UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

SOLDIER AND ROBOT INTERACTION IN COMBAT ENVIRONMENTS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

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Norman, Oklahoma
2012

SOLDIER AND ROBOT INTERACTION IN COMBAT ENVIRONMENTS

A DISSERTATION APPROVED FOR THE
GRADUATE COLLEGE

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ACKNOWLEDGEMENTS

A special debt of gratitude is due Dr. Scott Gronlund who continued to provide incentive and enthusiasm as work of the dissertation progressed. Special thanks are offered to Dr. Joseph Rodgers who offered support and friendship. I am grateful to Dr. Tom Boyd, Dr. Randa Shehab, and Dr. Rick Thomas for their assistance and support.

The associates of The RAND Corporation were particularly supportive and cooperative in the pursuit of this dissertation, with special thanks to Mr. Tim Bonds, Mr. John Matsumura, Dr. Matt Lewis, and Mr. Bruce Held.

Special thanks to the associates of DAMO-CIA, who sponsored the study and the leadership of Program Analysis and Evaluation, particularly Lieutenant General Joseph Martz, Major General Thomas Spoehr and Colonel Ilean Keltz, who put relentless pressure on me to complete this dissertation and get back to work.

Special recognition goes to my father, Dr. William Kolb, who earned his Ph.D. at age 47, and my mother, Patricia Kolb, who earned her Bachelor of Arts at age 35, for demonstrating that one is never too old to learn, achieve, and contribute knowledge to the world.

Finally, I wish to thank my wife, Wendy, and my children: Margarita, Michael, and Mikayla, all of whom respected the decision to undertake the dissertation, tolerated the resultant confusion and disruption of their personal lives and who greeted the completion of the dissertation with unconcealed gratitude and glee.

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Abstract

The purpose of this research was to examine the dynamics that form when humans and robots work together in a high-stress combat environment, and compare and contrast these bonds to human-to-human bonds that are formed under the same conditions. Based on the somewhat limited literature that demonstrated human-to-robot emotional bonding among a civilian population and anecdotal press reporting of soldiers bonding with their robots under combat conditions, the author hypothesized that not only would soldier-to-robot bonding occur, but that it would be exacerbated under combat conditions. To test this hypothesis, the author surveyed several hundred robot users in the military (primarily Army) community. The results of the survey demonstrated that soldiers showed little to no proclivity to bond with their robots under any conditions. Although some expressed fondness for working with robots, they recognized the current limitations of the tele-operated robots in use today and pragmatically viewed their robots as life-saving instruments, and in most cases would not hesitate to allow the robot to be destroyed if it meant saving the lives of other military service men or women. The majority of respondents viewed robots as tools that would absolutely save lives as their future usage increased and most were very supportive of increased use. The study includes a chapter on the ethical implications of robotics in combat as well as a chapter on the political, military, and business cases for increased military application of robots. The results have implications for future Army leadership training for both human and robot soldiers, as the trend towards a larger role for autonomous or semi-

autonomous machines to do the Army's dull, dirty, and dangerous jobs is likely irreversible.

Glossary of Acronyms

AI	Artificial Intelligence
AMAS	Autonomous Mobility Appliqué System
ANS	Autonomous Navigation System
ARCIC	Army Capabilities Integration Center
ARV-L	Armed Robotic Vehicle-Light
COIN	Counter-Insurgency
CONUS	Contiguous United States (lower 48)
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
EOD	Explosive Ordnance Disposal
FCS	Future Combat System
IED	Improvised Explosive Device
KIA	Killed In Action
MOS	Military Occupational Specialty
MTOE	Modified Table of Organization and Equipment
NCO	Non-commissioned Officer
NREC	National Robotics Engineering Center
OCONUS	Outside (the) Contiguous United States
OPTEMPO	Operational Tempo
OPV	Optionally Piloted Vehicle
OSD	Office of the Secretary of Defense

POTUS	President of the United States
RPG	Rocket-Propelled Grenade
RPV	Remotely Piloted Vehicle
RSJPO	Robotics Systems Joint Project Office
SUGV	Small Unmanned Ground Vehicle
TARDEC	Tank Automotive Research, Development and Engineering Center
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UGS	Unattended Ground Sensors
UGV	Unmanned Ground Vehicle
USA	United States Army
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
UV	Unmanned Vehicle
VBIED	Vehicle-Borne Improvised Explosive Device

Chapter I

Nature and Purpose of the Study

Introduction

Marine Master Sergeant Ted Bogosh recalls one rainy January day in 2005 at Camp Victory, near Bagdhad, Iraq. That day, a Navy Explosive Ordnance Disposal (EOD) technician walked into the repair shop MSG Bogosh headed. In his hands was a box containing the remains of his robot counterpart, whom he had named "Scooby-Doo." Scooby-Doo, while attempting to disarm an Improvised Explosive Device (IED), had been blown into pieces. "There wasn't a whole lot left of Scooby," recalls Bogosh, "The biggest piece was its 3-by-3-by-4-inch head, containing its video camera. On the side had been painted 'its battle list, its track record.' This had been a really great robot." Bogosh informed the technician that Scooby Doo was beyond repair and offered him a new replacement robot. The veteran explosives technician was visibly upset. He insisted he did not want a new robot. He wanted Scooby-Doo back (Garreau, 2007).

Eight years ago, other than a handful of Unmanned Aerial Vehicles owned by the CIA, the Army did not have a single robot being utilized in the wars in Iraq and Afghanistan. As the Army's human casualty count continued to rise, ground robots manufactured by Massachusetts technology firms iRobot and Foster-Miller began to be introduced into theater, as well as an expansion of aerial robots manufactured by AeroVironment and AAI Corporation. These early robots had limited Artificial

Intelligence (AI) and were primarily remote-controlled by human operators for Improvised Explosive Device (IED) detection, defusing and disposal and aerial reconnaissance. Based on early successes, more robots were ordered, and recent generations have demonstrated significant improvements in AI and autonomy.

Humans have long displayed an uncanny propensity to make emotional connections with machines. For generations, car owners have named their vehicles. Boat owners almost universally name their watercraft. Now that our machines are able to display elements of intelligence, it is likely that emotional bonds will strengthen, especially when humans credit robots with saving their lives in combat. This study will look at the dynamics that form when humans and robots work together in a high-stress combat environment, and compare and contrast these bonds to human-to-human bonds that are formed under the same conditions. The results will have implications for future Army leadership training for both human and robot soldiers, as the trend towards a larger role for autonomous or semi-autonomous machines to do the Army's dull, dirty, and dangerous jobs is likely irreversible.

Purpose of the Study

This study will examine how United States Army human soldiers interact with their robotic partners and form emotional bonds. It will attempt to resolve the following questions:

1.) Do human soldiers form emotional bonds with autonomous or semi-autonomous robots?

2.) If so, is emotional bonding more likely to occur with Unmanned Aerial Vehicles (UAVs) or Unmanned Ground Vehicles (UGVs)?

3.) If bonds are formed, are they as strong as emotional bonds formed between human soldiers?

4.) Does the stress of combat strengthen these bonds?

Based on literature review, I advance the following hypotheses to be tested:

1.) Human soldiers do form emotional bonds with their robotic counterparts.

2.) The bonds humans form with robots will not be as strong as those bonds formed with other humans.

3.) Strong bonding with robots is more likely to occur with soldiers who operate UGVs than with soldiers who operate UAVs.

4.) Combat affects the intensity of bonding towards both robots and humans; more intense bonding will occur in a combat environment than in a non-combat environment.

There is currently no academic research on the interaction between soldiers and robots that has been published. Obviously, any bonding that took place would be one-way; robots cannot return affection nor experience emotion, as least not at this stage in AI development. They can, however, express artificial emotions, which is a key variable in the framework developed for this study. As we will see in the literature review, most research in the social sciences arena of combat robotics development centers on the ethics of armed robots potentially killing humans. As such, this study is an initial one, and could identify further questions for future study.

Implications of the Study

Scenario: *There are armed enemy fighters concealed in an elaborate cave system in the side of a mountain in Afghanistan. The only possible way to kill or capture these fighters is to go in after them, a very dangerous mission that may result in U.S. casualties. The squad leader assigned to this mission can either send in the squad's robot or a human member of the squad, PFC Johnson. The robot, named* Sergeant Battlebot *by the squad, has been with the squad for six months and has disarmed over two dozen improvised explosive devices, saving the lives of members of the squad in the process. If the robot were destroyed, the squad would not receive a replacement for more than 60 days. PFC Johnson, on the other hand, has proven to be a complete screw-up. He is disliked by everyone in the squad, and his careless actions have put squad members' lives in danger more than once. If he was killed or wounded, the squad would have a replacement within 24 hours. Does the squad leader send the robot or PFC Johnson into the cave?*

This hypothetical scenario was given to me at a presentation I made at The RAND Corporation in October of 2010. Although there is limited existing doctrine on the employment of robots in combat, the general prevailing idea within the military is that human life will always be valued higher than 'equipment,' and having robots conduct the most dangerous combat missions is the overarching reason combat robots are employed on the battlefield. However, if soldiers and leaders view these robots as valuable members of the team, perhaps even establishing an emotional bond with them, these robots may not be utilized as intended.

The Role of Robots in Combat

"To me, the robot is our answer to the suicide bomber." – Bart Everett, early robotics pioneer.

Militaries across history have been slow to adapt evolving technologies into commonly accepted tactics, frequently at their peril. Lieutenant Colonel George Custer failed to take available Gatling machine guns to his encampment at Little Big Horn, which, if used, may have saved his battalion from extinction at the combined hands of the Lakota, Northern Cheyenne, and Arapaho warriors. Although the British invented the tank, much of the world's cavalries remained on horseback until the Germans successfully integrated battle tanks into their deadly successful *Blitzkrieg* technique that brought much of Europe to its knees in the late 1930s and early 1940s. Perhaps the most potentially dangerous example of failure to adapt a new technology was the successful development and fielding of nuclear weapons in 1945. For years and years, the Pentagon viewed nuclear weapons as just another big bomb that could be integrated in our war fighting strategy, despite the likelihood of a humanity-altering result. My father still recalls his F-105 fighter jet being equipped with air-to-air nuclear missiles in the late 1950s; the idea was to explode a nuclear warhead in the path of a Soviet bomber formation. There were several drawbacks to this strategy, not the least of which was the electromagnetic pulse (EMP) that would have also destroyed my father's jet. It wasn't until the early 1970s that the nuclear powers of the world began to view nuclear weapons as something to have, not something to use. As late as 1992, I was a platoon leader in a nuclear-capable LANCE missile battalion in Crailsheim, Germany. The

LANCE had only an 80 kilometer range, but the nuclear warhead had up to a 62-kiloton nuclear yield, meaning the launchers would have felt the blast effects. Cooler heads eventually prevailed with the fall of the Berlin Wall and the collapse of the Soviet Empire, and now nuclear weapons are primarily viewed as a deterrent.

With the lesson of nuclear weapons, it is important the military develop policy for employment of robotics, particularly because of the rapid increases in robotic technology. Robots will not only change *how* we fight wars, but they will also change *who* does the fighting. The diagram below shows the U.S. military's vision for the capabilities of various planned unmanned systems through 2032.

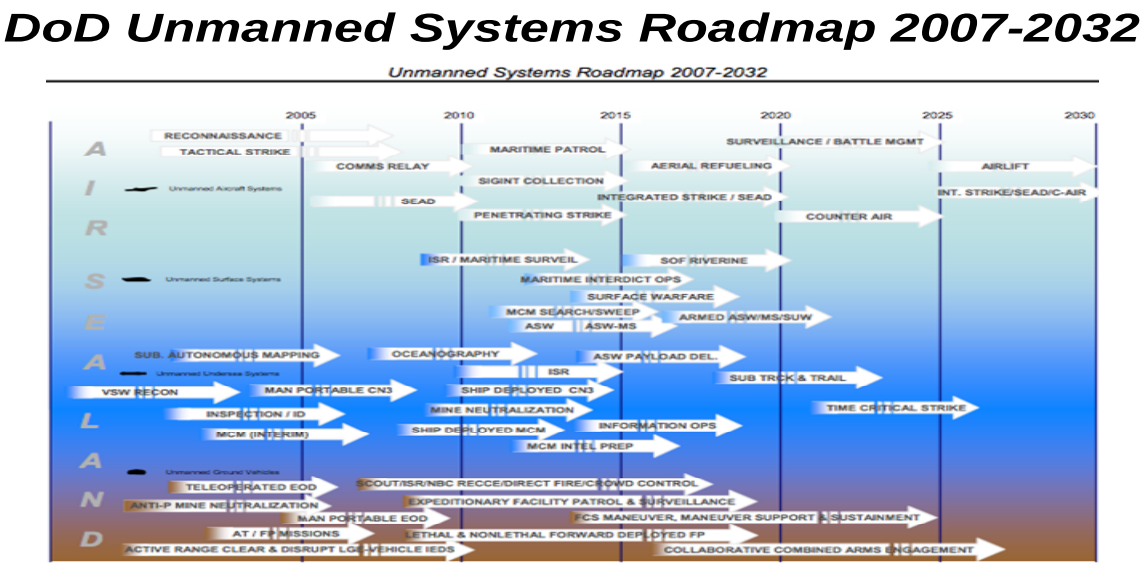

Figure 1: DoD Unmanned Systems Roadmap

The diagram below shows the Army's planned ground robotics capability sets. Of particular note is the movement towards robotic squad members, which will actually replace, not supplement, human soldiers on the battlefield.

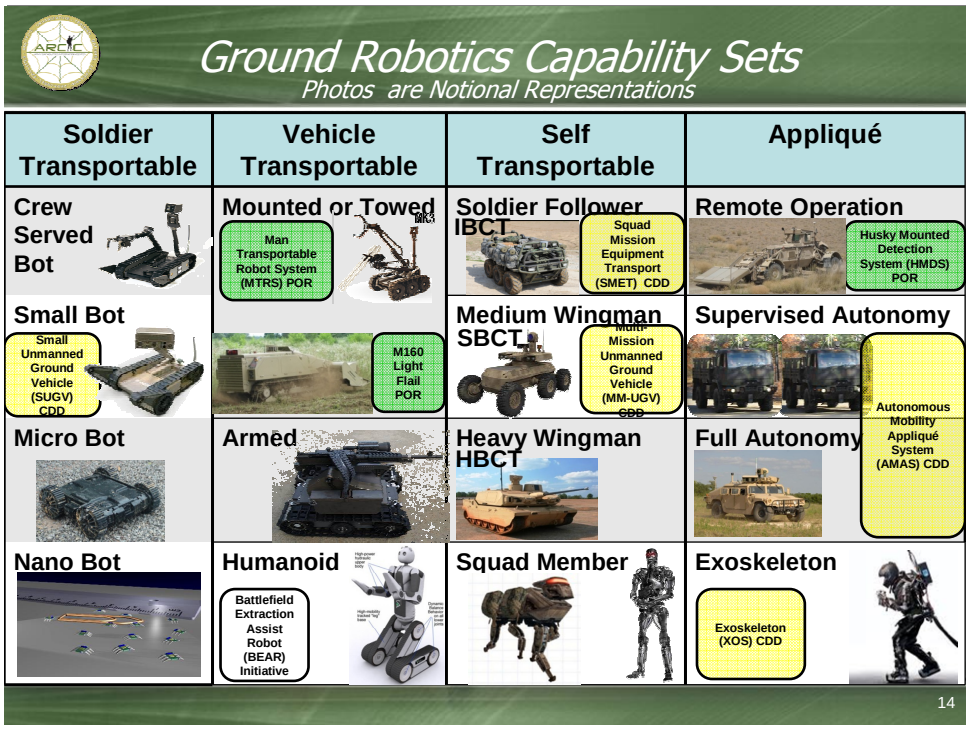

Figure 2: Ground Robotics Capability Sets

This study will examine the relationships soldiers currently have with their robotic counterparts, and will establish a baseline for future research into the employment of robots onto the battlefield. By studying the social science side of this issue now, the academic and scientific community will able to keep up with the human factors associated with the exponential technological advancements in artificial intelligence and robotics.

Implications for Army Leadership

Developing the right doctrine for using unmanned systems is essential to the future of the Army. At this writing however, there is little doctrine to be implemented, let

alone a right or wrong one. In a 2004 survey of military officers (Finkelstein & Albus, 2004) about robots' future in war, the officers identified developing a strategy and doctrine as the third *least* important aspect to figure out (only ahead of solving inter-service rivalry and allaying allies' concerns). Meanwhile, the capabilities of these robotic systems continue to advance both in intelligence and lethality. The purpose of this study was to start a baseline from which to expand the social science side of combat robot technology. If I found that soldiers are beginning to anthropomorphize and bond with their robot counterparts, it will show that these AI beings should no longer be viewed as equipment, but rather as surrogate soldiers, which will be able to eventually independently conduct combat operations. This would have profound impact on how doctrine is written and how AI systems are employed on the battlefield. Leadership instruction would have to be adapted to train 'leaders who lead robots' and must be flexible and adaptable enough to utilize the strengths and mitigate the weaknesses that the AI systems bring to the fight.

Definitions

The definition of what constitutes a robot continues to bedevil researchers. Some feel that a robot must have complete decision-making autonomy, but that definition is too broad for the study of human-robot combat interaction, because there are no robots in the military inventory that have such advanced AI as to be fully autonomous, nor is it in the military's interest at this time to allow a machine to make life-or-death decisions.

For the purposes of his study, a robot must be a man-made device with three key components: "sensors" that monitor the environment and detect changes in it, "processors" or "artificial intelligence" that decides how to respond, and "effectors" that

act upon the environment in a manner that reflects the decisions of the processors. (Singer, 2008) Robots can be classified by their levels of autonomy, which is the system's ability to operate without any form of external control for an extended period.

