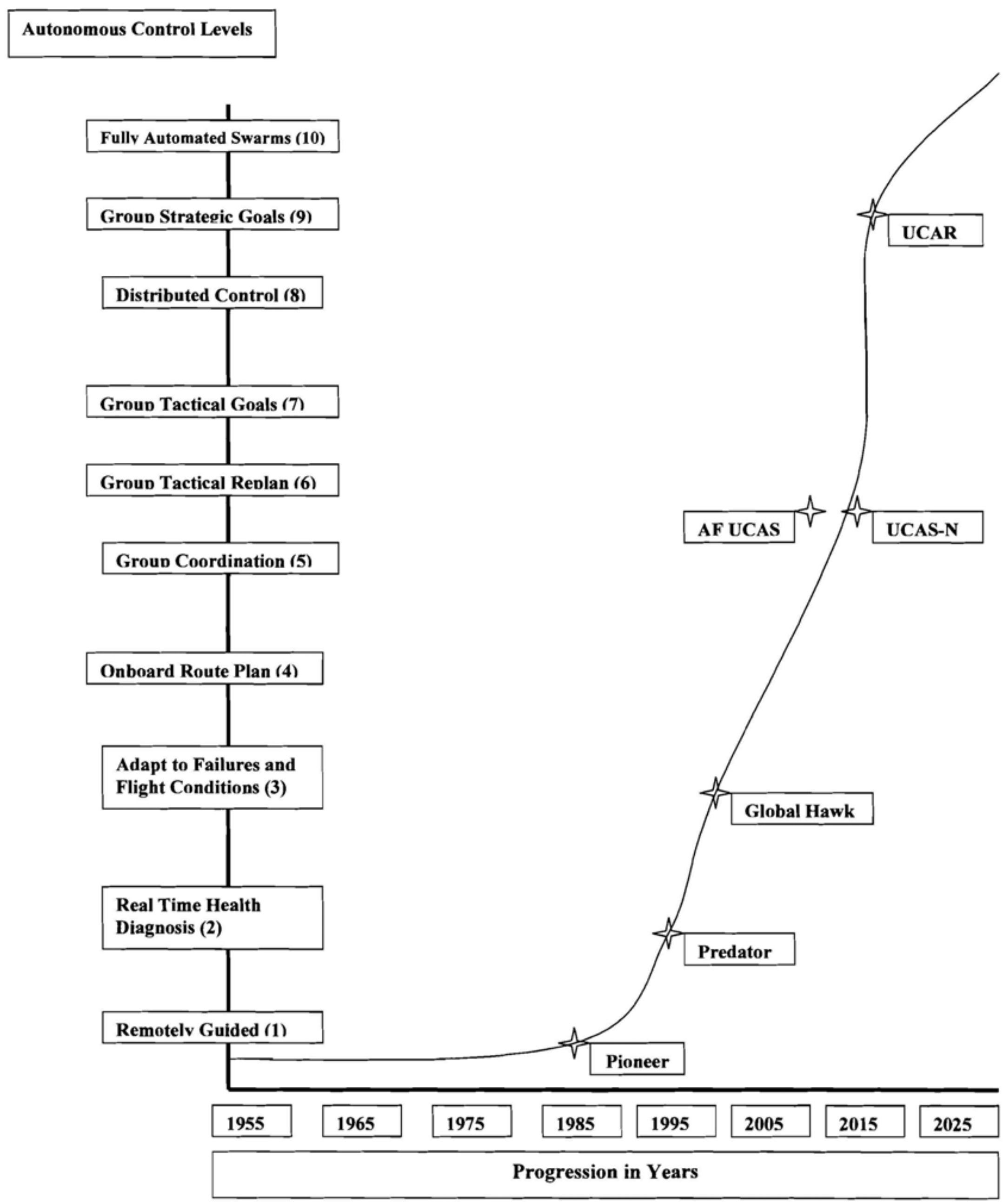

Figure 3. Autonomous Control Level (ACS) Trend

Source: Leighton Hanon, *Robots on the Battlefield--Are We Ready for Them*? "Unmanned Unlimited" Technical Conference, Workshop and Exhibit, 20-23 September 2004 (Chicago, IL: American Institute of Aeronautics and Astronautics): 5.

Table 2. Unmanned Robotic System Autonomous Control Levels (ACL)

1. ACL 1 (Remotely Guided): Directs all control of the unmanned robotic to the human operator.

2. ACL 2 (Real Time Health Diagnosis): Control mechanism on the unmanned robotic system that informs the system's operator of any system malfunction and allows the operator to initiate mission abortion.