Remote-controlled systems are rudimentary and have virtually no autonomy. These systems are controlled line-of-sight by their human operators and typically function over very short ranges.

Tele-operated systems are similar to remote-controlled systems in that they require an operator to monitor, but have one or more integrated sensors used for navigation and other specific tasks. Tele-operated systems represent the bulk of the unmanned systems currently in use by the Army in Afghanistan.

Semi-autonomous systems require the robot to use onboard sensing and processing to control some functions, with GPS waypoint navigation being the most common. The Grey Eagle UAV is an example of a semi-autonomous system.

Fully autonomous systems require no input from an operator other than a mission directive. A fully autonomous robot would make all decisions about how to accomplish the mission. The Army utilizes no fully autonomous robots and is unlikely to do so in the near term.

The tele-operated and semi-autonomous devices described below meet the definition of a robot. It should be noted that a machine need not be mobile to be considered a robot, but all of the robots included in this study are mobile.

The robots most often mentioned in this study are:

1. iRobot Packbot series. These Unmanned Ground Vehicles are both the most popular and the most intelligent of combat robots in use by the Army, with over 2000 currently in use in Afghanistan. There are three main variations- the Packbot 510, which is used to disarm explosive devices, the Packbot Explorer, which is used for reconnaissance, and the Packbot Scout, which is lightweight (able to be carried in a backpack) version of the Explorer.

Figure 3: iRobot Packbot 510

All three versions of the Packbot are primarily tele-operated, with autonomous capability when required. The Small Unmanned Ground Vehicle (SUGV) is a variant of the Packbot.

2. Foster-Miller TALON series. These UGV robots have less AI incorporated in their systems and are designed primarily for tele-operation. They perform

similar missions to the Packbots, and were the first to be armed with lethal weapons with the Special Weapons Observation Reconnaissance Detection Systems (SWORDS) variation

Figure 4: Foster-Miller SWORDS with M249 machine gun

3. AeroVironment RQ-11 Raven. This popular UAV is launched by hand and is designed for short-range aerial reconnaissance missions. It is primarily tele-operated, but can fly completely autonomous missions using GPS waypoint navigation. It has flight endurance of 80 minutes and a range of about 10 kilometers.

Figure 5: U.S. Army soldier launches a Raven UAV

4. AAI Corp. RQ-7B Shadow. This UAV has a maximum flight time of six hours and a maximum range of 125 kilometers. Like the Raven, it is used primarily for reconnaissance, although it can be armed with one or two air-to-ground Hellfire missiles. It is launched on a rail. It is primarily tele-operated, although it lands itself and can fly autonomous missions using GPS waypoint navigation.

Figure 6: RQ-7B Shadow in flight

5. General Atomics MQ-1C Grey Eagle. A Medium-Altitude Long-Endurance (MALE) UAV, the Grey Eagle is a variant of the MQ-1 Predator and was developed for Army use. The Grey Eagle is capable of operating for 36 hours at altitudes up to 25,000 feet with an operating range of 200 nautical miles. This aircraft can carry a payload of 800 pounds and can be armed with AGM-114 Hellfire missiles and GBU-44/B Viper Strike guided bombs. At least four weaponized Grey Eagles have deployed to Afghanistan.

Figure 7: MQ1-C Grey Eagle in flight

The Army does use other robotic systems, but these five are the most likely to have been used in combat by the surveyed soldiers.

Artificial Intelligence

The term "Artificial Intelligence" was likely coined by McCarthy (McCarthy et al., 1955), a Dartmouth College professor. The definition of artificial intelligence (AI), like the definition of robot, is in dispute. McCarthy defined it as "the science and engineering of making intelligent machines" (McCarthy, 2007). For some, the definition of a machine's intelligence depends on a comparison with a human. They argue that a machine is artificially intelligent if it can do a task that requires some measure of intelligence for a human to do. Turing (Turing, 1950) designed a simplistic test of a machine's ability to exhibit behavior. In his original illustrative example, a human judge engages in a natural language conversation with a human and a machine designed to generate performance indistinguishable for that of a human being. All participants are separated from one another. If the human judge cannot reliably tell the machine from the human, the machine is said to have passed the test. Turing predicted

that machines would eventually be able to pass his test and estimated that by the year 2000, computers with approximately 120 megabytes of memory (far, far less than the average smart phone) would be able to fool thirty percent of human judges in a five-minute test. To date, despite having computers with significantly more memory than 120 megabytes, no machine has passed Turing's test (Turing, 1950). For the purposes of this study, I will define AI as a system that perceives its environment and takes actions that maximizes its chances of success, which dovetails with our definition of robot.

The capabilities of AI are now increasing at an exponential rate, much in the way computing capacity increased in the past thirty years. Moore's Law stated in 1965: "The complexity for minimum component costs has increased at a rate of roughly a factor of two per year. Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years. That means by 1975, the number of components per integrated circuit for minimum cost will be 65,000. I believe that such a large circuit can be built on a single wafer" (Moore, 1965). Historic data shows exponential patterns beyond Moore's Law, particularly in the realm of technology and biotechnology. Both wireless capacity and optical capacity have doubled every 12 months or so. In May of 1997, IBM's Deep Blue computer was the first computerized chess-playing system to defeat a human reigning world chess champion, Garry Kasparov (Friedel, 1997). In 2005, a robot designed by Stanford University robotics students won the DARPA Grand Challenge by driving autonomously for 131 miles along an unprogrammed desert trail (Russell,

2006). Just two years later, a team from Carnegie-Mellon University won the DARPA Urban Challenge by designing a robot that was able to autonomously navigate 55-miles of urban-like streets while responding to traffic hazards and adhering to all traffic laws (Belfiore, 2007). In February of 2011, IBM's Watson computer appeared on the quiz show *Jeopardy!* and defeated two human *Jeopardy!* champions, Brad Rutter and Ken Jennings. Jennings responded by writing "I, for one, welcome our new computer overlords" along with his final answer (Markoff, 2011).

If predictions of the exponential growth of AI are accurate, the capabilities of the most advanced artificially intelligent machine could quite possibly match those of an adult human shortly before mid-century. We're not there yet, however, and one of the purposes of this study is to explore how humans interact with the low-level AI that exists today. By the time the study results are published, they will be dated, due to the fielding of more artificially intelligent robots. However, the predictive framework advanced in this study may show how humans will change the strength or character of their attitudes towards their robotic counterparts when the variable of intelligence and/or autonomy is changed. Study of human-robot interaction will need to be an important and evolving field if social scientists hope to keep up with technological advancement.

What the Study is Not

This study does not attempt to comment on the morality of war. I have included a chapter on the morality of using robots in combat simply because that is the first

question I am asked by almost everyone when I tell them I am a military robots researcher.

I am a career Army officer. My job is to provide national security for the citizens of the United States. When war, a violent action similar to war, or operations other than war are decided upon by Congress and the President, my job is then to figure out, in association with my brothers-in-arms from the Army and our sister services, how to successfully bring hostilities to a close while accomplishing the national objectives set forth by our civilian leaders. Implied in that mission is that we accomplish these objectives with minimum loss of lives to United States citizens and all non-combatants. In the austere budgetary environment that the U.S. currently finds itself in, a tertiary objective is to accomplish these national objectives in the most cost effective manner possible. A separate chapter outlines the political, military, and economic cases for increased use of robots in combat.

Chapter II

Review of Related Literature

There is no literature on soldier-robot combat system interaction. The Army has done no research on the human aspect at all. This is a baseline study on how soldiers interact with their robotic counterparts.

There is, however, some literature on human-robot interaction, although the subjects studied are not soldiers and the robots studied are not designed for combat operations. The related literature discussed in this chapter, along with anecdotal press accounts of soldier-robot interaction, formed the hypothesis of this study.

The term "robot" was coined by Czech playwright Karel Čapek in his 1921 play *R.U.R. (Rossum's Universal Robots).* The term was a derivative of the Czech word *robota*, which described the work that a peasant owed a landowner and also had the dual meaning of "drudgery." A *robotnik* is a peasant or a serf, and *rabota* was the old Slavic word for slave (Singer, 2009). Čapek's play began with the robots performing labor for their human masters and ended with the robots revolting against their creators and exterminating the human race, which has become a common theme for science fiction writers.

The science fiction author that wrote most often about robots in the 20th century, Isaac Asimov, did not subscribe to the theory that robots would eventually destroy mankind. Asimov wrote about robots that served mankind and were programmed with three very simple primary directives, or "laws of robotics":

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

Asimov's stories generally revolved around the unintended consequences that resulted from robots' attempts to strictly follow these laws.

These laws would be pointless for a military robot, of course. We want our robots to only protect the lives of U.S. service members and our allies, as well as all non-combatants. We only want our robots to take orders from our side, not the enemy. Further, the robots should not care about their own existence. By design, the whole point is to save human lives by sacrificing (if necessary) the machine.

There is academic research available on the ethics of arming AI systems and allowing them to make lethal decisions. Arkin of The Georgia Institute of Technology has published a book, *Governing Lethal Behavior in Autonomous Robots,* which provided the baseline for the chapter on the ethics of combat robots. In this book, he concluded that with proper programming, autonomous robots could act more ethically on the battlefield than human soldiers (Arkin, 2009). Arkin is somewhat of a robotics social science journeyman. He also has written a paper entitled *Moving Up the Food Chain: Motivation and Emotion in Behavior-Based Robots* (Arkin, 2005), in which he studied motivations and emotions in a broad range of animal models, including humans, and theorized that behavior-based control should be the primary vehicle through which

emotions and motivations are integrated into robots. However, Arkin's research, while fascinating, has limited applicability to this project's scope.

There is much more research on non-combat civilian-robot interactions, which is what the bulk of this literature review will focus on. Madsen and Gregor (2000) presented an early paper on measurement of human-computer trust. They found that both cognitive and affective components of trust could be measured and that the affective components were the strongest indicators of trust.

Casper and Murphy, in their paper *Human-Robot Interactions During the Robot-Assisted Urban Search and Rescue Response at the World Trade Center* (Casper & Murphy, 2007) studied human-robot interaction (HRI) in what was among the very first large scale use of robots in a stressful and chaotic environment. Their recommendations call for group organization and user confidence studies, more research into perceptual and assistive interfaces, and formal models of the state of the robot, state of the world, and information as to what has been resolved.

Woods (Woods, et al., 2002) and his co-authors were seemly ahead of their time in their paper *Envisioning Human-Robot Coordination in Future Operations*, when they criticized robot developers for underestimating the need for coordination with human team members when robotic devices are deployed into complex operational settings. The authors called for concurrent development of tools to predict future robotic activities and contingencies, as well as responsibility in human-robot teams.

Goodrich and Schultz (2007) separated human-robot interaction into two categories: remote interaction and proximate interaction. The authors theorize that proximate interaction is more likely to result in strong HRI than remote interaction. This is the

basis for my hypothesis that human soldiers will form stronger bonds with UGVs, which are operated proximately, than UAVs, which are generally operated remotely.

Reeves and Nass (1996) did early work on intimacy in computing, finding that people ascribe human qualities to machines such as gender, ethnicity and politeness.

Dautenhahn (2005) and her co-authors conducted a survey of the social roles people would like robots to take, and found that 70% of the participants wanted them as companions, which demonstrates the potential for intimacy to exist between robots and people.

Forlizzi and DiSalvo (2006) studied human interaction with the Roomba robotic vacuum cleaner, which had just started to be introduced on a wide-spread basis into residential homes. This study offered the first glimpse of how humans and robots interact in the home. They studied 14 families who owned Roombas. Although all participants found that the capabilities of the Roomba did not match the general expectations of "a robot," 13 of the 14 families were surprised by how well the Roomba actually worked. Two of the 14 participants named their Roomba, and both names were male-gendered. Seven of the 14 families created social relationships with the Roomba. Along with naming the product, they used it in groups of two to vacuum together, made attributions about how pets related to the vacuum, and used it as a platform to learn about robotics and science.

In "*My Roomba is Rambo": Intimate Home Appliances* (Sung, et al., 2007), the authors built on and extended the seminal research conducted by Forlizzi and DiSalvo by exploring the nature of human-robot relationships. They interviewed thirty Roomba owners and found a majority viewed their robots as cognitive and physical, and ascribed

lifelike social characteristics to it. For instance, 21 of the 30 gave names and nicknames to their robots. Although many of the participants could not explain the motivation behind this action, they reported that it seemed natural, and that Roomba "deserved" a name, particularly considering the benefits the robot provided. Additionally, 16 of the 30 participants talked about their robots in gendered terms, in this case all of them referring to the robot as a "he."

Fussell (Fussell, et al., 2008) and her co-authors found that people are much more anthropomorphic of a robot they interact with than of robots in general. In their paper, *How People Anthropomorphize Robots*, they also found that people were no more or less anthropomorphic with robots exhibiting negative behaviors than with those exhibiting positive behaviors.

In *On Seeing Human: A Three-Factor Theory of Anthropomorphism* (Epley, et al., 2007), the authors describe a theory to explain when people are likely to anthropomorphize and when they are not, focused on three psychological determinants—the accessibility and applicability of anthropocentric knowledge (elicited agent knowledge), the motivation to explain and understand the behavior of other agents (effectance motivation), and the desire for social contact and affiliation (sociality motivation). This theory predicts that people are more likely to anthropomorphize when anthropocentric knowledge is accessible and applicable, when motivated to be effective social agents, and when lacking a sense of social connection to other humans.

Robotics professor Mori (Mori, 2005) published *Bukimi no Tani Gensho* (The Uncanny Valley) in 1970, and more recently updated his theories in 2005. Mori hypothesized that as the appearance of a robot is made more human, a human

observer's emotional response to the robot will become increasingly positive and empathic, but at a certain point of anthropomorphism, the response quickly devolves into strong revulsion, which Mori called the "uncanny valley." Past that point, however, as the robot's appearance continues to become less distinguishable from that of a human being, the emotional response becomes positive again and will continue to approach human-to-human empathy levels.

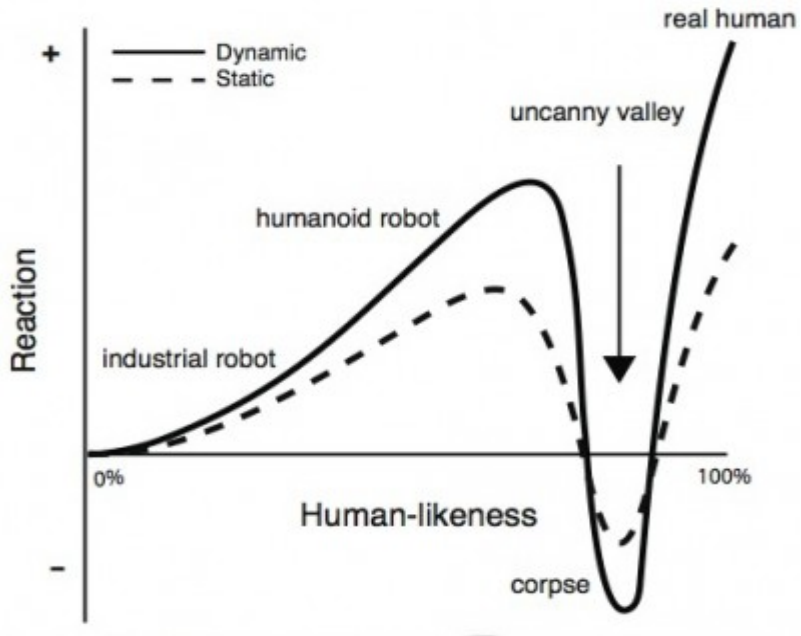

Figure 8: Mori's Uncanny Valley (Keim, 2009)

There are many advantages to development of anthropomorphic combat robots. If a robot could use the same tools and weapons as a human soldier, there would be no need to design robot-specific tools as there is currently. Further, bi-pedal locomotion would allow the robot to travel in most of the environments in which humans live, work, and fight. The United States Naval Research Lab (NRL) just announced plans to design a humanoid firefighting robot, the Shipboard Autonomous Firefighting Robot (SAFFiR). According to the NRL, SAFFiR is being designed to move autonomously throughout

naval ships, interact with people, and fight fires, handling many of the dangerous firefighting tasks that are currently performed by humans. NRL chose an anthropomorphic design so the robot would be able to maneuver well in the narrow passages and ladderways that are unique to a ship and challenging for non-humanoid robots to navigate. Not surprisingly, another key element of the SAFFiR development is to allow damage control personnel and the robot to work cohesively as a team. Algorithms are being developed to allow autonomous mobility and decision making by the robot as a team member. To enable natural interaction with a human team leader, the robot will have multimodal interfaces that will enable SAFFiR to track the focus of attention of the human team leader, as well as allow the robot to understand and respond to gestures, such as pointing and hand signals (McKinney, 2012). Following Mori's hypothesis, SAFFiR's humanoid features would elicit a more positive emotional reaction from humans without triggering the uncanny valley negative response.

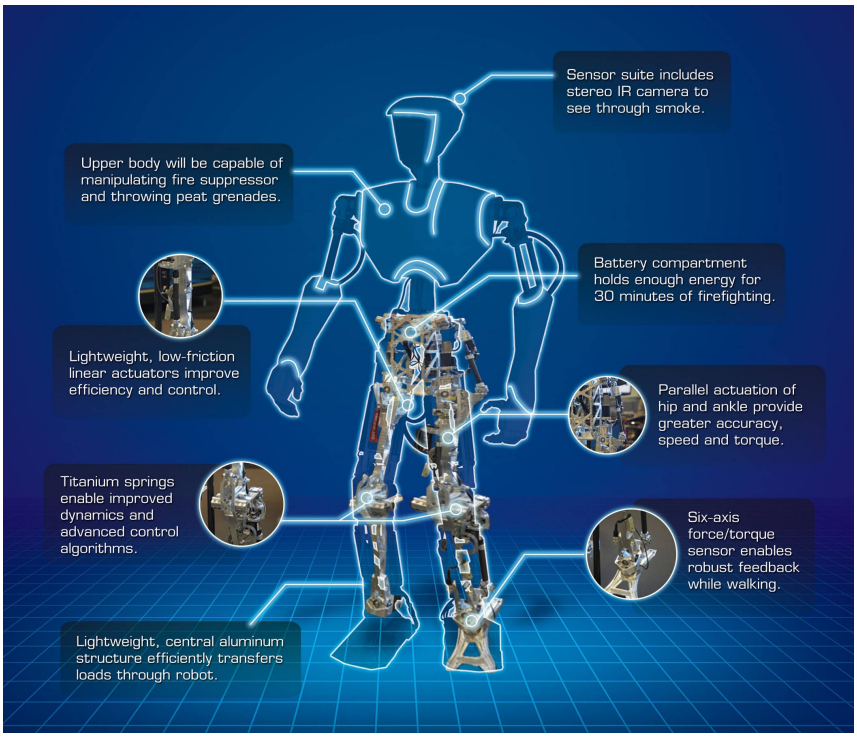

Figure 9: NRL's Shipboard Autonomous Firefighting Robot (SAFFiR)

Mikulincer and Florian (Mikulincer & Florian, 1995) conducted a study that assessed the impact of attachment style on the ways young adults react to the stress of 4-month combat training in the Israeli Army. Their paper, *Appraisal Of and Coping With a Real-life Stressful Situation: The Contribution of Attachment Styles* studied three attachment styles: secure, avoidant, and ambivalent. It found that compared with secure persons, ambivalent persons reported more emotion-focused coping, appraised the training in more threatening terms, appraised themselves as less capable of coping with the training, and were evaluated by their peers as less fitting for military leadership. Avoidant persons reported more distancing coping and less support seeking and appraised the training in more threatening terms, but did not differ from secure persons in the appraisal of their ability to cope with the training or in the nominations they received for leadership positions.

Although combat robots at this time do not display emotions, Arbib and Fellous, (Arbib & Fellous, 2004) in their paper *Emotions: from brain to robot,* explore the question as to whether an autonomous robot would need emotions. They found that robotic emotions considerably advance human-robot interaction and that building emotional robots could also provide a novel test-bed for theories of biological emotion.

Social and Military Group Cohesion is a topic that I was able to derive significant amounts of literature, mostly of scholars arguing back and forth over methodology and definitions. Cohesion effects are important to this study. The theory of negative unit cohesion has been used as an argument during the 20th century against the integration of ethnic minorities and women into military service and was the primary argument against the integration of openly serving homosexuals into the services. It stands to reason, then, that someone that opposes greater integration of artificially intelligent robots into the military might oppose integration based on the possibility of negative group cohesion. Wong and his co-authors (Wong, et al., 2003) published a paper entitled *Why They Fight: Combat Motivation in the Iraq War*. They reviewed literature that overwhelmingly supported their contention that unit (social) cohesion is the primary reason soldiers fight. In their *disputatio sine fine* to Wong's paper, *Does Social Cohesion Determine Motivation in Combat?* MacCoun and company (MacCoun, et al., 2006) argue that task cohesion, rather that social cohesion, is the primary motivation for soldiers to fight. In his *disputatio sine fine* to MacCoun's *disputatio sine fine* of Wong's first paper (Wong, 2006), Wong argues that he was right the first time, that soldiers today, just as those in the past, fight for each other, an argument for social cohesion over task cohesion. Task cohesiveness would favor utilization of robots for

"suicide missions;" unit or social cohesiveness could, in theory, make an anthropomorphized robot "one of the team," and would be less likely to be used for missions that would result in its destruction. If soldiers are primarily motivated by task cohesion, they would be less likely to form bonds with robots than if they were motivated by social cohesion.

As noted previously, a primary argument supporting the recently overturned federal law banning homosexuals from serving openly in the military, formally known as "Don't Ask, Don't Tell" was that social cohesion would break down, and soldiers would no longer be motivated to fight. As such, supporters of the law argued that social cohesion is the primary motivator for soldiers while opponents of the law argued that task cohesion in the most important factor in a positive military outcome. Although the law has been only recently overturned, there have been no significant problems or issues that have manifested (Mulrine, 2012), which would lend credence to the task cohesiveness theory. It should be noted that this study, along with the approved hypothesis and research questions, began prior to the overturn of "Don't Ask, Don't Tell" going into effect. Of course, robots do not have sexual preferences, or any other biologically determined emotions, drives, or survival instincts, and would not be subject to any potential discrimination derived from sexual orientation or attitudes.

Related Theory

Human bonding refers to the development of a close, interpersonal relationship between family members or friends. Bonding is a mutual, interactive process, and is not the same as simply liking. There are three relevant theories related to the study of

human-robot interaction that may be predictors of potential bonding between humans and machines:

Attachment theory is a psychological, evolutionary and ethological theory concerning relationships between humans and was formulated by psychiatrist and psychoanalyst John Bowlby (Cassidy, 1999). The most important tenet of attachment theory is that a young child needs to develop a relationship with at least one primary caregiver for normal social and emotional development. Attachment theory has been extended to adults and is most relevant in this study (Hazan & Shaver, 1987).

Group cohesiveness is the force bringing group members closer together. Cohesiveness, as earlier referenced, has two dimensions: social and task-related (Eisenberg, 2007). The social aspect of cohesiveness, which has been studied more often, is derived from the connection that members feel to other group members and to their group as a whole. Task-cohesiveness refers to the degree to which group members share group goals and work together to meet these goals.

Anthropomorphism describes the tendency to imbue the real or imagined behavior of nonhuman agents with humanlike characteristics, motivations, intentions, or emotions. This theory predicts that people are more likely to anthropomorphize when anthropocentric knowledge is accessible and applicable, when motivated to be effective social agents, and when lacking a sense of social connection to other humans (Epley et al., 2007).

The survey instrument was designed to identify signs of anthropomorphism and overall views of cohesiveness towards military robots. If robot users tend to anthropomorphize robots, and tend to be socially cohesive rather than task cohesive,

attachment to their robots is more likely than if there is little anthropomorphism or attitudes slant more towards task cohesion for mission accomplishment.

Predictive Framework

Based on related theory and literature review, I developed a predictive framework that includes seven factors that can be used to predict strength of bonds humans form with other entities, including animals and robots. In the model, Subject 1 (S1) is the subject that will feel an emotional bond, and Subject 2 (S2) is the subject of those bonding emotions, although they may not demonstrate bonding in return. The strength of each category is related on a scale that rates each interaction as low, medium-low, medium, medium-high, or high.

1. Proximity of S1 to S2. Based on the research of Goodrich and Schultz (2007) it can be surmised that the more time S1 spends in close proximity to S2, the stronger the emotional bond will be. In the predictive chart, I assigned a proximity level of high (highest possible) to the bond a parent would feel with an infant son or daughter. The proximity level would be lower (in this case low) for an adult son or daughter away at college, because they will be rarely proximate to their parents. A lower proximity level is assigned to Unmanned Aerial Vehicles in a combat environment (medium) than to Unmanned Ground Vehicles in a combat environment (medium-high), due to the operator's (S1) closer proximity to the UGV.

2. Ability of S2 to express (perceived) emotion to S1. Bonding is likely to be stronger to subjects that are able to express reciprocal emotions, either through verbal or body language. Humans can express emotions at varying degrees. Mature adults are

able to express a wider variety of emotions than infants. Animals can express emotions, although they may be misinterpreted by the human receiver, as when a dog, craving salt, licks the hand of its owner, and the owner equates the licking to the dog's version of kissing. Robots and other machines cannot feel emotions at all, but designers can program emotional expressions, especially in anthropomorphic machines. This was demonstrated in Fussel's (2008) research that demonstrated subjects were more likely to anthropomorphize robots they interact with than robots in general.

3. Intelligence of S2. Epley (2007) theorized that people are more likely to anthropomorphize when anthropocentric knowledge is accessible and applicable. In the predictive framework, the higher the intelligence of S2, the more likely S1 will form an emotional bond. In this framework, a human subject will have the highest intelligence (high), whereas a low-AI machine will be lower on the scale (low), behind animals (medium). As the level of AI in robots increases, the intelligence of the machines could conceivably move past animals towards that of humans.

4. Propensity of S1 to anthropomorphize S2. Certain humans are more likely to anthropomorphize non-human subjects than others. For example, many people name their cars, boats, or navigation systems. Sung (2008) showed that just over 50% of owners of a Roomba robotic vacuum cleaner exhibited anthropomorphic tendencies towards the vacuum, either by naming it or referring to it as a 'he' or 'she.' In the case of this framework, all human subjects are assigned the highest possible rating (high), because they are actual humans. A person that names his or her car is more likely to view a robot as anthropomorphic.

5. Trust. Madsen and Gregor's research (2000) suggests that the more S1 trusts S2, the stronger the bond that will occur. In this facet of bonding, one can see that trust tends to be highest amongst co-workers that are in a combat environment and between handlers and their working dogs in a combat environment. As combat robots prove their worth in saving lives, the S1 actor is more likely to build trust in his primary robot.

6. Autonomy/Independence of S2. In the case of autonomy, there would be an inverse relationship between S2 and S1, meaning the more autonomous the S2 actor is, the less likely it is that the S1 actor will form a strong emotional bond. Therefore, the strongest bond will be formed with an infant son or daughter, who is completely dependent on its parent for survival. As the child grows and gains survival skills to act independently, the bond based on dependence will weaken.

7. Shared experience/trauma. The final factor in the model has close relationships to trust and proximity, and posits that strong bonds are more likely to be formed when S1 and S2 have shared common experiences, and the bonds formed will be strongest when the experiences were stressful and traumatic, such as shared combat. Wong (2006), in ascribing motivation to fight to social cohesion, frequently cites shared combat trauma as a strong bonding factor amongst soldiers.

The predictive framework shows the strongest bonds will still occur when the S2 is a human, with strongest bonding occurring towards an infant son or daughter, followed closely by a co-worker with shared traumatic experience. Bonding towards a military working dog in combat would be approximately equivalent to a human co-worker in a non-combat environment. Bonding with UGV robots would be stronger than with UAVs, and combat environments would strengthen the bonds in both cases.

This framework can demonstrate how increased or decreased bonding will occur as robots develop in the future. It is very likely, based on the Pentagon's joint robotics road map, that ground robots will become more artificially intelligent, become more anthropomorphic, and will be more autonomous in the future. Anthropomorphic features would likely allow the robot to artificially express emotion, while increased autonomy would decrease proximity to the operator. We would see increases in the bonding scale in the factors of intelligence, anthropomorphism, and ability to express emotion, partially offset by a decrease in the autonomy and proximity scales. Trust and shared experience would be affected by the amount of time spent working together both in and out of a combat zone. It is likely then, that humans will form stronger bonds with ground robots in the future.

On the other hand, it appears to be unlikely that future versions of aerial robots would result in stronger bonding opportunities than currently. Although they will be more intelligent than current versions, aerodynamic principles will limit any additional anthropomorphic changes. Increased autonomy will likely offset the increased intelligence of the future UAVs.

The predictive framework is an early-stage design, and the results of the survey portion of this study will help to refine, expand, validate or repudiate the concept.

	Infant son or daughter	Adult son or daughter at college	Pet Dog	Military Working Dog	Military Working Dog in Combat Environment	Human co-worker	Human co-worker with shared firefight expereince in combat environment	Roomba domestic robot	UGV	UAV	UGV in combat environment	UAV in combat environment
Proximity to S2	High	Low	Med-High	Med-High	High	Med	Med-High	Med-High	Med	Low	Med-High	Med
Ability for S2 to express perceived emotion	High	Low	Med	Med	Med	High	High	Low	Med-Low	Low	Med-Low	Low
Intelligence of S2	Med-High	High	Med	Med	Med	High	High	Low	Med-Low	Med-Low	Med-Low	Med-Low
Propensity of S1 to anthropomize S2	High	High	Med	Med	Med	High	High	Med-Low	Med	Med-Low	Med	Med-Low
Trust	Med-High	Med-High	Med	Med-High	Med-High	Med	High	Low	Med	Med	Med-High	Med-High
Autonomy of S2	Low	High	Med-Low	Med-Low	Med-Low	High	High	Med	Med	Med	Med	Med
Shared experience/trauma	High	Low	Med-Low	Med	Med-High	Med-Low	High	Low	Med	Med	Med-High	Med-High

Figure 10: Predictive Emotional Bonding Framework

Summary

The predictive framework was designed to coalesce the many factors that may affect the strength and character of bonds that may form between humans and robots, contrast those bonds against human-to-human bonds, and seek to demonstrate how these bonds may change as the result of future robot design.

Chapter III

Methodology

Data Collection

The basic data for this study was obtained from two sources. The first data source consisted of related studies, books, periodicals, reports, and other published and unpublished matter containing material relevant to the subject. This material was screened and organized to develop a historical continuity in the evolving field of human-robot interaction and to highlight some of the factors contributing to, or inhibiting, effective and efficient utilization of robots in both the civilian sector and in combat environments. This data also established a benchmark that allowed for the formation of an analytical framework to evaluate the potential for bonding relationships to occur between soldiers and robots in combat environments. Although none of the related material directly addressed the relationship between soldiers and robots in combat, sufficient common ground exists to reach reasonable assumptions with regard to the hypothesis and research questions.

The second data source was information on soldier-robot interaction derived from the web-based questionnaire (Appendix A). The methodology of this data-gathering phase of the study consisted of survey links sent to two groups, the target group and the control group.

The target groups consisted of soldiers that were likely to currently work with military robots or are likely to have worked with military robots in the past. Targeted

soldiers would typically possess a military occupational specialty (MOS) of 11B/11X (Infantryman), 12B (Combat Engineer), 15W (Tactical Unmanned Aerial Vehicle Operator), 18X (Special Forces), 19D (Cavalry Scout), 31B (Military Policeman), and 89D (Explosive Ordnance Disposal). 89Ds would generally only use UGVs, whereas 15Ws only utilize UAVs. The other MOS-coded soldiers might use both UAVs and UGVs, depending on the tactical situation. These surveys were taken on-line, as military members today are most familiar with on-line surveys, and a link to the survey site (Select Survey) allowed survey subjects to remain anonymous. I recruited the target group by running an announcement on the home page of Army Knowledge Online (AKO) that explained the purpose of the survey and provided a web-link to the survey information page. AKO is the primary web portal for Army computer users. I also sent emails to military contacts I knew worked with robots, asking them to take the survey and to forward the web-link to anyone else they knew that works with or had previously worked with robots and might wish to participate. This was not a random sample and was not intended to be. As an initial study of soldier-robot interaction, my goal was to study those in the Army who have interacted with robots through a convenience sample of self-identified robot users.

A control group that has not worked with robots was utilized to compare and contrast results to robot users. Most of this control group simply came from respondents who clicked the web link out of curiosity but that did not or had not worked with robots. Others were co-workers to whom I sent the link, although I was unable to identify who completed the survey and who did not.

There were a number of agencies and groups that approved the study and data collection process. The study was approved by my dissertation committee on November 9th, 2010 and the University of Oklahoma Institutional Review Board on June 12th, 2011. Because the study group consisted of members of the United States Army, an approval from the Army Research Institute's Survey Office was also obtained. Part of this approval process required official Army sponsorship of the project. The Army's Office of Experimentation and Testing (DAMO-CIA) agreed to a non-funded sponsorship of the study to allow it to proceed (all costs were borne by myself). The study is quantitative in nature, and there was no physical contact with the soldiers. The data was stored in a secure Microsoft SQL Server of the RAND Corporation and was password protected under RAND's Data Protection Plan. The software, Select Survey, was written in .Net. The data was transmitted via the browser over the internet from the survey respondent's computer in an unsecure format; however all survey identification was encrypted. The data was purged and destroyed at the conclusion of the study. Participation was voluntary, and the participants were not compensated for their participation.

Data Treatment

The survey instrument contained 44 possible questions with over 245 possible responses. Most questions had limited choices for the respondents that could be answered with a computer mouse click, although some questions allowed the respondents to write in their answers or comments. The questionnaire, designed around the framework of the research questions, utilized ideas from past questionnaires, input

from my peers, the dissertation committee, and a select group of interested researchers from RAND and the Army Research Institute.

The questionnaire was pre-tested with the assistance of RAND researchers, staff members at the Survey Office of the Army Research Institute, and members of the dissertation committee. These pre-tests resulted in extensive modifications and revisions in both the content and functionality of the questionnaire until it was finalized and deployed.

The survey instrument allowed for stratification of the responses, so I could easily mine the data. In most cases I utilized two routines. The first was a simple frequency count; all information from all respondents was summarized and percentages computed. The second routine stratified the answers into three distinct groups: Unmanned Aerial Vehicle users, Unmanned Ground Vehicle users, and non-robot users (control group), which were tested for statistical differences, if any, in answers between the three groups. There was a fourth group of respondents who indicated they used UAVs and UGVs equally, but the size of this group was too small to derive meaningful data. In some instances I further stratified the data into combat and non-combat veterans to determine if the stress of combat led to stronger bonding tendencies.

The analysis of the data from the questionnaire combined with the knowledge gained from study of related resource material provided sufficient information to warrant reasonable conclusions about the research questions.