3. ACL 3 (Adapt to Failures and Flight Coordination): Control mechanism on the unmanned robotic system that identifies any internal malfunction that may be present while the system is functioning. Once a malfunction is identified, the unmanned system will attempt to fix the deficiency. In the case of a malfunction too severe for repair, the unmanned system will abort the current mission.

4. ACL 4 (Onboard Route Plan): Route planning based on sensor deployment, for situations where planning is a cooperative effort of geographically collocated and dispersed unmanned robotic system operators. Additionally, it uses spatially integrated depictions of navigation data regarding the sensor deployment to enhance the operator's situational awareness.

5. ACL 5 (Group Coordination): Unmanned robotic system mechanism that encompasses task generation and allocation, flight path generation and tracking, and synchronization between cooperative tasks.

6. ACL 6 (Group Tactical Replan): Unmanned robotic system capable of conducting in flight changes regarding task allocation, flight path generation and tracking, and synchronization between cooperative tasks.

7. ACL 7 (Group Tactical Goals): Mechanism that allows an unmanned robotic system to engage targets of priority by tactical importance.

8. ACL 8 (Distributed Control): The ability for an unmanned robotic system to control several subordinate systems under the control of a single operator.

9. ACL 9 (Group Strategic Goals): Mechanism that allows an unmanned robotic system to skip targets at the tactical level and engage targets by strategic importance.

10. ACL 10 (Fully Automated Swarms): Mechanism that influences multiple unmanned robotic systems based off of the modeled behavior of insects such as bees and ants. Allows one operator to control hundreds of unmanned systems.

Source: Leighton Hanon, *Robots on the Battlefield--Are We Ready for Them*? "Unmanned Unlimited" Technical Conference, Workshop and Exhibit, 20-23 September 2004 (Chicago, IL: American Institute of Aeronautics and Astronautics): 5.

Autonomous operations, allowing weapons to make decisions for themselves, is leading to armed autonomy in the unmanned combat aerial system and the unmanned combat aerial robot. This higher level of autonomy can greatly increase the productivity of an individual operator in terms of targets tracked and engaged. Additionally, it will inevitably increase the pace of war, but will impose new management responsibilities on the operator, managing a team of unmanned aerial systems, and introduce new management challenges to commanders. This higher level of autonomy raises ethical issues such as “how much autonomy should we actually give an armed unmanned system?” (Epstein 1997, 230).

Higher levels of unmanned system autonomy will allow an unmanned combat aerial system to locate and launch weapons at specific targets that are selected in advance. As discussed earlier in this chapter, this concept is an extension of the Tomahawk guidance system that adds the capability to search, locate, acquire, and engage a target. The difference is that the unmanned combat aerial system (UCAS) will carry multiple smaller unmanned aerial systems on board. Simply put, the unmanned combat aerial system will relay the coordinates of the targets to the multiple smaller unmanned aerial systems and launch them (Hanon 2004, 4).

The unmanned combat aerial robot presents a more elaborate method of engagement than the unmanned combat aerial system. The unmanned combat aerial robot allows an unmanned system to search for a target, detect and recognize the target of opportunity, and engage it. The decision to launch a weapon at the target could be made autonomously or could be approved by the human on the ground before launch. Autonomous Control Level 6 will allow multiple unmanned aerial systems to recognize multiple targets and decide among themselves what unmanned aerial system will engage the targets. This process takes a level of mission planning out of the direct control of the operator and places it within the unmanned aerial system team. Flight mission planning functions are assigned to an independent distributed computer system, rather than a computer located physically with the unmanned aerial system operator. A machine makes calculations that differ only in the location of the computer and the number of communication links used (Hanon 2004, 6).

Autonomous Control Level 9 is intended to be used with the future unmanned combat aerial robot system. The unmanned combat aerial robot will enable teams of unmanned aerial systems to assess the battlefield, the quantity of targets, the location of the targets, and the targets' threat potential, in order to determine which unmanned aerial system will engage which target and the order of engagement priority. This includes the ability to skip a low value target to engage a higher value target. At this level, the unmanned aerial system team is assigned a mission or goal and uses its combined intelligence to decide how to execute and pursue the assigned mission (Hanon 2004, 7).

The overall concept for these new systems is that they will operate autonomously and be managed as a group by a single operator. Individual unmanned aerial systems will be capable of communicating with each other and the operator during execution of the mission by exchanging sensor information, position and health information, as well as information from outside the group, to create and maintain a common operating picture of the battlefield and the targets populating the battlefield. At higher levels of autonomous control, unmanned systems will possess the capabilities to adjust its mission to attack new targets at higher values as they occur, deciding among themselves which individual entity should attack the threat based on its position, health, sensor suite, and weapons load. In general, the unmanned system team can redeploy its forces in order to maximize its performance as the battlefield situation evolves (Reinhardt, James, Flanagan 1999).