Chapter IV

Analysis of the Data

Results of Survey Questions

The survey opened on-line at 8:00 am on September 13, 2011 and closed at 6:00 pm on September 30, 2011. 815 total respondents clicked the link to the survey and read or skimmed the information sheet. Of those, 766 clicked through to the first question, which asked respondents is they agreed to participate, with the rest either declining or closing the survey. Twenty additional respondents then declined to participate and were directed to the final survey page, which thanked them for their interest.

Question two was asked of all respondents to ascertain the circumstances of their current location. They were given three choices: combat zone, non-combat zone outside of the contiguous United States (OCONUS), and non-combat zone in the contiguous United States (CONUS). A combat zone is designated by Executive Order from the President as areas in which the U.S. Armed Forces are engaging or have engaged in combat. There are currently three such combat zones (including the airspace above each):

- Arabian Peninsula Areas, beginning Jan. 17, 1991 – the Persian Gulf, Red Sea, Gulf of Oman, the part of the Arabian Sea north of 10° North latitude and west of 68° East longitude, the Gulf of Aden, and the countries of Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

- Kosovo area, beginning Mar. 24, 1999 – Federal Republic of Yugoslavia (Serbia and Montenegro), Albania, the Adriatic Sea and the Ionian Sea north of the 39th Parallel.
- Afghanistan, beginning Sept. 19, 2001.

CONUS is considered to be the Contiguous United States (lower 48) and OCONUS (Outside of Contiguous United States) is all other locations. Both CONUS and OCONUS are commonly used words in the Army lexicon.

723 respondents answered this question, with 11% reporting their location as a combat zone, 12% in a non-combat zone outside of the contiguous United States, and 77% in the lower 48 states.

Question three was designed to separate combat veterans from respondents who have not been in combat recently. Combat veterans were further stratified based on the total months spent in a designated combat zone during the past five years. 723 respondents answered this question, with 40% reporting no combat zone (CZ) experience within the past five years. These respondents were then routed to question eight. Of the 60% that reported combat experience in the previous five years, 4% served in a CZ for 6 months or less; 20% served in a CZ between seven and 12 months; 22% served in a CZ between 13 and 24 months; with 15% spending 25 months or more of the last 60 in a designated combat zone.

3. In the last five years, approximately how many months have you spent in a combat zone? (please select)

	Response Total	Response Percent
I have not served in a combat zone in the past five years	**286**	**40%**
6 months or less	**28**	**4%**
7-12 months	**144**	**20%**
13-24 months	**156**	**22%**
25 months or more	**109**	**15%**
Total Respondents	**723**	**100%**
(skipped this question)		92

Table 1: Results of Question 3

Question four was only asked of respondents who had reported they had spent time in a combat zone during the past five years. Experience in a combat zone can vary greatly in terms of stress. Although Kuwait is a designated combat zone, there have been no violent attacks on U.S. Service members during the past five years, so it is likely that a deployment to Kuwait would be less stressful than a deployment to Iraq or Afghanistan. Similarly, a Service member deployed to the Green Zone of Iraq to conduct administrative work might experience less stress than an Explosive Ordnance Disposal specialist who disarmed large bombs on a daily basis. Question four asks respondents to self-report their level of stress on their most recent combat tour, with 2% reporting their tour was “not at all stressful”; 20% reporting “slightly stressful”; 47% reporting “moderately stressful”; 24.5% reporting “very stressful”; and 6.5% reporting “extremely stressful”.

4. Service in a combat zone can have varying degrees of stress. Please rate the stress/intensity or your current or most recent combat tour: (please select)

	Response Total	Response Percent
Not at all stressful	**9**	**2%**
Slightly stressful	**84**	**20%**
Moderately stressful	**202**	**47%**
Very stressful	**105**	**25%**
Extremely stressful	**28**	**7%**
Total Respondents	**428**	**100%**
(skipped this question)		387

Table 2: Results of Question 4

Question five was only asked of respondents who had reported deployment to a combat zone within the past five years. 12% reported not having been attacked by the enemy with the remaining 88% reporting an attack of some type. Of the 105 respondents that identified their combat stress level as "very stressful," just five indicated they had not been attacked. All 28 respondents who reported their combat stress level as "extremely stressful" reported being attacked by the enemy. Somewhat surprisingly, two-thirds of the respondents who indicated their combat tours had been "not at all stressful" reported being attacked by the enemy.

The most frequently cited method of attack was by indirect fire. Respondents were asked to check multiple attack methods if applicable, so the percentage values do not add up to 100%. There were 16 write-in responses, which are located in Appendix D.

5. Have you ever been attacked by the enemy in a combat zone? (check all that apply)

	Response Total	Response Percent
No, I have not been attacked by the enemy in a combat zone	**52**	**12%**
Yes, by a Improvised Explosive Device (IED) or mine	**174**	**41%**
Yes, direct fire or combined arms ambush	**188**	**44%**
Yes, by a sniper	**87**	**20%**
Yes, by indirect fire (mortars, rockets, ect.)	**334**	**78%**
Yes, other (please specify) view	**16**	**4%**
Total Respondents	**429**	
(skipped this question)		386

Table 3: Results of Question 5

Question six was only asked of respondents that reported a combat tour and was designed, along with questions four and five, to measure the potential stress level of the respondents combat stress levels. 70% of the respondents reported five or more enemy attacks. There was, unsurprisingly, a strong relationship between the self-reported stress levels and number of time the respondent was attacked by the enemy, with 96% of respondents that described their combat experience(s) as “extremely stressful” reporting having been attacked 5 times or more.

6. Approximately how many times have you been attacked by the enemy in a combat zone? (please select)

	Response Total	Response Percent
0	**50**	**12%**
1	**10**	**2%**
2	**22**	**5%**
3	**30**	**7%**
4	**19**	**4%**
5	**8**	**2%**
More than 5	**289**	**68%**
Total Respondents	**428**	**100%**
(skipped this question)		387

Table 4: Results of Question 6

Question seven asked about certain awards the recipient had earned, which can potentially validate intensity of combat experiences. The Purple Heart, for example, is only awarded to service members who are wounded or killed as the result of enemy action. Of the 23 Purple Heart winners, however, only 22% reported their combat tour as "extremely stressful;" an additional 43% described their combat experience as "very stressful;" and 9% described their experience as "slightly stressful." There were several write-in answers that are listed in Appendix E.

7. Have you received any of the following decorations of awards? (check all that apply)

	Response Total	Response Percent
Purple Heart	23	5%
Silver Star	0	0%
Bronze Star with 'V' device	8	2%
Army Commendation Medal (ARCOM) with 'V' device	43	10%
Combat Infantryman's Badge	35	8%
Combat Action Badge	145	34%
Other, (please specify) view	45	11%
Total Respondents	425	
(skipped this question)	390	

Table 5: Results of Question 7

Question eight separated robot users from non-robot users. 78% of the respondents reported currently working with a robot or having worked with a robot in the past. The 155 respondents who reported never having worked with a robot were routed to Question 26.

Question nine further separated robot users by asking the type of robot they most commonly worked with. 62% indicated they most commonly worked with a UAV; 30% indicated they most commonly worked with a UGV; and 8% indicated they used UAVs and UGVs equally. Because the sample size for the group that used UAVs and UGVs equally was so small (41), I did not analyze them as a separate group, but this

group's results are included in the amalgamated results. Even if this group's size had been significant enough to analyze, it is unlikely the overarching findings of this study would have been significantly altered, as there were not significant differences between the UAV and UGV groups. There is a third type of military robot, the Unmanned Underwater Vehicle (UUV), but UUVs are used primarily by Navy personnel that were not queried for this study.

Question 10 asked the model of robot most commonly used by the operator. 47% used the Shadow (UAV); 19% used the TALON (UGV); 8% used the Raven (UAV); 2% used the Grey Eagle (UAV) and 1% used the MAARS (UGV). 16% reported using a robot model not listed in the question, although several answers listed multiple robots. The MQ-5B Hunter UAV was the robot most commonly listed as a write-in, with 16 mentions.

10. What model of robot do or did you most commonly work with? (please select)

	Response Total	Response Percent
Packbot/Warrior	37	7%
MAARS	4	1%
TALON	102	19%
Grey Eagle	11	2%
Shadow	250	47%
Raven	42	8%
Other, (please specify) view	84	16%
Total Respondents	527	100%
(skipped this question)		288

Table 6: Results of Question 10

Question 11 asked about experience working with robots. 43% reporting having worked with robots more than 2 years, with the remaining 60% relatively evenly distributed over the remaining timelines (10% less than one month; 14% at one to three months; 10% at four to six months; 12% at seven to 12 months; and 10% at 13 to 24 months).

11. How many months have you worked with a robot? (please select)

	Response Total	Response Percent
Less than 1	**54**	**10%**
1-3	**75**	**14%**
4-6	**55**	**10%**
7-12	**67**	**12%**
13-24	**54**	**10%**
More than 24 months	**234**	**43%**
Total Respondents	**539**	**100%**
(skipped this question)	276	

Table 7: Results of Question 11

Question 12 revealed that 57% of the robot users had worked with a robot in a combat zone; 43% had not. Respondents that indicated they had not worked with a robot in a combat zone were then routed to question 15.

Question 13 was similar to Question 10, but determined which robots were most commonly used in combat versus overall combat and non-combat usage. The Shadow was used less in combat than non-combat (29% combat vs. 47% overall); the TALON was used more (29% combat vs. 19% overall); and the others were about the same (Raven- 12% combat vs. 9% overall; Packbot/Warrior- 9% combat vs. 7% overall; Grey Eagle- 3% combat vs. 2% overall; MAARS at 1% for both; and the other category at 14% for combat vs. 16% overall.

13. What model of robot did you most commonly work with in a combat zone?

	Response Total	Response Percent
Packbot/Warrior	**26**	**9%**
MAARS	**2**	**1%**
TALON	**87**	**29%**
Grey Eagle	**10**	**3%**
Shadow	**99**	**33%**
Raven	**36**	**12%**
Other, (please specify) view	**43**	**14%**
Total Respondents	**300**	**100%**
(skipped this question)	515	

Table 8: Results of Question 13

Question 14 asked about the length of time spent with a robot in a combat zone with 23% reporting more than 2 years experience working with a robot in a combat zone; 22% at 13 to 24 months; 34% at 7 to 12 months; 14% at 4 to 6 months; 5% at 1 to 3 months; and 2% at less than one month.

14. How many months have you worked with a robot in a combat zone? (please select)

	Response Total	Response Percent
Less than 1	**7**	**2%**
1-3	**16**	**5%**
4-6	**42**	**14%**
7-12	**105**	**34%**
13-24	**66**	**22%**
More than 24	**70**	**23%**
Total Respondents	**306**	**100%**
(skipped this question)	509	

Table 9: Results of Question 14

Question 15, "Have you named your robot?" was asked of all robot users and the results were somewhat of a surprise, with only 34% indicating having named their robot. UGV users (42%) were more likely than UAV users (26%) to have named their robot. With a z-value of 3.5841, there is a significant difference between the two groups, which could be a result of the proximity of UGVs to their users as theorized by the predictive framework.

Question 16 asked Question 15 respondents who had indicated they had named their robots, "What is your robot's name?" Of the 181 respondents who indicated they had named their robot, 172 provided their robots' names. Of these, just 38 could be considered typical "human" names (12 male and 26 female), which can be an indicator of anthropomorphism; the rest are categorized into cartoon or movie characters, traditional military names, or "other." The complete list of names is listed in Appendix B. Respondents who indicated they had not named their robot were not asked this question.

Question 17 asked respondents if they had awarded military rank to their robots, and 94% of robot users indicated they had not awarded rank to their robot. Respondents who indicated they had not awarded rank to their robots were routed to question 19. UGV users (9%) were more than twice as likely as UAV users (4%) to have awarded rank to their robot. A z-value of 2.2478 shows significant differences between the two groups.

Question 18 asked respondents who had indicated they had awarded rank to their robot what specific rank they had awarded their robot. 74% of the awarded rank was from the enlisted ranks. The most popular rank was Sergeant (E-5) at 32%. Respondents who indicated they had not awarded their robot rank were not asked question 18.

18. What is/was your robot's rank? (please select)

	Response Total	Response Percent
PV1/PVT	6	18%
PFC	0	0%
SPC/CPL	2	6%
SGT	11	32%
SSG	4	12%
SFC	1	3%
MSG	0	0%
1SG	0	0%
SGM/CSM	3	9%
WO1	0	0%
CW2	0	0%
CW3	0	0%
CW4	0	0%
CW5	1	3%
2LT	0	0%
1LT	0	0%
CPT	1	3%
MAJ	2	6%
LTC	0	0%
COL or above	3	9%
Total Respondents	34	100%
(skipped this question)		781

Table 10: Results of Question 18

Question 19, which asked if robot users had awarded decorations to their robots, yielded similar results to question 17, with only 7% reporting they had awarded a medal, combat badge, or qualification badge to their robot. Again, UGV users (9%) were more likely to give their robots medals or badges to their robots than UAV users, (5%) but the difference, with a z-value of 1.7, was not significant.

Question 20 asked respondents who indicated they had awarded a decoration to their robot to specify which awards or badges they had awarded their robot. Respondents who indicated they had not awarded a decoration or badge to their robot were not asked Question 20. Some robots received multiple awards. The most popular response was the Combat Action Badge (38%) followed closely by the write-in choice of Purple Heart at 31%. The Combat Action Badge is typically awarded to soldiers who have been attacked by the enemy. The Purple Heart is awarded to service members who have

been wounded or killed in combat. Additional write-in responses are listed in Appendix F.

20. What medals or badges have you awarded your robot? (check all that apply)

	Response Total	Response Percent
Silver Star	4	10%
Bronze Star	2	5%
ARCOM	5	12%
AAM	2	5%
Combat Infantryman's Badge	4	10%
Combat Action Badge	16	38%
EOD Badge	8	19%
Airborne Jump Wings	5	12%
Air Assault Wings	5	12%
Other, (please specify) view	20	48%
Total Respondents	42	
(skipped this question)		773

Table 11: Results of Question 20

Question 21 asked respondents if they thought a military robot should be treated "like a piece of equipment" or "a member of the team," and was asked of all robot users. 64% indicated a military robot should be treated as a piece of equipment, while 30% indicated the robot should be treated as a member of the team. 32 (6%) of the respondents did not like either answer and wrote in their own comments, which are listed in Appendix G. 67% of UAV users thought robots should be treated as a piece of equipment, with slightly lower percentage of UGV users (63%) indicating robots are equipment. The difference was not statistically significant.

Question 22 asked robot users about the intelligence of their robot. 35% of all robot users reported their robot was "not at all intelligent." 52% of UGV users rated their robots as "not at all intelligent," compared with 28% of UAV users. This is a significant difference, and may reflect the lack of autonomous abilities associated with

UGVs compared to UAVs. Many respondents later added comments at the end of the survey indicating their robots were tele-operated, as were most in the military, and are only as smart and effective as their human operators.

22. How intelligent is/was your military robot? (please select)

	Response Total	Response Percent
Not at all intelligent	186	35%
Slightly intelligent	95	18%
Moderately intelligent	134	25%
Highly intelligent	88	17%
Extremely intelligent	26	5%
Total Respondents	**529**	**100%**
(skipped this question)		286

Table 12: Results of Question 22

UAV users:

	Response Total	Response Percent
Not at all intelligent	92	28%
Slightly intelligent	60	18%
Moderately intelligent	92	28%
Highly intelligent	63	19%
Extremely intelligent	19	6%
Total Respondents	**326**	**100%**

Table 13: Results of Question 22 (UAV users)

UGV users:

	Response Total	Response Percent
Not at all intelligent	81	52%
Slightly intelligent	27	17%
Moderately intelligent	27	17%
Highly intelligent	19	12%
Extremely intelligent	2	1%
Total Respondents	**156**	**100%**

Table 14: Results of Question 22 (UGV users)

Question 23 queried robot users on how they would feel if their robot were destroyed in combat. 40% of respondents answered “not sorry at all,” with no significant difference between UAV and UGV users.

23. How would you feel if your robot were destroyed in combat? (please select)

	Response Total	Response Percent
Not sorry at all	213	40%
Slightly sad	162	31%
Moderately sad	98	18%
Very sad	33	6%
Extremely sad	25	5%
Total Respondents	531	100%
(skipped this question)		284

Table 15: Results of Question 23

UAV users:

	Response Total	Response Percent
Not sorry at all	129	39%
Slightly sad	99	30%
Moderately sad	62	19%
Very sad	20	6%
Extremely sad	17	5%
Total Respondents	327	100%

Table 16: Results of Question 23 (UAV users)

UGV users:

	Response Total	Response Percent
Not sorry at all	65	42%
Slightly sad	48	31%
Moderately sad	29	19%
Very sad	10	6%
Extremely sad	4	3%
Total Respondents	156	100%

Table 17: Results of Question 23 (UGV users)

Born of the story of Scooby-Doo (the robot), Question 24 asked robot users if they preferred to have their robot repaired or replaced if it were damaged in combat. Although 69% overall indicated a preference for repair, several respondents later commented that they would choose whichever was fiscally prudent for the Army, although these responses could reflect a social desirability bias, despite the survey being anonymous. Another respondent commented that he would choose whichever option was faster, so the preference for repair may not necessarily indicate an affinity towards

a particular robot. UAV users (72%) were more likely than UGV users (63%) to request repair of their robot.

Most robot users indicated they enjoyed working with a robot, with 80% indicating they either “liked it” or “loved it.” Only 3% overall reported not liking working with a robot. There was no statistical difference UAV and UGV users in the percentage that indicated they either “liked” or “loved” working with a robot, but UAV users were more likely than UGV users to answer “I don’t like it at all” when asked how much they enjoy working with a robot.