Much of this innovative autonomous mission planning described above relies heavily on the required speed and memory capacity in which a system's computer can process the real time data that is occurring throughout a robot's environment. Concept models such as Moore's Law, depicted in figure 4, illustrate a popular trend that may help explain the past development of computer processor speeds and the speculated processor speeds of the future. Unmanned systems will eventually be required to carry an extensive package of mission planning software that will require intense software development and prototyping. As explained earlier, Global Hawk already employs contingent mission software that allows the system to compensate for possible malfunctions and will systematically select an emergency airfield for landing in case the deficiency cannot be corrected in flight.

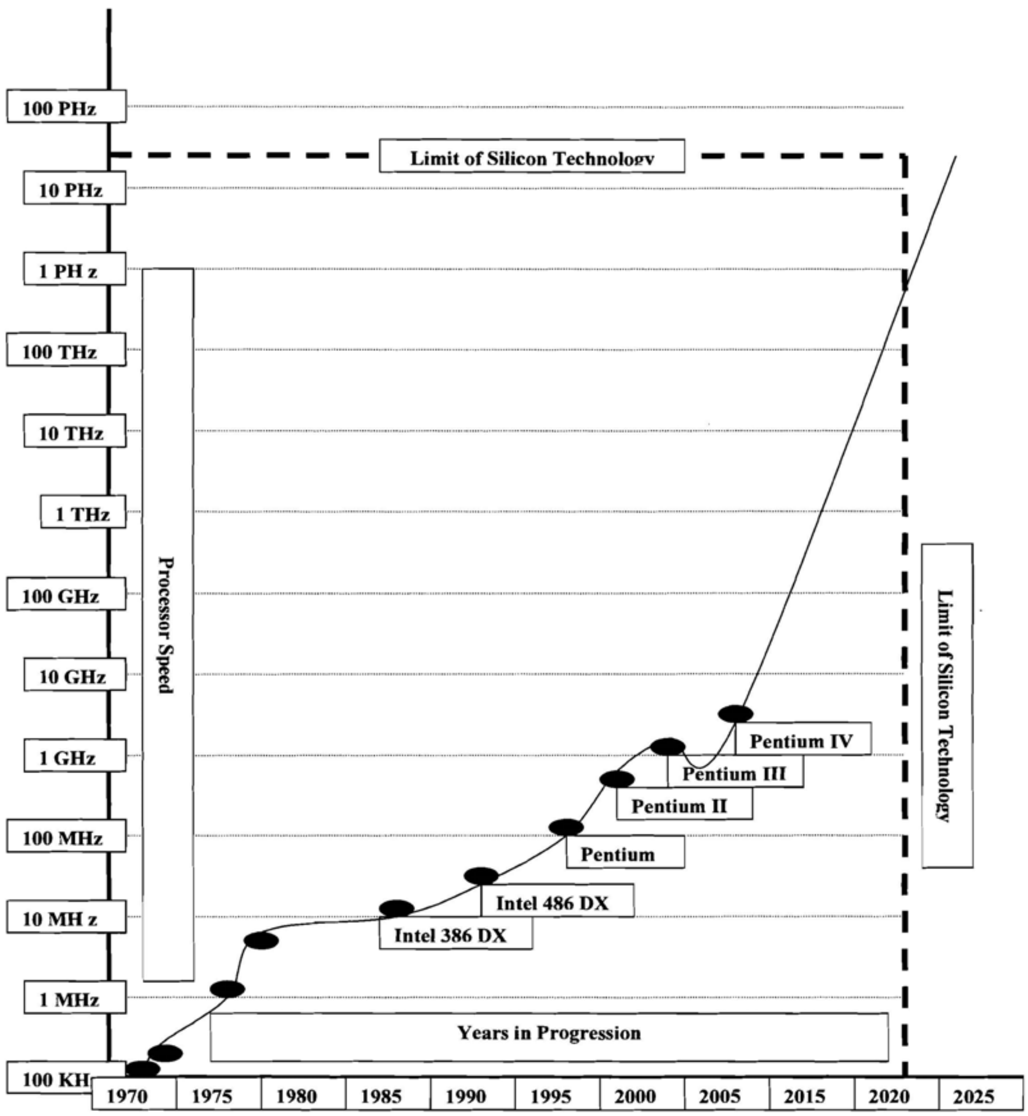

Figure 4. Processor Speed Trend from the Present to the Future
Source: Leighton Hanon, *Robots on the Battlefield--Are We Ready for Them*? "Unmanned Unlimited" Technical Conference, Workshop and Exhibit, 20-23 September 2004 (Chicago, IL: American Institute of Aeronautics and Astronautics): 6.