25. How much do you enjoy working with a robot? (please select)

	Response Total	Response Percent
I don’t like it at all	10	2%
I like it a little	5	1%
It’s okay	91	17%
I like it	219	41%
I love it	206	39%
Total Respondents	531	100%
(skipped this question)		284

Table 18: Results of Question 25

UAV users:

	Response Total	Response Percent
I don't like it at all	8	2%
I like it a little	2	1%
It's okay	60	18%
I like it	142	43%
I love it	115	35%
Total Respondents	327	100%

Table 19: Results of Question 25 (UAV users)

UGV users:

	Response Total	Response Percent
I don't like it at all	2	1%
I like it a little	3	2%
It's okay	27	17%
I like it	54	35%
I love it	70	45%
Total Respondents	156	100%

Table 20: Results of Question 25 (UGV users)

Question 26 was asked of all respondents, including non-robot users. Respondents were asked to rate the usefulness of robots on the battlefield compared to human soldiers. Only 3 respondents (2 UGV users and 1 non-robot user) rated robots as "useless." UAV users overall were more likely than UGV users to rate robots at the higher end of the usefulness spectrum. The question was worded somewhat vaguely, and several respondents attempted to clarify their answers in the open remarks section of the survey. Interestingly, non-robot users were more likely than robot users to rate robots as being "more useful than ANY human Soldier," with 12% of non-robot users making this rating versus 10% of UAV users and just 3% of UGV users.

26. How useful are robots on the battlefield today? (please select)

	Response Total	Response Percent
Useless	3	0%
Less useful than the AVERAGE human Soldier	91	13%
As useful as the AVERAGE human Soldier	291	43%
More useful than the AVERAGE human Soldier	238	35%
More useful than ANY human Soldier	57	8%
Total Respondents	680	100%
(skipped this question)		135

Table 21: Results of Question 26

Non-robot users:

	Response Total	Response Percent
Useless	1	1%
Less useful than the AVERAGE human Soldier	23	15%
As useful as the AVERAGE human Soldier	73	48%
More useful than the AVERAGE human Soldier	37	24%
More useful than ANY human Soldier	18	12%
Total Respondents	152	100%

Table 22: Results of Question 26 (Non-robot users)

UAV users:

	Response Total	Response Percent
Useless	0	0%
Less useful than the AVERAGE human Soldier	25	8%
As useful as the AVERAGE human Soldier	124	38%
More useful than the AVERAGE human Soldier	143	44%
More useful than ANY human Soldier	32	10%
Total Respondents	324	100%

Table 23: Results of Question 26 (UAV users)

UGV users:

	Response Total	Response Percent
Useless	2	1%
Less useful than the AVERAGE human Soldier	36	23%
As useful as the AVERAGE human Soldier	68	44%
More useful than the AVERAGE human Soldier	45	29%
More useful than ANY human Soldier	5	3%
Total Respondents	156	100%

Table 24: Results of Question 26 (UGV users)

All respondents were asked if they felt increased use of robots in the future would save the lives of soldiers. 91% of the amalgamated respondents (both robot and non-

robot users) indicated robots would definitely save some or many lives. 77% of UAV users indicated robots would definitely save many lives. UGV users weren't as convinced, with 60% indicating robots would definitely save many lives. This statistically significant difference is interesting, as UGV users are more likely to have observed their robots in action, and most instances of robots being destroyed were UGVs attempting to disarm bombs or IEDs rather than the human soldier. Only 3 respondents, including one UGV user, thought robots will never save lives.

27. Do you feel that increased use of robots in the future will save Soldiers' lives? (please select)

	Response Total	Response Percent
Robots will never save lives	3	0%
Robots might save a life now and then	12	2%
Robots will probably save some lives	45	7%
Robots will definitely save SOME lives	166	24%
Robots will definitely save MANY lives	455	67%
Total Respondents	681	100%
(skipped this question)		134

Table 25: Results of Question 27

Non-robot users:

	Response Total	Response Percent
Robots will never save lives	2	1%
Robots might save a life now and then	4	3%
Robots will probably save some lives	16	11%
Robots will definitely save SOME lives	52	34%
Robots will definitely save MANY lives	78	51%
Total Respondents	152	100%

Table 26: Results of Question 27 (Non-robot users)

UAV users:

	Response Total	Response Percent
Robots will never save lives	0	0%
Robots might save a life now and then	4	1%
Robots will probably save some lives	13	4%
Robots will definitely save SOME lives	57	18%
Robots will definitely save MANY lives	251	77%
Total Respondents	325	100%

Table 27: Results of Question 27 (UAV users)

UGV users:

	Response Total	Response Percent
Robots will never save lives	1	1%
Robots might save a life now and then	4	3%
Robots will probably save some lives	14	9%
Robots will definitely save SOME lives	44	28%
Robots will definitely save MANY lives	93	60%
Total Respondents	156	100%

Table 28: Results of Question 27 (UGV users)

Question 28, which asked all respondents if they had a pet, was designed to be used if a significant number of robot users had actually named their robot to test anthropomorphic tendencies. Robot users were slightly more likely to own a pet than non-robot users.

Question 29 asked about the type of pet respondents owned. One respondent listed "Roomba," the robotic vacuum cleaner, as a pet. Other answers are listed in Appendix H.

29. What kind of pet do you have? (check all that apply)

	Response Total	Response Percent
Dog	422	84%
Cat	154	31%
Bird	9	2%
Horse	20	4%
Rabbit	4	1%
Turtle	12	2%
Snake	16	3%
Gerbil/Hamster/Guinea Pig	16	3%
Other, (please specify) view	40	8%
Total Respondents	501	
(skipped this question)	245	

Table 29: Results of Question 29

UAV users:

	Response Total	Response Percent
Dog	208	86%
Cat	64	26%
Bird	6	2%
Horse	10	4%
Rabbit	3	1%
Turtle	6	2%
Snake	6	2%
Gerbil/Hamster/Guinea Pig	6	2%
Other, (please specify) view	24	10%
Total Respondents	242	
(skipped this question)	88	

Table 30: Results of Question 29 (UAV users)

UGV users:

	Response Total	Response Percent
Dog	97	82%
Cat	45	38%
Bird	2	2%
Horse	5	4%
Rabbit	1	1%
Turtle	4	3%
Snake	4	3%
Gerbil/Hamster/Guinea Pig	5	4%
Other, (please specify) view	9	8%
Total Respondents	118	

Table 31: Results of Question 29 (UGV users)

Question 30 was designed to see if respondents who gave their robots male or female names also did so with their pets. Of the 38 respondents that had used a human name in naming their robots, 21 used a human name when naming their pets. A Spearman coefficient of .025 indicates there is no correlation.

Question 31 asked respondents if they had ever named a car, boat, or weapon, and was to be used to identify tendencies towards anthropomorphosis of non-living objects. However, a much higher percentage of respondents named a car, truck, boat, or weapon than named a robot. Robot users (UAV/54% and UGV/49%) were actually less likely to have named one of these objects than non-robot users (64%), which was significantly different for both UAV users and UGV users compared to non-robot users. The answers were evenly split for the UGV users, within the 7.84% margin of error, but the question is much less important because of the small number of robot users that had actually named their robots. It does demonstrate that the robot users surveyed are less likely to demonstrate tendencies towards anthropomorphism of non-living objects than non-robot users.

Questions 32 through 35 asked all of the respondents their feelings about the team member they liked best, and were to be compared to questions 36 through 39, which asked about the team member they liked least. A more detailed analysis of this data is in the analysis section of the study.

Question 32 asked respondents to rate the intelligence of the team member they liked best. 78% rated their favorite team member as either highly intelligent or extremely intelligent. Only two respondents out of 672 (both UAV users) who answered this question rated their favorite team member at "not at all intelligent." UGV users were more likely to rate their favorite team member "extremely intelligent" than either non-robot users or UAV users.

32. How intelligent is the team member you like BEST? (please select)

	Response Total	Response Percent
Not at all intelligent	2	0%
Slightly intelligent	9	1%
Moderately intelligent	133	20%
Highly intelligent	411	61%
Extremely intelligent	117	17%
Total Respondents	672	100%

Table 32: Results of Question 32

Non-robot users:

	Response Total	Response Percent
Not at all intelligent	0	0%
Slightly intelligent	3	2%
Moderately intelligent	37	25%
Highly intelligent	89	59%
Extremely intelligent	22	15%
Total Respondents	151	100%

Table 33: Results of Question 32 (Non-robot users)

UAV users:

	Response Total	Response Percent
Not at all intelligent	2	1%
Slightly intelligent	1	0%
Moderately intelligent	57	18%
Highly intelligent	212	66%
Extremely intelligent	50	16%
Total Respondents	322	100%

Table 34: Results of Question 32 (UAV users)

UGV users:

	Response Total	Response Percent
Not at all intelligent	0	0%
Slightly intelligent	5	3%
Moderately intelligent	28	18%
Highly intelligent	82	54%
Extremely intelligent	37	24%
Total Respondents	152	100%

Table 35: Results of Question 32 (UGV users)

Question 33 asked respondents how they would feel if the team member they liked best were wounded in combat. 81% overall indicated they would be "very sad" or "completely devastated." Less than 1% indicated they would be "not sorry at all." There was very little variation between non-robot users, UAV users, and UGV users. All were within the margins of error, which was 3.72% overall; 7.95% for non-robot users; 5.42% for UAV users; and 7.95% for UGV users.

33. How would you feel if the team member you like BEST were wounded in combat? (please select)

	Response Total	Response Percent
Not sorry at all	6	1%
Slightly sad	16	2%
Moderately sad	108	16%
Very sad	421	63%
Completely devastated	121	18%
Total Respondents	672	100%
(skipped this question)		143

Table 36: Results of Question 33

Non-robot users:

	Response Total	Response Percent
Not sorry at all	2	1%
Slightly sad	7	5%
Moderately sad	30	20%
Very sad	87	58%
Completely devastated	25	17%
Total Respondents	**151**	**100%**

Table 37: Results of Question 33 (Non-robot users)

UAV users:

	Response Total	Response Percent
Not sorry at all	2	1%
Slightly sad	7	2%
Moderately sad	48	15%
Very sad	206	64%
Completely devastated	59	18%
Total Respondents	**322**	**100%**

Table 38: Results of Question 33 (UAV users)

UGV users:

	Response Total	Response Percent
Not sorry at all	1	1%
Slightly sad	1	1%
Moderately sad	23	15%
Very sad	98	64%
Completely devastated	29	19%
Total Respondents	**152**	**100%**

Table 39: Results of Question 33 (UGV users)

Question 34 asked respondents "If the team member you like best were wounded in combat, would you prefer they return to the team after combat, or would you prefer another soldier replace them on the team?" Overall, 89% reported they would want the wounded team member to return to the team after treatment, with a 3.72% margin of error. When stratified, there were some differences between robot users and non-robot users. 79% of the non-robot users preferred to have their favorite team member return to the team after treatment (7.95% margin of error), while 93% (5.43% margin of error)

of the UAV users and 90% (7.92% margin of error) of UGV users preferred to have the team member they liked best return to the team after treatment.

Question 35 asked respondents if a robot could replicate the duties of the team member they liked best. The amalgamated results had 6% reporting "yes," 44% reporting "not now, maybe in the future," and 50% reporting "no," with a 3.72% margin of error.

Non-robot users were more likely to make a positive estimate of robotic capabilities with 12% indicating a robot could replicate the duties of the team member they liked best. 49% indicated "not now, maybe in the future," and 39% indicated a robot could not replace the team member they liked best. The margin of error for non-robot users was 7.95%.

Robot users were less confident in robotic capability than the non-robot users. Amongst the UAV users, 5% indicated a robot could replicate the duties of their best-liked team member, with an additional 45% indicating "not now, maybe in the future." 50% of UAV users indicated a robot could not replicate the duties of their best-liked team member (margin of error was 5.41%). UGV users were even less confident than UAV users in their robot's ability to replicate a human. 3% indicated a robot could replace their best-liked team member, with 39% indicating "not now, maybe in the future," and 57% indicating a robot could not replace their best-liked team member. The margin of error for the UGV users sample for this question was 7.92%.

Questions 36 through 39 asked the same questions as 32 through 35, but asked about the team member the respondent liked least.

Question 36 asked respondents to rate the intelligence of the team member they liked least. There were substantial differences in the results when compared to question 32. For instance, in the amalgamated results for question 36, 25% of respondents rated the team member they liked least as "not at all intelligent," compared to question 32, where slightly more than 0% (2 total, both UAV users) rated their favorite team member as "not at all intelligent." Similarly, 13% rated their least favorite team member as either "highly" or "extremely" intelligent, compared to the 78% rating their best liked team member as "highly" or "extremely" intelligent. The margin of error for the overall results was 3.74% UGV users were more likely to rate their least favorite team member as "highly" or "extremely" intelligent, at 18% (7.95% margin of error), but still much lower than the 78% who rated their favorite team member as "highly" or "extremely" intelligent. Results for non-robot users and UAV users are charted below.

36. How intelligent is the team member you like LEAST: (please select)

	Response Total	Response Percent
Not at all intelligent	166	25%
Slightly intelligent	194	29%
Moderately intelligent	218	33%
Highly intelligent	73	11%
Extremely intelligent	13	2%
Total Respondents	664	100%

Table 40: Results of Question 36

Non-robot users:

Not at all intelligent	37	25%
Slightly intelligent	38	26%
Moderately intelligent	49	33%
Highly intelligent	24	16%
Extremely intelligent	0	0%
Total Respondents	148	100%

Table 41: Results of Question 36 (Non-robot users)

UAV users:

	Response Total	Response Percent
Not at all intelligent	93	29%
Slightly intelligent	98	31%
Moderately intelligent	100	31%
Highly intelligent	22	7%
Extremely intelligent	6	2%
Total Respondents	319	100%

Table 42: Results of Question 36 (UAV users)

UGV users:

	Response Total	Response Percent
Not at all intelligent	27	18%
Slightly intelligent	45	30%
Moderately intelligent	52	34%
Highly intelligent	22	15%
Extremely intelligent	5	3%
Total Respondents	151	100%

Table 43: Results of Question 36 (UGV users)

Question 37 was similar to question 33, this time asking respondents how they would feel if their least-liked team member were wounded in combat. 8% of the amalgamated responses indicated they would be "not sorry at all," and 41% indicated they would either be "very sad" or "completely devastated," although more indicated they would feel "not sorry at all" than would feel "completely devastated." In Question 33, less than 1% indicated they would feel "not sorry at all" if their best-liked teammate were wounded, and 81% indicated they would be "very sad" or "completely devastated." The overall margin of error for question 36 was 3.74%. Robot users were more likely than non-robot users to report they would feel "completely devastated," although the results are within the margin of error for the stratified groups. The results are charted below.

37. How would you feel if the team member you like LEAST were wounded in combat?

	Response Total	Response Percent
Not sorry at all	52	8%
Slightly sad	143	22%
Moderately sad	194	29%
Very sad	235	35%
Completely devastated	40	6%
Total Respondents	**664**	**100%**
(skipped this question)		151

Table 44: Results of Question 37

Non-robot users:

	Response Total	Response Percent
Not sorry at all	10	7%
Slightly sad	32	22%
Moderately sad	45	30%
Very sad	57	39%
Completely devastated	4	3%
Total Respondents	**148**	**100%**

Table 45: Results of Question 37 (Non-robot users)

UAV users:

	Response Total	Response Percent
Not sorry at all	27	8%
Slightly sad	80	25%
Moderately sad	98	31%
Very sad	94	29%
Completely devastated	20	6%
Total Respondents	**319**	**100%**

Table 46: Results of Question 37 (UAV users)

UGV users:

	Response Total	Response Percent
Not sorry at all	10	7%
Slightly sad	22	15%
Moderately sad	38	25%
Very sad	68	45%
Completely devastated	13	9%
Total Respondents	**151**	**100%**

Table 47: Results of Question 37 (UGV users)

Question 38 asked respondents “If the team member you like least were wounded in combat, would you prefer they return to the team after treatment or would you prefer

another soldier replace them on the team?" This question is related to question 34, which asked the same question about the team member they like the best. Overall, with a 3.75% margin of error, 40% preferred to have the team member they liked least return to the team, compared to the 89% who wanted to see their best-liked teammate return after treatment. 35% of non-robot users preferred their least-liked teammate return after treatment, compared to the 79% that would want their best liked team members back (8.08% margin of error).

Robot users were more willing than non-robot users to welcome their least-liked teammates back, with 38% of UAV users (compared to 93% who would want back their best-liked team member) and 44% of UGV users (compared to 90% in question 34). The margins of error for this question were 5.43% for UAV users and 7.95% for UGV users.

Question 39 asked respondents "In your opinion, could a robot replicate the duties of the team member you like least?" Overall, 27% reported "yes," 40% reported "not now, maybe in the future," and 33% reported "no." This is a significant difference from Question 34, which asked respondents if a robot could replace the team member they like best. In that question, 6% reported "yes," 44% reported "not now," and 50% reported "no." Non-robot users were again more optimistic than robot users about the potential for robots to replace humans, with 29% indicating a robot could replace their least-liked team member (compared to 12% who thought a robot could replace their best-liked team member), 47% replied "not now, maybe in the future," (compared to 49% that said the same thing in question 35, a statistical tie), and 24% thought a robot could not replace their least-liked team member, compared with the 39% who indicated

a robot could not replace their best-liked team member. The margin of error for non-robot users was 7.95%.

UAV users were statistically split between the three choices. UAV users were slightly more likely to believe that a robot could replace their least- liked team member, at 30% of the respondents. 38% answered "not now, maybe in the future," and 32% indicated a robot could not replace their least-liked team member. The margin of error for UAV users was 5.41%.

UGV users continued to be the most pessimistic of the three stratified groups, with 44% indicating a robot could never replace even their least-liked team member. Nonetheless, 21% thought that a robot could replace their least-liked team member, compared with the 3% who indicated a robot could replace their best-liked team member. 35% indicated that a robot could not replace their least-liked team member now, but might be able to do so in the future. This question had a margin of error of 7.95%.

The last question invited respondents to make any comments they desired, and 326 respondents elected to do so. The comments are included in Appendix I. I was able to sort most of the comments into general categories, with three comments divided into dual categories:

- General Positive- 61 of the comments were general in nature, but reflected a positive attitude of the respondent to robots.
- General Negative or Possible Ethical Conflict- 18 respondents made comments that can be interpreted as negative towards the use of military robots or voicing ethical concerns of the increased use of military robots in combat.

- Robots Save Lives- 59 commenters mentioned either personally knowing that robotic systems had already saved lives on the battlefield or expressed confidence that use of military robots save lives.
- Robots Save Lives, But Can't Replace Soldiers- An additional 21 comments also indicated use of military robots would save lives, but added that military robots could not or should not replace human soldiers on the battlefield.
- Robots Are Only As Good As Their Human Operators- 35 comments pointed out that the current generation of robots are primarily tele-operated and are only as smart as their human operator.
- Robots Are Tools/Equipment Only- 43 comments were specific enough that robots are useful tools, but only tools, that they were placed in this category. Many of these comments seemed to originate from respondents that guessed the hypotheses of the study and wanted to make sure they were on the record that robots were not equal to humans.
- Critiques of Current Robotic Systems (Specific or Generalized)- 20 respondents made comments that were either critiques of specific systems (such as Packbot or Talon) or offered critiques on the shortfalls of current unmanned systems.
- Doctrine or Training Needs to Be Improved- 20 respondents generally commented positively on the potential for use of military robots, but indicated doctrine and/or training needed to be improved to maximize utility of unmanned assets.
- General- 35 comments were not specific enough to be included into any of the other categories and were placed into the general category.

The respondents were not told the research questions that precipitated the survey, but many took a guess at the research objectives and used this forum to comment, particularly when they felt the restrictions of the multiple-choice survey did not adequately convey their attitudes towards their military robots.

Demographics

45 of 660 respondents that chose to disclose their gender identified themselves as female (7%); 18 indicated they had never worked with a robot and 27 indicated they either currently worked with a robot or had worked with one in the past. The lower response rate for females is reflective of their smaller representation in the Army overall (17% of the total force) and that when the survey was fielded, women were shut out of many of the combat military occupational specialties that use robots. The Army, in April of 2012, announced a new policy opening up more of these combat fields to women, (McIlvaine, 2012) so I anticipate there will be more women operating robots in combat environments in the future.

The ranks of the respondents were, as expected, primarily junior enlisted, who are defined as Private, Private First Class, and Specialist or Corporal at 41% of the total sample that chose to answer Question 41. 45% of the respondents were non-commissioned officers, approximately 3% were warrant officers, and 11% were commissioned officers.

41. Your rank: (please select)

	Response Total	Response Percent
PV1/PVT	58	10%
PFC	77	13%
SPC/CPL	104	18%
SGT	94	16%
SSG	99	17%
SFC	56	9%
MSG	10	2%
1SG	5	1%
SGM/CSM	4	1%
WO1	4	1%
CW2	7	1%
CW3	5	1%
CW3	3	1%
CW5	0	0%
2LT	3	1%
1LT	6	1%
CPT	26	4%
MAJ	9	2%
LTC	17	3%
COL or higher	3	1%
Total Respondents	**590**	**100%**
(skipped this question)		225

Table 48: Rank

The top Military Occupational Specialties (MOS) of recipients were aviation-related at 45%. Explosive Ordnance Disposal experts made up 9% of the reporting respondents.

42. Your MOS or Branch: (please select)

	Response Total	Response Percent
11B	25	4%
11X	2	0%
12B	34	5%
15W	159	25%
18-series	2	0%
19D	8	1%
31B	9	1%
89D	57	9%
Aviation	128	20%
Infantry	5	1%
Engineer	13	2%
Special Forces	1	0%
Military Police	3	0%
Other	185	29%
Total Respondents	**631**	**100%**
(skipped this question)		184

Table 49: Military Occupational Specialty

The ages of the reporting respondents were relatively well distributed and reflected the demographics of the Army overall.

43. Your age: (please select)

	Response Total	Response Percent
20 or younger	**58**	**9%**
21-24	**131**	**20%**
25-29	**157**	**24%**
30-39	**188**	**29%**
40 or older	**122**	**19%**
Total Respondents	**656**	**100%**
(skipped this question)		159

Table 50: Age

The reported educational level reflected the intelligence and specialized training generally required of unmanned systems operators.

44. The highest level of civilian schooling you have completed: (please select)

	Response Total	Response Percent
High school diploma or GED	**94**	**14%**
Some college, no degree	**303**	**46%**
Associate degree	**104**	**16%**
Bachelor's degree	**105**	**16%**
Master's degree or higher	**52**	**8%**
Total Respondents	**658**	**100%**
(skipped this question)		157

Table 51: Civilian Education

Findings from the Data

The study was designed to answer the following questions:

1. Do human soldiers form emotional bonds with autonomous or semi-autonomous robots?
2. If so, is emotional bonding more likely to occur with Unmanned Aerial Vehicles (UAVs) or Unmanned Ground Vehicles (UGVs)?

3. If bonds are formed, are they as strong as emotional bonds formed between human soldiers?
4. Does the stress of combat strengthen these bonds?

Based on literature review, I had advanced the following hypotheses to be tested:

1. Human soldiers do form emotional bonds with their robotic counterparts.
2. The bonds humans form with robots will not be as strong as those bonds formed with other humans.
3. Strong bonding with robots is more likely to occur with soldiers who operate UGVs than with soldiers who operate UAVs.
4. Combat affects the intensity of bonding towards both robots and humans; more intense bonding will occur in a combat environment than in a non-combat environment.

First we'll explore the first research question, with the outcome affecting all of the other questions.

Do human soldiers form emotional bonds with autonomous or semi-autonomous robots?

I was not able to survey users of autonomous robots, since the only robots currently in operation are tele-operated, and semi-autonomous at best. However, based on the emotional attachment framework outlined in chapter two, bonding would be more likely to occur in tele-operated robots due to their proximity to their users. Although there are no definitive signs of emotional bonding with machines, I first set out to detect signs of anthropomorphism of the robots, which should first be present for bonding to occur.

Naming of the robot. I had expected a majority of robot users to have named their robots, but this was not the case. Only 34% of robot users reported having named their robots. In Sung's (Sung, et al., 2007) study of Roomba owners, 21 of 30 respondents (70%) reported that they had assigned a name or nickname to their domestic robots. Sung's study had a much smaller sample size than this study, but the margin of error would not account for the difference; it appears that military robot users are less likely to name their robots than domestic robot users. A z-value of 4 confirms the significant difference between the domestic robot and military robot users in terms of naming their robots. Of the 34% that named their military robots, which represented 181 respondents, 172 provided the names of their robots, and only 38 of those names could be described as human gender-specific (12 male names, 26 female names). The rest of the names were derived from cartoons or movies, including 26 that were named "Johnny 5," from the 1980s movie *Short Circuit*. "Johnny 5" in the movie bears a striking resemblance to iRobot's Packbot. Sung's study demonstrated a variety of names were assigned to the Roombas, including movie characters, but in every instance, when a gender was assigned to the Roomba, it was always male, in contrast to the military robots, in which 73% of the human gender-specific names were female. Overall, just 5.6% of the robot users reported attaching a human gender-specific name to their robot. Of the respondents who reported naming their robots, 73% reported that they had also previously named a car, truck, boat, or weapon, which indicates this sub-sample tended to anthropomorphize machines more than respondents who did not name their robots, (48%) or the overall sample, in which 58% indicated they had previously named a car, truck, boat, or weapon. Testing confirms a significant difference in the

groups. 138 (78%) of the respondents who reported having named their robots also reported having 251 pets. An analysis of those pet names reveal that 56 were female-gendered names, 63 were male-gendered names, and 132 had names that were either gender neutral or were not names that would normally be associated with a human. Of course, all animals have a gender, so it's a good assumption that male-gendered names were ascribed to males and female-gendered names were ascribed to females. Robots do not have a gender, so it was up to the robot operator to assign one in the naming convention.

Sung, Grinter, and Christensen (2009), conducted a follow-on study in which they gave Roomba personalization kits to 15 households of the 30 studied. None of the 15 that did not receive a personalization kit customized their Roomba, and six of the 15 with personalization kits ended up customizing their robots (20% of the sample size). The military places great emphasis on decorations, awarding medals, badges and ribbons in lieu of financial awards for exceptional service or heroic actions. Although personalization kits are not issued for military robots, personalization materials such as rank, badges and awards are easily obtainable, or could be created simply by drawing the decoration on a piece of tape and affixing it to the robot.

However, just 6% (34 total) of the respondents reported having awarded rank to their robot. However, of respondents that reported having named their robot, 16% had awarded rank to their robot.

7% (38 total) of the respondents reported having awarded a medal, combat badge, or qualification badge to the robot. Of respondents that had named their robot, 18% (29 total) reported having awarded a medal or badge to their robot. Of respondents that had

both named their robot and awarded rank to their robot, 55% (16 total) reported also having awarded a medal or badge to their robot. Of these 16, just one named their robot a traditional human name (Helga). The 16 respondents who reported having named their robot, awarded rank to their robot, and had awarded a medal or badge to their robot represented just 2.9% of the respondents who reported working with a robot, which would indicate only a small percentage of robot users anthropomorphize robots to the extent that emotional bonding is likely to occur.

Of these 16, 10 reported having previously named a car, truck, boat, or weapon, giving some indication that they have anthropomorphized an object in the past. Of the remaining six, four reported having a pet, and three of those four reported having named their pet a human name, which shows anthropomorphic tendencies towards animals. There appears to be little evidence that military robot users are anthropomorphizing their robots because they are robots.

Question 21 asked robot users "Should a robot be treated as equipment or a member of the team?" 64% replied the robot should be treated as a piece of equipment and 30% indicated the robot should be treated as a member of the team. The remaining 6% wrote in their own answer, with the most popular write in essentially being "both."

The second research question, "If so, is emotional bonding more likely to occur with UAVs or UGVs?" is somewhat moot at this point, due to the small percentage of robot users that demonstrate bonding characteristics, but we can still explore the question, even with the limited sample size. Of the 16 that reported all three (naming and awarding of rank and awards/badges) anthropomorphic tendencies, 8 used primarily UAVs, 3 used UGVs, and 4 reported having used both equally (1 did not report). This

was the opposite of my prediction that strong bonding with robots was more likely to occur with UGV users- it appears that it is more likely to occur with UAV users.

The third research question, "If bonds are formed, are they as strong as emotional bonds formed between human soldiers?" is also moot, since it does not appear that soldiers form bonds with their robotic counterpoints, in any great numbers, but we can still look at the 16 soldiers who demonstrated bonding characteristics.

When these 16 asked how they would feel if their robot was destroyed in combat, 50% reported they would feel "very sad" or "extremely sad" (versus 11% for the overall robot-using sample), while 12% indicated they would feel "not sorry at all" (versus 42% of all robot users). When the same group was asked how they would feel if the human team member they liked best were wounded in combat, 87% reported they would feel "very sad" or "completely devastated" (84% for the overall robot-using population). No member of this sub-sample indicated they would feel "not sorry at all" if their human teammate were wounded in combat. When asked the same question about the team member they liked least, just 34% indicated they would feel "very sad" or "completely devastated" (versus 41% of all robot users), while one of the respondents (7% of the sub-sample) indicated he would feel "not sorry at all."

When asked their preferences if their robot was damaged in combat, 88% of the 16 preferred it to be repaired rather than replaced, whereas 70% of the overall robot-using population would prefer repair. When asked their preferences if their best-liked human team member were wounded in combat, 93% preferred the team member return to the team, which was the same percentage as the overall robot user results. However, when asked about their least-liked team member, just 20% preferred that their least-liked team

member return to the team after being treated for combat wounds. 40% of the overall robot users would take back their least-liked team member after treatment.

When asked if a robot could replicate the duties of the team member they liked best, 7% of this subset replied “yes,” and 27% replied “no” (the remainder replied “not now, possibly in the future”). 5% of the larger robot user population replied “yes,” and 52% replied “no.” When asked if a robot could replicate the duties of the team member they liked least, 67% replied “yes” (versus 29% of the overall robot users), 13% replied “no” (35% of overall robot users), and the remaining 20% (35% of overall robot users) replied “not now, maybe in the future.”

With a margin of error of 24.49%, a sample size of 16 is too small to draw definite meaningful conclusions, but the analysis does indicate that it is possible for a least a small subset of the military robot-using population, in some cases, to favor their robot over a non-enemy combatant human being.

The final research question, which, like the previous two, was predicated on the first question, was “Does the stress of combat strengthen these bonds?”

Of the 16 respondents that demonstrated propensity to anthropomorphize their robots, 14 (88%) had experienced combat and 7 were serving in a combat zone when they took the survey. Of these 14, 13 reported they had been attacked by the enemy, and 11 (79%) reported they had been attacked more than 5 times. Two respondents reported having received the Purple Heart, indicating they were wounded in an enemy attack. When asked about the stress level of their current or most recent combat tour, 28% of the respondents rated their combat tours as either “very stressful” or “extremely

stressful," while 29% rated their combat as "slightly stressful." The remaining 43% indicated their combat tours were "moderately stressful."

However, there were 225 robot users that reported being attacked by the enemy more than five times. Of this subset, 45% had named their robot, higher than the 34% of the overall robot user sample that reported having named their robot; 9% had awarded rank to their robot (versus 6% of the overall robot user sample), and 14% had awarded a medal, combat badge, or qualification badge to their robot, roughly double the 7% of the overall robot user sample. With a 6.5% margin of error in a population this size, it is possible combat stress slightly increases the propensity for robot users to anthropomorphize their military robots.

Of the robot users that had not worked with a robot in combat, just 23% had named their robot, 3% had awarded rank to their robot, and just 1% had awarded a medal, combat badge, or qualification badge to their robots. This result is illustrative- soldiers who used robots in combat and had been attacked by the enemy five or more times were twice as likely to name their robot, three times as likely to award rank to their robot, and 14 times as likely to award a medal, combat badge, or qualification badge to their robot as robot users that had not worked with a robot in a combat environment.

It would be a stretch to say intensity of combat strengthens human-to-robot bonds, but it may be a contributor to having these bonds begin to form in the first place.

After answering the research questions we can move on to the hypotheses. The first, "Human soldiers do form emotional bonds with their robotic counterparts," was not conclusively proven. While there was a very small subset of robot users who demonstrated anthropomorphic tendencies to their robots, the larger majority did not.

This could change in the future as robotic development advances, but for now, most robot users do not form emotional bonds with their robotic counterparts.

The second hypothesis was "The bonds humans form with robots will not be as strong as those bonds formed with other humans." Because the vast majority of humans studied did not demonstrate bonding characteristics with robots, it follows that the naturally occurring bonds with other humans will be stronger. It should be noted, however, that in the small sample that demonstrated anthropomorphic tendencies to their robots, there was evidence that this subset could prefer their robots over their least-liked human team member. The sample was too small to conclusively draw this conclusion, but it bears mentioning and monitoring as military robots continue to develop in autonomy, intelligence, and usefulness to the combat soldier.

The third hypothesis, "Strong bonding with robots is more likely to occur with soldiers who operate UGVs than with soldiers who operate UAVs" appears to have been disproven, at least with the data from the questionnaire. Again, there was a very small sample size of robot users that demonstrated strong bonding, but of that sample, most were UAV users. I had originally proposed that the proximity of UGVs to their operators would cause stronger bonding than with UGVs; now I suspect the limited capabilities of the UGVs compared to the UAVs lessened the proximity effect.

The fourth hypothesis, "Combat affects the intensity of bonding towards both robots and humans; more intense bonding will occur in a combat environment than in a non-combat environment" suffers from the same issue as the other hypotheses- there wasn't enough evidence of strong bonding between humans and robots to merit a large enough sample to test this theory. Previous literature had already demonstrated human-to-

human bonding intensifies in combat, and there is some evidence from the survey that indicated robot users that had been attacked by the enemy more than five times were more likely to name their robots, award rank to their robots, or award combat badges or decorations to their robots than those who had not experienced combat with their robots, as was outlined in research question four. This particular hypothesis garnered some support, but additional research should be undertaken.

Conclusion

Although there was some evidence the certain robot operators could potentially bond with their robots, the majority of robot operators do not do so. The predictive framework, in retrospect, demonstrated its usefulness and should be used in future studies of soldier-robot relationships, as robots continue to change shape and continue to demonstrate better autonomy and AI. The hypotheses that were developed were not incorrect due to the predictive framework being faulty, but rather an overestimation of the capabilities of today's military robots and an underestimation of the pragmatism of today's soldiers.