Legal implications for managing armed unmanned robotic systems on the battlefield greatly affect the battlefield management process and the roles and responsibilities of how human beings will be required to interact with these new weapons. Historically, as technology moved forward, necessary battlefield tasks that were traditionally performed by humans became obsolete or are replaced with new requirements arising from new technology. Occasionally, new weapon systems are also applied to missions for which systems were never originally designed. The technology running the system is simply misused or not fully understood by the users. As a result, questions pertaining to the legality of such acts may lead to the indictment for a war crime. Earlier in this chapter, we reviewed a case study involving the 1988 incident involving the *USS Vincennes* and its Aegis system. Not fully understanding the boundaries of the technology led to the death of 290 civilians. Presently, most experienced remote control unmanned aerial system operators can successfully manage four to five systems at one time. In the case of future autonomous weapon systems, the number of weapons under the control of a single operator significantly increases. Additionally, the rate at which weapons may be launched will increase greatly, limited only by the rate at which targets appear, rather than the speed in which a human operator may handle them. The speed in which command decisions must be made will increase dramatically, driven by the number of weapon systems available. Launch considerations will be constrained by an operator's reaction time. It will become increasingly difficult to leave the "man in the loop" because of the high number of decisions that will be required and the pace at which these decisions must be made. The pace of the weapons will overwhelm the mental capacity of the operator. In this scenario technology would control the man.

The dynamic capability that outlines future unmanned combat systems magnifies the urgency for the laws of warfare to keep progress with technological development. In the past, it may have been somewhat acceptable to assume some margin of legal risk associated with past technology and warfare. However, with literally thousands of variables involved with the intricacies of software development, testing, prototyping, and distribution alone, the development of a working legal framework is extremely difficult.

Today, many business workers have duties, backgrounds, and training that qualifies them as professionals, including computer programmers, systems analysts, software engineers, and database administrators. The United States Legal Code's definition of a professional is "a person who has the knowledge of an advanced type in field of science or learning customarily acquired by a prolonged course of specialized intellectual study." In many cases, depending on the particular nature of their job, not all technologists are required to perform by the same ethical principles as that of a licensed professional such as a physician or attorney that is accredited by a university or college. Before physicians and attorneys are professionally licensed, they are required to take an oath of office that legitimizes their professional obligation regarding the seriousness of responsibility and commitment that they are about to face throughout their career. Many individuals that work in the field of information technology are specialized technicians trained to perform highly detailed tasks that are very compartmentalized in nature. Their job does not require them to visualize the overall purpose of the system under programming and assembly; their job requires them to make the system functional. From a legal perspective, not every individual that works in the field of computer programming, software design, and systems analysis may be recognized as a professional because they are not licensed. Historically, many malpractice lawsuits have ruled a significant number of computer designers and programmers not liable for their malpractices simply because they do not meet the legal definition of a professional (Reynolds 2007, 35).

Lawrence Kolberg, a Harvard psychologist, found that the most important aspect of one's moral development is education. People can continue their moral development through further education that involves the examination of current issues and human behavior. An organization that develops computer software may benefit from consistently communicating a company's code of ethics from the top down. Organizations should mandate ethical education programs that encourage employees to act responsibly and ethically. Such programs may be structured in workshop formats in which employees apply the organization's code of ethics to hypothetical but realistic case studies. This process may contribute to moral standardization among all employees working in the field of computer technology. Within a corporation, clearly defining the parameters of appropriate behavior sets the conditions of what is deemed "right" and what is deemed "wrong." Overall, the existence of formal training programs regarding ethics may reduce a software company's liability in the event of legal action (Reynolds 2007, 15). Such training programs may be based off of the same principles as the Seven Army Values.

Defense technology continues to become more complex by the day. As more systems become increasingly automated, laws pertaining to software development and quality will become prevalent. Even if software is well designed, programmers are prone to make mistakes during the process of turning design specifications into lines of codes. Although defects in any system can cause serious problems, the consequences of software defects in armed autonomous systems may prove deadly. The legal concerns relating to this issue may lie between the matter of software quality and other factors such as cost, ease of use, or time it takes to bring these technologies to market. Such issues will require serious examination. According to some estimates, an experienced programmer unknowingly injects approximately one mistake into every ten lines of code. System analysts, programmers, database specialists, and project managers, are all responsible for a specific part in order to ensure that software is produced with minimal error.

Most corporations implement specific software quality control measures in those systems where safety issues are considered critical such as unmanned weapon systems. These quality control measures fall under four specific functions that serve to enforce software quality. They are risk, redundancy, and reliability. Risk is defined in this context as the probability of an undesirable event occurring times the magnitude of the event's consequences if it does happen. These consequences may include damage to property, accidental injuries to people, and accidental deaths. Redundancy is the provision of multiple interchangeable components to perform a single function in order to cope with failures and errors. Such examples may include safety features such as a computer chip that does not allow an armed weapon to launch or fire until it is properly overridden. Lastly, reliability is the probability of a component or system performing without failure throughout its use. Although the probability of failure may seem relatively low, it is important to remember that unmanned weapon systems are made up of many different parts by a number of manufacturers that abide by subtle differences regarding product testing and quality control standards (Reynolds 2007, 220).

One of the most important and challenging areas of safety for critical system design is the human interface. Depending on the design of the interface, it is possible that some designs may give the operator the feeling that there is an enormous gap between themselves and the robot in the robot's physical reaction to his or her commands, whereas a good interface design would make the user interface transparent and would give the robot operator a feeling of being in direct contact with the robot (Epstein 1997, 38).

Human behavior is not nearly as predictable as the reliability of hardware and software components that are a part of a weapon system. The system designer must certainly consider what human controllers may do to make a system operate safely and effectively. The challenge is to design a system that not only works as it should, but that leaves the operator little room for random judgment. Additional risk may be incurred if a designer fails to anticipate the pertinent information that the operator needs to know and how the operator will react, especially during an emergency. Every individual is likely to react differently during an emergency. Some may react rationally while others may panic causing a bad situation to become worse. Poor interface design between systems and humans can greatly increase risk and cause tragic consequences (Reynolds 2007, 221).

Time and again, the issue of accountability and responsibility when software fails continues to be the most common concern while considering future changes in the laws of warfare based on upcoming technological advances. The fact that many hands are involved in building software programs creates a domino affect that spreads out from the software program itself, to everyone who uses the software (Epstein 1997, xix). As a result of the increasing importance of computer technology in our everyday lives, the development of reliable effective software systems has become an area of mounting public concern. This concern has commonly led to debates on whether the licensing of computer programmers and designers would improve the quality and reliability of software. Proponents argue that licensing would strongly encourage professionals working in the computer industry to follow the highest standards of the profession and practice of the code of ethics, and that licensing would allow violators to be legally investigated. Without licensing, there are no requirements for specific standards of quality or behavior and no concept of professional malpractice (Reynolds 2007, 49).

Regardless of the degree of institutional training, system programmers are actually true products of their own objectivity and personal experiences. This is not due to the fact that they are programmers. As individual software programmers, these individuals may be highly accomplished. Nevertheless, is it truly possible for them to actually conceptualize all the complexities of an actual war zone? Additionally, how versed are they regarding the legal consequences if an unmanned weapon system accidentally inflicts an unnecessary injury or death? The software programmers are simply one set of variables out of dozens that effect the courses of law. Human machine interface, the speed of information, and the tendency to process more data than what is actually needed are all key variables with powerful implications. Many legal arguments and the adjustment of current law will indeed stem from such issues. Historically, it seems that laws pertaining to warfare have been relevant to direct human actions. In essence, humans have always been responsible for what they do or fail to do. The trend for the future seems to point toward placing responsibility on what a machine did or failed to do. If an unmanned machine was a part of a potential war crime scene on the battlefield, future laws of warfare will guide prosecutors in finding the human that was directly or indirectly involved with the unmanned machine. One may construe this particular analogy as the “man in the machine.” Conversely, having reviewed the variety of autonomous control levels that are projected to be functional in the near future, where would the line of too much autonomy be drawn? Where is the imaginary boundary that legally relieves humans from being held liable in case of an accidental war crime? We have only just begun addressing a fraction of these questions in today’s military. In the future, new legal issues that have sprung from the cases of older legal issues will likely force major changes to the Law of War. Steady advances in technology will reveal legal and ethical issues that are currently unimaginable.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

I do not fear computers. I fear the lack of them.

—Isaac Asimov

Conclusions

Looking forward, one could easily realize that it is extremely difficult to forecast what kind of world technology will bring us in the future. However, it is clear that it will be difficult to maintain laws and ethical thinking current and relevant to the latest technological milestones. Some experts agree that the speed of technology is moving so fast that the world as we know it may be subjugated to an "event horizon." The most problematic aspect of highly sophisticated weaponry is that educated psychopaths or terrorists can build them. Whether technology is used for "good" or "evil," is dependent on the intent of the user.