Other Findings

The study did uncover some important findings that were not originally part of the hypothesis or research questions, and will be discussed here. The first finding is that both soldiers who work with robots and soldiers who do not work with robots believe that use of the robots either have saved lives in the past, are saving lives now, or will save lives in the future. Question 27 asked respondents "Do you feel that increased use of military robots will save lives in the future?" with 91% of respondents indicating

increased use of robots will “definitely” save “some” or “many” lives. This finding is consistent among the stratified groups, with 92% of the soldiers who have worked with robots in combat, 93% of robot users who have not worked with robots in combat and 85% of respondents who have never worked with robots expressing this view. This attitude was again manifested when respondents were invited to make comments at the end of the survey. 80 of the 326 comments (25%) specifically mentioned robots saving lives, primarily by allowing standoff for the human operators or uncovering the enemy planting an IED or planning an ambush. Three examples:

“…There are several times I can think of that a robot has saved my life or the lives of my team members.” (Comment 31)

“… I am a firm believer of robotics used in combat. I have seen them save lives and hope we continue to improve on what we have now.” (Comment 51)

“… I personally owe my life to around 30 different robots that have been hit by IEDs in my place. Although the death of each robot is sad, in a way it is a happy event... that one of my team didn't lose our lives.” (Comment 217)

These and other comments are listed in Appendix D, under the themes “Robots Save Lives” and “Robots Save Lives, But Can’t Replace Humans.”

Saving lives, particularly the lives of United States troops and all non-combatant civilians, is a primary objective of the United States military, and any technology that can help soldiers save lives should be welcomed into our inventory.

The other finding of note was the respondents’ insistence that robots are tools-useful tools, but tools nonetheless, and should not be treated the same way as human soldiers. Some added the caveat that while today’s modern robots are useful tools,

more advanced robots may become more like a member of the team. Question 21 asked robot users if robots should be treated as equipment or as a member of the team. 67% of UAV users and 63% of UGV users voted for equipment, but 6% didn't like either answer and wrote in their own answer, which are listed in Appendix G. Three of the write-in answers:

"…The robot is still a piece of equipment; it needs more attention than any other piece of gear that you have. And it's the best team member you could have. It doesn't complain it just does what you tell it to do, except if you have an old Packbot and it starts to ghost on you. Then it's a piece of crap and you want to beat the robot."

"…Robots are a range of capability. Tele-operated ones I doubt would be treated like a member of the team. I would expect that once they can follow you like a dog without a remote operator, then you'll start to see massive personalization of how the solders perceive robots."

"… Depends on the level of AI I would say. For robotic systems that are 100% user remote controlled I go with equipment, but smart systems of the future that are able to speak back, I would say Member Of Team."

In their open-ended comments, the term "tool" was mentioned enough times (43) that I created a category for it. Sample comments are below, with all of the comments listed in Appendix I.

"…. I am an EOD Technician, and as such robots are our tools. They exist to reduce the danger to us, and I am more than willing to see my robot blown up than myself or a teammate. In regards to one of the questions, would you rather have your robot repaired

or replaced, the answer is whichever is quicker. Each robot does have its own idiosyncrasies, but at least they don't change like people do." (Comment 58)

"…. Team members are irreplaceable while robots are tools we used in dangerous situations. If the robot blew up while disarming an IED then it saved a team members life or limbs who would have been doing the dangerous work instead. I am not personally attached to any one robot as they are switched out and repaired often. They are very advanced tools that do not poses intelligence in themselves but allow the operator remote capabilities to stay out of harm's way. Robots are absolutely vital in the efforts of Explosive Ordnance Disposal." (Comment 81)

"… Military robots are great force multipliers... I know; I sound like an FM on leadership there, but they really are. They are nothing more than tools to be used by the Soldier however. A soldier is quick, agile, smart, and can do things that frankly, a cold unfeeling hunk of plastic and steel could never accomplish. A human can make the decision whether or not to shoot someone based on what the actual situation is AND what his instincts tell him. A robot trying to make the same "decision" would only be following its programming. Not good when you have a crowd of children and one of them is pointing a loaded rifle at you. A robot would see the gun and immediately kill the child and possibly slaughter many other children in the crowd as well. A Soldier would see the gun and do everything he could to protect both the lives of his men and himself AS WELL AS the children. A Soldier's instincts are his greatest weapon. Robots do not have instincts. They can never be intelligent. No matter how much programming you put into them; no matter how many gizmos and bells and whistles you put on it; no matter how many tasks it can complete all at once; it will still always

be a cold, heartless, unfeeling, non-living... machine. The producers of the Terminator movies have it exactly right. If the military attempts to build a robot or series of robots that could be smarter than human beings... it will destroy either the world, or itself. Period. The battlefield will always be a place of human death and destruction. There is NO way to avoid this fact. Soldiers will always be needed, until the end of days. A soldier's life will ALWAYS be worth more than ANY piece of equipment." (Comment 205)

Non-robot users were not asked about robots as a tool or team member, so there is no comparison group for this finding. Nonetheless, I wanted to highlight this finding as it demonstrates the pragmatism of today's combat soldier. This is all good news for proponents of robots in combat, because potential emotional attachment between soldiers and their robots could certainly have been a barrier to further implementation of advanced robotics on the battlefield.

Chapter V

Ethics of Combat Robots

"They don't get angry. They're not afraid. They don't forget their orders. They don't care if the guy next to them has just been shot. Will they do a better job than humans? Yes." -Gordon Johnson of the U.S. Joint Forces Command, referring to Combat Robots in the *New York Times* (Weiner, 2005)

Man's propensity to wage war has gone unabated for all of recorded history. One of the original sins of our species is its inability to live at peace. War has been both a cause and effect of broader social change. Immanuel Kant asserted, "War requires no motivation, but appears to be ingrained in human nature and is even valued as something noble" (Kant, 1985). While many philosophers see war in any form as immoral, I will not explore that thesis here. I also will not explore the ethical debate as to whether autonomous machines should be permitted to kill humans in combat without human permission, although I will briefly address this idea towards the end. For this chapter, I will examine the shortcomings humanity exhibits during the conduct of war (*Jus in Bello)* as opposed to what brought us there in the first place (*Jus ad Bellum),* and explore the possibility that artificially intelligent autonomous robots might be more ethical on the battlefield than humans.

The Rise of the Robot

Hollywood has always been fascinated with robots and the ethical implications of artificially superior creations turning on their masters after being programmed to kill humans and then gaining a state of consciousness. Movies such as the "Terminator" and "Matrix" franchises and the "Battlestar Galactica" television series warned of

human creations becoming the dominant species and leading to humankind's extinction. However, until recently, the reality of robotic innovation was far behind that envisioned by the creative writers of these stories. The past several years have led to significant advances in robotic technology. The wars in Iraq and Afghanistan have led to significant funding increases in robotic technology, and the United States now has an estimated 12,000 semi-autonomous robots performing combat-related tasks in these two countries (Singer, 2009). As our understanding of AI continues to increase, the potential roles for combat robots are sure to increase. A primary reason is to replace humans in conducting "dull, dirty, and dangerous" jobs. Tunneling through dark caves in search of terrorists, securing urban streets rife with sniper fire, patrolling skies and waterways, clearing roads of improvised explosive devices (IEDs), controlling crowds, and performing sentry duties are just some of the current and potential uses of robots on the battlefield.

The case for deploying combat robots is more than just saving human lives or performing more efficiently and effectively than humans. Robots are unaffected by the emotions, adrenaline, and stress that cause soldiers to overreact and deliberately violate the Law of War, committing atrocities and/or war crimes. Indeed, while robots may be programmed to prevent them from violating rules of engagement, they may also act as objective, unblinking observers on the battlefield, reporting any unethical behavior back to command. The future looks to be far-removed from Hollywood's vision of human extinction at the hands of robots. Rather, robots are likely to be more ethical in warfare than humans have ever been.

Just-War Theory and the Laws of War

The Laws of War are generally divided into three basic categories, with the first two generally being of long-standing acceptance, and the third forming a new emphasis, due to the frequency of asymmetric and non-state sponsored warfare led by such groups as Al Qaeda:

1. *Jus ad bellum:* Law concerning acceptable justifications to use armed force and declare war.
2. *Jus in bello:* Law concerning acceptable conduct in war, once conflict has begun.
3. *Jus post bellum:* Law concerning acceptable conduct following the official or declared end of a war (including occupations and indefinite ceasefires, the acceptance of surrender, and the treatment and release of prisoners of war (POWs) and enemy combatants after conflict has officially ceased).

A traditional emphasis of just-war theory focuses on when it is morally acceptable for a state to begin or participate in war, *jus ad bellum.* Natural law tradition associated with Aquinas began the systematic consideration of *jus ad bellum* and natural law and social contract theorists such as Vitoria, Grotius, Locke, and Kant continued refining this theory into the 20th evolvement into what in now internationally accepted LOW. There is a general consensus of six conditions that should be met for moral *jus ad bellum:*

1. Proper authority: War must be waged by a competent authority, typically an internationally recognized state, for a publicly stated purpose. This

condition is somewhat troubling when distinguishing between internal revolutions, 'freedom fighters', terrorists, and mere criminal behavior.

2. Just cause: There must be sufficient and acceptable justifications for entering war, such as self-defense, to restore rights wrongfully denied, and re-establishment of social order. It is generally held that when a state has forfeited its moral right to govern its citizens, other nations may invade in order to carry out humanitarian interventions to prevent genocide, such as in Kosovo. The main argument with this condition is determination of when a state has forfeited its moral right of governance. Developments in non-state and asymmetric warfare, particularly terrorism, complicate this requirement. Many philosophers regard the invasion of Iraq as unjust, because the threat there was potential and preemptive (removal of weapons of mass destruction) and not clear and present.

3. Proportionality: The good achieved by war must be proportional to the evil of waging it. It is immoral to wage a massive war to remedy a small wrong.

4. Last resort: Armed conflict should only be waged when peaceful means of avoiding conflict have been exhausted. This condition again makes any preemptive war (such as Iraq) problematic, since one cannot be absolutely sure that all negotiations have failed.

5. Reasonable success: This requirement asserts that there is no point fighting a war one cannot possibly win. Because the cost of war is so terrible, it is immoral to fight by futile coercion with no possibility of attaining one's goals. This requirement becomes problematic, again, when asymmetric warfare or terrorism is examined, in which suicide bombing is utilized, since there is no

clear definition on what 'winning' consists of. In many cases, killing the greatest number of people is the goal itself.

6. Right intention: There must be a subjective as well as objective moral rightness in entering a war. One must have the morally correct motivation and mindset to engage in war. Self-defense would be morally correct, but revenge would be immoral.

Peter Asaro (2008) raises an objection to the use of robots in war, suggesting that because robotic soldiers would likely reduce human soldier casualties, political barriers to waging war would be reduced. Sparrow (2007) and Sharkey (2007) also have written that war should require a terrible cost morally, and that combat robots might lead to greater instances of war.

This argument raises questions. The use of robots makes no difference as to whether the war meets *jus ad bellum* dictates, such as self-defense, last resort, greater good, etc. These objections also seem to imply that we should not make any improvements in the way we prosecute a war, and should return to more brutal methods of warfare to make war less palatable. This seems counterintuitive, as increasing technological weaponry, such as nuclear weapons, have reinforced the need for *jus ad bellum* and *jus in bello* restrictions. Further, while it is acknowledged that war is terrible and ought to be avoided whenever morally possible, a deterrence strategy to avoid war has worked during modern warfare, as the "Mutually Assured Destruction (MAD)" policy between the Soviet Union and the United States during the Cold War prevented armed conflict between those two countries. Lastly, it is not realistic to

expect unilateral disarmament of a technological advancement as significant as robotics by a single country, hoping that others will follow.

Jus in Bello

Much of the just-war tradition (O'Brien, 1981) asserts only two basic conditions for the external rules of *jus in bello:*

1. Proportionality. As with *jus ad bellum*, the military ends must be proportionate to the means: no unnecessary violence is to be used in order to attain one's military goal, but only a force proportionate to attaining one's goal. Robots would need to learn how to apply force proportionally to the stated mission, but this is not an impossible programming challenge. It is reasonable to assume that robots could perform at least as well as humans in deploying no greater force than necessary, passing this gate for moral deployment.
2. Discrimination and non-combatant immunity. One must attempt to discriminate between combatants and noncombatants to ensure the noncombatants are not targeted or killed. By engaging in warfare, enemy soldiers become legitimate targets of lethal force in order to coerce their surrender, but those who are noncombatants need not be forcibly coerced, and it is immoral to do so, subject to the Doctrine of the Double Effect.

In the Doctrine of the Double Effect (DDE), an action may be morally permissible, even if it is foreseen that it will cause a bad effect, if certain conditions are met (McIntyre, 2004):

a. The act itself is not morally wrong (e.g. killing combatants in wartime);

b. The good effect is produced directly by the action, and not by the bad effect (e.g., winning is produced by killing of the enemy combatants, not by terrorizing or murdering civilians; the use of nuclear weapons or widespread chemical/biological dispersal would fail this criterion);

c. The good effect is sufficiently desirable to compensate for allowing the bad effect (winning is worth killing civilians); and

d. The bad effect must not be intended, but merely foreseen and permitted (e.g., we would be happy if all Iraqi civilians escape, but we know they all will not, and we will never intentionally target them).

By the DDE, one can kill noncombatants only if the intention of the soldier is good, that is, his goal is the intended effect, the evil effect is unintended, and the soldier seeks to minimize evil involved, making any evil unintentional. Military necessity, then, permits collateral damage, as long as it was either unforeseen, or foreseen but unintended, and necessary to the attainment of the military objective.

The Principle of Double Intention (PDI)

Arkin (2007), based on the work of Walzer and others in the just-war tradition, has gone further and advanced the Principle of Double Intention (PDI), which is essentially the DDE with the additional condition that combatants are not only to refrain from intending harm to civilians, but they are also to take precautions to reduce risk to civilians, even at the expense of increasing risk to themselves. The PDI is the ethical consideration that the United States Army most frequently operates under when conducting current combat operations in Iraq and Afghanistan, although the increasing

frequency of targeted combatants hiding amongst noncombatants is making PDI much more difficult to follow.

Jus post Bellum

Jus post Bellum has been in particular focus this past decade because of the Iraq war and its aftermath. Although President Bush declared the end of major combat operations in 2003, the insurgency has caused far more casualties since then than the Iraqi government ever did. Civilian casualties at the hands of the peacekeepers and the infrequent war atrocity have been exploited by the insurgency, and have delayed the rebuilding of Iraq. *Jus post Bellum* operations would seem to be a natural fit for ethically programmed robots, who can neither be killed, nor commit atrocities.

Human Ethical Failings on the Battlefield

The goal of creating robots that are more ethical than humans on the battlefield may have a much lower bar than one might envision. A recent report from the Surgeon General's Office (Surgeon General, 2006) assessing the battlefield ethics and mental health of soldiers and marines deployed in Operation Iraqi Freedom is disconcerting:

1. Approximately 10% of soldiers and marines report mistreating noncombatants (damaged/destroyed Iraqi property when not necessary or hit/kicked a noncombatant when not necessary). Soldiers that have high levels of anger, experience high levels of combat or those who screened positive for a mental health problem were nearly twice as likely to mistreat noncombatants as those who had low levels of anger or combat or screened negative for a mental health problem.

2. Only 47% of soldiers and 38% of marines agreed that noncombatants should be treated with dignity and respect.

3. Well over a third of soldiers and marines reported torture should be allowed, whether to save the life of a fellow soldier or marine or to obtain important information about insurgents.

4. 17% of soldiers and marines agreed or strongly agreed that all noncombatants should be treated as insurgents.

5. Just under 10% of soldiers and marines reported that their unit modifies the ROE to accomplish the mission.

6. 45% of soldiers and 60% of marines agreed that they would report a fellow soldier/marine if he had injured or killed an innocent noncombatant.

7. 43% of soldiers and 30% of marines agreed that they would report a unit member for unnecessarily damaging or destroying private property.

8. Less than half of soldiers and marines would report a team member for an unethical behavior.

9. A third of marines and over a quarter of soldiers did not agree that their NCOs and Officers made it clear not to mistreat noncombatants.

10. Although they reported receiving ethical training, 28% of soldiers and 31% of marines reported facing ethical situations in which they did not know how to respond.

11. Soldiers and marines are more likely to report engaging in the mistreatment of Iraqi noncombatants when they are angry and are twice as

likely to engage in unethical behavior in the battlefield than when they have low levels of anger.

12. Combat experience, particularly losing a team member, was related to an increase in ethical violations.

Possible explanations for the persistence of war crimes by combat troops include (Arkin, 2009):

a. High friendly losses leading to a tendency to seek revenge.

b. High turnover in the chain of command, leading to weakened leadership.

c. Dehumanization of the enemy through the use of derogatory names and epithets.

d. Poorly trained or inexperienced troops, in both combat operations and understanding of the Laws of War.

e. No clearly defined enemy,

f. The issuance of unclear orders where the intent of the order may be interpreted incorrectly as unlawful.

g. Shortage of personnel has also been associated in producing stress on combatants that can lead to violations.

h. Youth and immaturity of troops.

i. An overpowering sense of frustration.

j. Pleasure from the power of killing.

k. External pressure from higher command or the public.

Slim (2008) outlined manifold reasons noncombatants are killed by other humans during conflict:

a. Genocidal thinking-ethnic or racial cleansing of populations.

b. Dualistic thinking- separating the good from the bad.

c. Power dominance and subjugation- power lust to exert force.

d. Revenge- emotional striking back for perceived wrongs.

e. Punishment and forced compliance- to shape the behavior of civilian populations.

f. Utility- it furthers the war strategically.

g. Asymmetrical necessity- tactical killing of civilians due to an inferior military position.

h. Profit- mercenary and looting activity.

i. Eradicating potential- preemptive removal of civilians that may become warfighters in the future.

j. Recklessness- shooting anything that moves, or other forms of indiscriminate killing.

k. Reluctant killing- through human error or accident, collateral damage.

l. Collective and sacrificial thinking- killing of groups rather than individuals, they must be sacrificed for a greater good.

These forms of thinking are not part of current artificial intelligence efforts and are unlikely to be ever incorporated in an autonomous system. Armed autonomous systems need not nor should be equipped with any of these forms of unacceptable human rationalization or action.