Just twenty years ago, the use of a simple pocket calculator was forbidden in most school systems. A student caught using a calculator was deemed as "a cheater." Presently, student use of calculators is fully encouraged by most educators. In many cases, the fundamental skills that are found in basic arithmetic such as adding, subtracting, multiplying, and dividing can be easily forgotten due to this reliance on the calculator. Currently, basic manual calculations that are used to derive an answer may be seen as too tedious or too intellectually challenging. It is much easier to let the calculator do the work. Philosophically, many scholars debate that advances in technology are taking humanity into an existence of complacency and laziness. Mankind's identity and ability for self-preservation are slowly becoming replaced by reliance on an artificial cyber world. Many individuals today may be the earliest examples of such a world, as those who participate in “virtual reality” computer programs in order to escape the world in which they live. Images of the 1992 movie “Lawnmower Man” come to mind. “Lawnmower Man” depicted the story of a mentally challenged young man who was constantly tormented by the public and escaped reality by participating in “virtual reality” on his friend’s home computer. Within the young man’s “virtual reality,” he was the “king of the world;” and as a result, he did not ever want to return to the “real world” again. Although this example is merely science fiction, it helps illustrate the general idea. In essence, man becomes lost in the machine. Additionally, the personal values that make him or her an individual disappear; again--man becomes the machine.

In his book, *The Case of the Killer Robot*, Richard Epstein explores the question of “what will be the impact on human abilities as technology progresses?” Epstein uses a hypothetical example of a computer system that composes music considerably better than any human on Earth. As a result, listeners do not want to listen to any more music composed by human composers. They only want to listen to music generated by the computer. Music composed by human composers becomes obsolete and all musicians who compose and perform music are pushed aside by the public’s enthusiasm for the computer-generated music (Epstein 1997, 229). The concept of computers doing almost everything that is intellectually challenging certainly has powerful implications regarding future laws of warfare. Humans may end up as mere slaves to an encompassing network of intelligent computers that intrude on every aspect of human life. Laws that are created by humans may be forced to impose limitations on our own technology (Epstein 1997, 230).

Complete weapons automation has appeared both very practical and necessary in air warfare where the environment is relatively simple and speeds are very great (Van Creveld 1991, 241). The best classic example of complete weapons automation has been the strategic nuclear missile defense systems that were implemented during the Cold War between the United States and the former Soviet Union. The concept of these systems entailed the identification of an enemy attack followed by an automatic launch sequence that was designed to launch dozens of nuclear missiles at each nation's strategic targets. Such a concept was eventually deemed "unlawful" and then disbanded due to the numerous false alarms and false detections of "ghost targets" that were commonly caused by flocks of geese flying in the search path of a system's radar fan. As a result, laws and policies replaced the automated freedom of the entire missile defense system with human intervention. In essence, any requirement pertaining to launching nuclear missiles was subjected to human decision making and manual "button pushing" to prevent the risk of nuclear disaster. This particular case offers a clear example regarding machines with too much autonomy (Van Creveld 1991, 242).

The task of updating current and future law will undoubtedly remain a continuous process in a world where the wealthier nations have a tendency to obsess over new and improved weapons. Since 1945, the term "war" itself has acquired an unsavory connotation. Following the laws that govern the usage of "politically incorrect" words, it has tended to be taken out of our vocabulary. Changing the name of a particular battlefield effect or the name of a particular weapon seems to be a common practice in order to conform to modern war terminology. Reading any number of articles about military technology or advertisements published by the defense industry, one would never guess that the purpose of weapons is to “kill.” Instead they are presented much like the newest appliances or the latest power tools. Like any other gadget, weapons are considered to derive their fascination from the sheer engineering skill that goes into developing them and the power of the weapon resulting from that skill. The terminology associated with describing battlefield effects has been softened in order to conform to modern culture. For example, “kill” has been replaced with “lethal,” instead “firing on a target” we now “engage the target,” and the term “enemy” is now replaced with the term “combatant” (Van Creveld 1991, 293). In summary, the terms mentioned above suggest that technology may be transforming war into a game of adventurism. Laws will become a “check and balance” measure in order to preserve the value of life itself and remind society that no human being is less valued than another. This principle will become even more important as unmanned robotic systems begin to do increasingly more wartime “dirty work” for humans.

Removing the human from the fight and allowing unmanned machines to do the killing may promote a society that becomes desensitized to violent conflict and dehumanizes its enemy. Within the past twenty years, this concept has already become a reality as more television programs, movies, and video games depict a dramatic increase in violence. The degree of graphic images that unmanned machines could bring into American living rooms is unimaginable. The content of the latest reality television programs or most current news footage could be dramatically enhanced as unmanned robotic systems transmit live video feeds from the battlefield by a high-definition camera installed on the machine itself. Presently, we are not far from such a construct. Ethically, how would our adversaries view us? Currently, in Operation Enduring Freedom and Operation Iraqi Freedom it is deemed unlawful for soldiers to keep photographs of deceased enemy or friendly personnel. Photographs of this nature are always deemed classified and are normally used in official legal investigations. Will similar laws and policies be implemented pertaining to such photographs and video footage that were obtained by unmanned robotic systems?

Throughout history, nations have attempted to lawfully restrict technological advances in weapon systems. This has occurred since at least 1139 when the Lateran Council attempted to outlaw the crossbow (Casagrande 1993, 10). The underlying reasons for such restrictions were rooted in a sense of chivalry. In essence, the laws of armed conflict remain as a set of moral standards (Kaszuba 1997, 28). In the past, warfare has taken advantage of the latest technological innovations to gain decisive advantage over the enemy. Future wars will undoubtedly reflect the same trend. The ever-increasing accuracy of standoff weapon systems will continue to increase the options of targeting an adversary before he is are able to respond or realize that he was engaged.

Treaties as well as the Law of Armed Conflict (LOAC) regulate the use of force during armed conflict. Weapons systems, including small arms, ammunition, and cruise missiles are subject to a legal review in order to ensure compliance with the Law of Armed Conflict. Once declared legal, the employment of these weapons may be further controlled by Rules of Engagement and the concept of discriminate use of force. Unfettered civilian death and destruction can easily impair the restoration of lasting peace. The influence of the media has added to the political reactions and a perception of excessive civilian casualties. Law of Armed Conflict considerations have been incorporated into each aspect of weapon's design and employment. The laws of warfare will allow unmanned robotic systems to operate as human extensions in the contemporary operating environment. However, unmanned robotic systems become more technologically complex, laws that govern the design and production of these systems will likely become more stringent. Such actions may be considered safety measures as more unmanned robotic systems are introduced into the United States' weapons arsenals. As a generic example, over ninety years ago, the first automobiles did not have the safety features or environmental specifications that currently exist in present day cars. As automobiles became more common and increasingly more threaded into society, more auto production specifications were mandated by law. The difference between the number of automobiles on the nation's roads ninety years ago and the number of cars on the road today have called for a significant increase in the laws that regulate public safety in order to reduce the number of injuries and fatalities resulting from automobile accidents, and the installation of carbon monoxide and nitrogen oxide control features that decrease environmental pollution.

Automated weapon systems have been a large part of the United States military for nearly thirty years. As stated in chapter 4, systems such as the Patriot, Aegis, and mines are weapon systems that have clearly demonstrated various degrees of autonomy in one aspect or another. There is massive spending and research taking place in order to eventually take the human "out of the loop" in order for unmanned robotic systems to operate autonomously. Unmanned robotic systems that can independently locate their target and destroy them without human intervention are no longer concepts of science fiction, but reality. The move to autonomy may be required to accommodate current United States military plans. One of the main goals of the Future Combat Systems (FCS) project is to use unmanned robotic systems as force multipliers so that one Soldier in the contemporary operating environment can be the nexus for initiating a large-scale unmanned robotic system attack from the ground and the air. Obviously, one Soldier alone could not possibly control multiple unmanned robotic systems at one particular time without at least some degree of autonomy (Sharkey 2008, 87).

Currently, the overarching issue regarding autonomy and unmanned robotic systems is that no particular autonomous or artificial intelligence system currently has the necessary skills to discriminate between combatants and innocents. Allowing them to make the decision on who to kill would fall short of the ethical principles of a just war under *Jus in Bello* as reflected in the Geneva and Hague Convention and the many protocols designed to protect civilians, wounded Soldiers, the sick, and captives. Presently, there are no artificial sensing or visual systems that can solve this problem. Sensors such as cameras, sonars, lasers, and temperature sensors may be able to identify the characteristics of a human, but cannot distinguish the difference between “combatant” and “innocent.” The principles of discrimination and situational awareness must be applied to this problem. Understanding someone else’s intentions and predicting their likely behavior in a particular situation are learned skills that are extremely difficult for humans to understand and even more so for machines. Human behavioral cues can be very subtle and there are an infinite number of circumstances where lethal force is inappropriate (Sharkey 2008, 88).

Presently, in Operation Iraqi Freedom and Operation Enduring Freedom, the use of unmanned robotic systems in the contemporary operational environment has reflected exceptional results in targeting combatants. In the foreseeable future, unmanned robotic systems will be subjected to the process of human intervention while using lethal force. Acting as direct extensions of the human Soldier is perhaps the most likely role of the unmanned robotic system until ethical and legal issues have been clearly identified and solved.

Unmanned robotic systems can conceivably abide by the current laws of warfare better than humans during violent conflict. Throughout history, battlefield ethics has been a serious issue for the conduct of military operations. Breeches in military ethical conduct often have very serious political consequences as evident from situations such as My Lai in Vietnam and Abu Ghraib in Iraq. Such incidents undoubtedly cause significant damage to the United State's public image worldwide. As the military continues to move forward at its current rate towards the deployment of unmanned robotic systems, the United States' military must ensure that when these systems are deployed they are employed in a manner that is consistent with current laws. Ethical and legal considerations regarding unmanned robotic systems may include principles such as the right of refusal in the case of unlawful orders, the capability to report unethical behavior to higher headquarters, and the ability to incorporate existing battlefield protocols such as the Geneva Convention, Rules of Engagement, and Codes of Conduct. Human emotions that trigger clouded judgment and condone self-preservation do not affect unmanned robotic systems. Emotions such as rage, revenge, and anger that are normally prevalent during violent conflict are unable to influence the behavior of an unmanned system.

In conclusion, any writing pertaining to "robots" is probably not complete without mentioning the "Three Laws of Robotics," written in 1942, by the famous science fiction writer, Isaac Asimov. In his book, *I Robot*, Asimov writes three rules that all "robots" must obey. The first rule is "a robot may not injure a human being or, through inaction, allow a human being to come to harm." Second, "a robot must obey orders given to it by human beings, except where such orders would conflict with the First Law." Last, "a robot must protect its own existence as long as such protection does not conflict with the First or Second Law." Today, such laws seem somewhat ridiculous and oversimplified. However, in 1942 it is certain that these laws were solid principles that existed during a time where "robots" were topics of mere fiction and wild imagination. Ironically, "robots" of today have already broken a portion of Asimov's First Law: "a robot may not injure a human being" (Rogers 2006). Will humans allow this trend to continue?

Recommendations

The most outstanding unsolved issue regarding the effective and lawful use of unmanned systems has been the lack of connectivity in order to successfully allow a nation's unmanned robotic systems to communicate with those of other nations and provide viable information to commanders. Alliances between the United States and Great Britain (as well as other key allies) pertaining to world security will eventually mandate such efforts. Additional challenges include the development of integrated command and control networks that allow for total digital connectivity with multiple battle command systems. Clear visualization of the common operating picture (COP) provided by an unmanned robotic system's intelligence, surveillance, and reconnaissance

(ISR) capabilities continues to be a challenging process as commanders require more intelligence data in an increasingly complicated environment.

Today, the most common function of unmanned robotic systems is as extensions of the warfighter. In essence, a human remains in control of the unmanned system at all times. In the near future, human intervention is inevitable until the issues of discrimination and proportionality are resolved. Presently, the level of technology and the degree of artificial intelligence that is required to make such distinctions simply does not exist.

The importance of software standardization for unmanned robotic systems is a critical area for further analysis. Standardized procedures regarding software design, production, and testing are variables that are subjected to very sparse legal guidelines or, more likely, no legal guidelines at all. To begin the analysis of such a complicated issue, proposed training models pertaining to a software company's standards of ethical guidelines may be significant. As modern society and culture become more dependent on technology and robotic systems become a larger facet of our everyday life, the development of a professional code of conduct or oath of responsibility may be crucial regarding information technology providers to ensure that the laws of warfare are followed to the greatest extent possible.

In summary, recommendations from this research regarding future unmanned robotic systems are as follows:

1. The United States military's increased use of unmanned robotic systems will not significantly change the current laws of warfare in relation to conduct during violent

conflict or the justification for going to war. However, laws that govern the design and production of unmanned robotic systems will eventually require revision.

2. Unmanned robotic systems will remain under the control of human operators until the issues of automated discrimination and proportionality can be resolved.

3. Unmanned robotic systems possess the ability to abide by the current laws of warfare better than humans.

4. As technology pertaining to unmanned robotic systems becomes more complex, policies and protocols that outline the process of software production will be forced to become more stringent.

All the information presented in this thesis is unclassified and freely available to the public. A further, and more thorough analysis on the legal and ethical implications of the use of unmanned robotic systems in the current operational environment will likely require access to classified data.

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