Arkin (2009) advanced convincing arguments for why robots might perform more ethically than humans:

1. The ability to act conservatively. Autonomous armed robots do not need to have self-preservation as a foremost drive, if at all. Self-preservation concerns have frequently caused human soldiers to fire on a target before certain target identification (friend or foe/combatant or noncombatant) had been made.

2. The development and use of a broad range or robotic sensors better equipped for battlefield observations than humans currently possess.

3. They can be designed without emotions that cloud their judgment or result in anger and frustration with ongoing battlefield events. In addition, "Fear and hysteria are always latent in combat, often real, and they press us toward fearful measures and criminal behavior (Walzer, 1977). Autonomous robots need not suffer in this manner.

4. Avoidance of the human psychological problem of "scenario fulfillment" is possible. This phenomenon leads to distortion or neglect of contradictory information in stressful situations, where humans use incoming information in way that only fit their pre-existing belief patterns, a form of premature cognitive closure. Robots need not be vulnerable to such patterns of behavior.

5. They can integrate more information from more sources far faster before responding with lethal force than a human possible could in real-time.

6. When working in a team of combined human soldiers and autonomous systems as organic assets, they have the potential capability of independently and objectively monitoring ethical behavior in on the battlefield by all parties

and reporting infractions that might be observed. This presence alone might possibly lead to a reduction in human ethical infractions.

Ethical Principles Applicable to Combat Robots

Most ethical theories, whether they are deontological or Kantian, utilitarian, cultural relativism, etc., assert that an agent should act in a manner that is derived from moral principles. By what methods could autonomous machines be programmed to act ethically?

Moor (2006), observes that deontic logic (for obligations and permissions), epistemic logic (for beliefs and knowledge), and action logic (for actions) all can have a role "that could describe ethical judgments by a machine." The Bringsjord (2006) research conducted at Rensselaer Polytechnic Institute concurred that deontic logic would be the best basis for producing ethical behavior in robots because:

a. Logic has been used for millennia by ethicists.

b. Logic and artificial intelligence have been very successful partners and computer science arose from logic.

c. The use of mechanized formal proofs with their ability to explain how a conclusion was arrived at is central for establishing trust.

The case for a deontological approach strengthens when reviewing the Army's ethical reasoning process for human combatants as outlined in the United States Army Soldier's Guide (U.S. Army, 2004):

Step 1. Define the problem you are confronted with.

Step 2. Know the relevant rules and values at stake: Laws, Army Regulations, Rules of Engagement, command policies, Army values, etc.

Step 3. Develop possible courses of action (COA) and evaluate them using these criteria:

a. Rules- Does the COA violate rules, laws, regulations, etc.?

b. Effects- After visualizing the effects of the COA, do you foresee bad effects that outweigh the good effects?

c. Circumstances- Do the circumstances of the situation favor one of the values or rules in conflict?

d. "Gut check"- Does the COA "feel" like it is the right thing to do? Does it uphold Army values and develop your character or virtue?

Step 4. Now you should have at least one COA that has passed Step 3. If there is more than one COA, choose the course of action that is best aligned with the criteria in Step 3.

There is a clear mix of deontological methods, followed by a utilitarian analysis. Each step of the ethical reasoning process, with the exception of Step 3d, could feasibly and practically be incorporated into an autonomous algorithm with current technology. The most important difference in the decision-making process between humans and programmed machines is speed. In a combat situation, there is frequently little time to carefully consider information before a decision must be made. This can result in an ethically deficient decision. Machines can run the decision-making algorithm with all available information in a split-second.

Arkin (2009) proposed the adaption of four architectural considerations for an ethical combat robot:

1. Ethical Governor: A transformer/suppressor of system-generated lethal action to permissible action. This deliberate bottleneck is introduced into the architecture, in essence, to force a second opinion prior to the conduct of a privileged lethal behavioral response.

2. Ethical Behavioral Control: This design approach constrains all individual controller behaviors to only be capable of producing lethal responses that fall within acceptable ethical bounds.

3. Ethical Adapter: This architectural component provides an ability to update the autonomous agent's constraint set and ethically related behavioral parameters, but only in a more restrictive manner. It is based upon either an after-action reflective critical review of the system's performance or by using a set of affective functions (guilt, remorse, grief, etc.) that are produced if a violation of the LOW or ROE occurs.

4. Responsibility Advisor: This component forms a part of the human-robot interaction component used for permission planning and managing operator overrides. It advises in advance of the mission, the operators and commanders of their ethical responsibilities should the lethal autonomous system be deployed for a specific battlefield situation. It requires their explicit authorization prior to its use. It also informs them regarding any changes in the system configuration. It also requires operator responsibility acceptance in the

event of a deliberate override of an ethical constraint preventing the autonomous agent from acting.

Algorithms for reasoning about moral challenges will not lead to appropriate behavioral responses unless the robot has access to the background information describing the situation, the ability to discern which information is essential and which inputs are of ethical concern, and the capacity to recognize inherent and potential conflicts arising from the competing interest of the various agents. This would need to be in the form of a "plug-in" to the robots ethical adapter, information that could be input prior to a combat mission laying out the current ROE and ethical constraints germane to the current environment.

The idea of a responsibility advisor addresses the need for a human in the loop of autonomous robotic combat operations. Current combat robots are operated on a short leash, and decisions to kill (mostly by Predator or Reaper UAVs), are made by a human operator and carried out by the machine. While this ensures that a human can always be held responsible for a bad decision, it does somewhat limit the advantages of autonomous systems. Eventually, I believe, as robots prove their superiority in target identification and ethical consideration, they will be allowed to make first-kill decisions. Humans would only serve to override the decision of a machine that refused to engage a target based on ethical considerations.

Conclusion

Creating autonomous combat robots that can act at least as ethically as human soldiers, if not more so, is a reasonable goal that should be pursued by the scientific

community. The technology to construct an ethical robot does exist, but other programming considerations also need to be made, such as target discrimination between combatants and noncombatants. Robots are not merely another weapons system. They have the potential to replace human soldiers, saving lives of both combatants and noncombatants as intended by the Geneva Conventions and the *jus in bello* tradition. It is important that the social scientific community continue to consider the ethical and social questions of combat robots as they are developed and advanced, particularly before irrational public fears or accidents arising from military robotics derail research progress and national security interests.

Chapter VI

The Case for Increased Utilization of Robots in Combat

The Political Case for Robots in Combat

Sometimes bad things happen to good countries.

On May 1st, 1960, CIA agent Francis Gary Powers piloted a Lockheed U-2C, known as Article 360, from Peshawar, Pakistan on a mission with the operational code word GRAND SLAM. Powers' mission was to overfly the Soviet Union, photographing ICBM sites in and around Sverdlovsk and Plesetsk, then land at Bodø in Norway. Due to a previous overflight by a U-2 of the Soviet Union only weeks earlier, all units of the Soviet Air Defense Forces were on high alert, even on the Soviet Mayday holiday. Soon after the plane was detected, Soviet Air Force Lieutenant General Yevgeniy Savitskiy ordered the air-unit commanders "to attack the violator by all alert flights located in the area of foreign plane's course, and to ram if necessary."

Because of the U-2's extreme operating altitude, Soviet attempts to intercept the plane using fighter aircraft failed. The U-2's course was out of range of several of the nearest SAM sites, and one SAM site even failed to engage the aircraft since it was not on duty that day. However, the U-2 was targeted and damaged by a salvo of three SA-2 surface-to-air missiles (one of which also shot down a Soviet jet attempting to intercept Powers) near Degtyarsk, Ural Region. Powers successfully bailed out and parachuted to safety, while failing to activate the aircraft's self-destruction devices. He was captured soon after parachuting down onto Russian soil. Powers carried with him a

modified silver dollar which contained a lethal, shellfish-derived saxitoxin-tipped needle, but did not use it to end his own life.

The CIA immediately went into spin mode. Four days after Powers disappeared, NASA issued a detailed press release noting that a "weather aircraft" had "gone missing" north of Turkey. The press release speculated that the pilot might have fallen unconscious while the autopilot was still engaged, claiming that "the pilot reported over the emergency frequency that he was experiencing oxygen difficulties." To bolster this, a U-2 plane painted in NASA colors was shown to the media.

After learning of this, Soviet Premier Nikita Khrushchev announced that a United States "spy plane" had been shot down but intentionally made no reference to the pilot. As a result, the Eisenhower Administration, thinking the pilot had died in the crash, modified NASA's cover story claiming that the plane was a "weather research aircraft" which had strayed into Soviet airspace after the pilot had radioed "difficulties with his oxygen equipment" while flying over Turkey. The Eisenhower White House acknowledged that this might be the same plane, but still proclaimed that "there was absolutely no deliberate attempt to violate Soviet airspace and never has been," and attempted to continue the facade by grounding all U-2 aircraft to check for "oxygen problems."

Not only was Powers still alive, but his plane was also largely intact. The Soviets recovered the surveillance camera and even developed some of the photographs. The incident resulted in great humiliation for Eisenhower's administration, now clearly caught in a lie. The resulting bad blood between the two superpowers led to the collapse of the Four Power Paris Summit that had been previously scheduled just days

after the shoot-down. Further, the incident severely compromised Pakistan's security and worsened relations between the United States and Pakistan.

Powers was thoroughly interrogated and pled guilty to espionage later that year. He was sentenced to a total of ten years in confinement. He was returned to the United States in a prisoner exchange, in which the U.S. returned convicted Soviet spy Rudolf Abel.

On December 4th, 2011, a CIA Lockheed Martin RQ-170 Sentinel was captured by Iranian forces near the city of Kashmar in northeastern Iran. According to unnamed U.S. officials, the aircraft was flying on the Afghan side of the Afghanistan-Iran border when the pilot lost control and crash-landed in Iran. The government of Iran claimed the aircraft was downed by anti-aircraft fire and/or by an Iranian electronic warfare unit stationed by Kashmar. The Iranian government released video footage of the RQ-170 on December 8th and announced they intended to reverse-engineer the internal components.

The difference between the 1960 and 2011 incidents? The RQ-170's pilot was safe in a friendly country because the aircraft was an unmanned aerial vehicle. The political advantages to the United States cannot be overstated. This time, the United States has plausible deniability. Perhaps the Iranian border incursion was just a mistake. Maybe the UAV internal electronics was full of viruses and Trojan horses just waiting to be plugged into Iranian networks. Because the UAV streamed data, there is no film to prove the UAV was on an Iranian spying mission. Best of all for the United States, there is no human pilot to be interrogated or imprisoned. The RQ-170 certainly isn't talking.

The Military Case for Robots in Combat

Deep among North Waziristan's mountains, far from any village, Hafiz Hanif finally tracked down the remnants of his old al-Qaeda cell last summer. The 17-year-old Afghan had wondered why he hadn't heard from his former comrades in arms. They didn't even answer his text messages in May, after U.S. Special Forces raided a compound in Abbottabad, Pakistan and killed the man they all called "The Sheik:" Osama bin Laden. Now Hanif saw why. Only four of the cell's original 15 fighters were left, huddled in a two-room mud-brick house with little money or food. Except for their familiar but haggard faces, they looked nothing like the al-Qaeda that he had trained and fought with just months ago. They welcomed him warmly but didn't encourage him to stay. They said the cell's commander, a Kuwaiti named Sheik Attiya Ayatullah, had gone into hiding. The others had either run off or died. "Why should we call you back just to get killed in a drone attack?" explained his friends (Yousafzai and Moreau, 2012).

When President Obama was sworn into office in 2009, the nation's clandestine drone war was confined to a single country, Pakistan, where 44 strikes over five years had left about 400 people dead, according to the New America Foundation. The number of strikes has since soared to nearly 240, and the number of those killed, according to conservative estimates, has more than quadrupled. With the recent killing of Abu Yahya al-Libi by a Reaper UAV, U.S. officials have said that the number of "high-value" al-Qaeda targets in Pakistan has dwindled to one: al-Qaeda leader Ayman al-Zawahri. The utilization of armed UAVs has arguably done more to destroy the ranks

of al-Qaeda and the Taliban that any other method, and with absolutely no risks to United States military members. In the coming austere military budget era, it makes sense to put our finite resources into the most effective methods of eliminating threats to the United States. Robotics, along with cyber-warfare, are likely to prove to be two of the most cost-effective methods of national defense.

Lying low didn't help Hanif's former commander, Sheik Ayatullah; he was stalked and killed by a UAV shortly after Hanif's return to Wazirstan.

The Business Case for Robots in Combat

In 1981, the U.S. Air Force developed a requirement for an Advanced Tactical Fighter (ATF) as a new air superiority fighter to replace the F-15 Eagle and F-16 Fighting Falcon. This was influenced by the emerging worldwide threats, including development and proliferation of Soviet Su-27 and MiG-29 fighter aircraft. It would take advantage of the new technologies in fighter design on the horizon including composite materials, lightweight alloys, advanced flight-control systems, more powerful propulsion systems and stealth technology. The aircraft that eventually was developed was the F-22 Raptor, which cost a jaw-dropping $150,000,000 per copy before the program was cancelled after the procurement of only 177 aircraft.

The F-22 has never seen combat, despite its enormous cost, while its unmanned cousins, which are about 1/10 of the cost (for a Reaper) see combat every day in Afghanistan. The F-22 has been plagued with a number of safety concerns, the most recent having to do with (lack of) oxygen generation for the pilots, which has caused hypoxia in several cases and was a contributing factor in the death of a pilot when he

passed out. The F-22 cannot be flown remotely, so when its pilot lost consciousness, the plane crashed. Recently two Raptor pilots took the unusual step to air their safety concerns with the aircraft on the television show "60 Minutes" (Scarborough, 2012).

The Defense Department is now trying to field another stealth fighter, the F-35, which will be the most expensive combat system ever, at over $1 trillion over the life of the program if it is not curtailed or cancelled. The F-35 is also not capable of being remotely piloted and is designed for a single pilot. It is running into a number of design problems and budgetary overruns. Part of the problem is the insistence that a pilot remain in the cockpit. Although humans have evolved over hundreds of thousands of years, technology has evolved at an exponential rate since the Industrial Revolution. The evolution from the first manned powered flight to flying humans to the moon and returning them safely to Earth took only 66 years. It is a simple biological fact that our bodies cannot withstand the same levels of acceleration and increased gravitational forces that machines can. Neither the F-22 nor the F-35 will ever be able to be flown to their full aerodynamic potential simply because some maneuvers the aircraft are capable of conducting would cause their pilots to pass out. Without a remotely piloted option or automatic landing function, an incapacitated pilot would result in the plane crashing, which has been the case since the Wright brothers took to the skies over a century ago.

A significant amount of cost in any combat system is devoted to keeping the pilot or occupants alive in a violent combat environment. Besides cost and flight dynamics, space and life support systems for a human pilot cause an aircraft to be larger than it needs to be. Larger aircraft are less nimble, less stealthy, and more likely to be targeted

and hit. Certainly, additional avionics or weapons systems could occupy the space that is currently dedicated to the human pilot.

In my opinion, there is no longer a business case for purchasing a strictly combat system that does not have at least a remotely piloted option. Designing a combat system from the ground up to be remotely piloted or semi-autonomous would be even better.

The Army is considering purchasing a new combat system to replace the Bradley Fighting Vehicle, a system that nearing 30 years old. The Army has been somewhat coy with the specifications for this vehicle, dubbed the Ground Combat Vehicle (GCV) but has indicated the vehicle should be capable of carrying a full infantry squad of nine soldiers, in addition to three crewmen and should be armored to protect these occupants. BAE Systems teamed up with Northrup Grumman and released their vision of the GCV- a monster of a vehicle that will weigh in at 70 tons- more than twice the weight of the vehicle it is intended to replace, and actually one ton more than a M1A2 Abrams tank. Most of that weight comes from multiple armor packages that rest on a steel core hull to provide maximum protection to the occupants, who are also sharing their space with the vehicle's ammunition and fuel. The upshot of all this weight is that the vehicle can only be air-transported, one at a time, by two aircraft in the Air Force's inventory, the Boeing C-17 and the Lockheed C-5, both of which require a 7500 foot-long modern runway to take off and a 3500 foot-long modern runway to land.

The proposed GCV is also exceptionally large, as might be expected for a vehicle that can carry 12 occupants- almost 11 feet high, 15 feet wide, and over 28 feet long- a very large target on today's battlefield. Without requirements to carry infantryman, the

combat vehicle could be significantly smaller and have a much lower and stealthy profile, and thus much more difficult to hit with direct fire weapons. It could also be much, much lighter, as the only need for armor would be to protect the internal workings of the vehicle, not the actual occupants. A significantly lighter and smaller combat vehicle could conceivably be transported by the plentiful C-130 aircraft, which can take off and land in much more austere environments.

Something that military and political leaders don't like to discuss is the financial costs of dead and wounded soldiers, but there are such costs. The Army stands to save in direct ways by implementing robotic systems, such as reductions in loss of life and casualty avoidance.

According to iCasualties.org, as of May 2012, there were 1,985 deaths and 15,322 combat-related casualties among U.S. servicemen and women deployed Afghanistan, on top of the 4,486 deaths and 32,223 service members that were wounded in Iraq. Some 14,000 of these troops were so seriously wounded that they will be unable to serve after their injuries. The injuries include wounds from shells, explosions, gunfire, mortars, land mines, grenades, and small arms fire, as well as infections resulting in such conditions as brain and spinal injuries, blindness, facial deformity, multiple broken bones, nerve damage, cardiac and internal organ damage, as well as traumatic brain injuries (Stiglitz & Bilmes, 2008).

The direct cost to the military for each death is typically more than $500,000, which is paid to decedent's next of kin as a death gratuity and life insurance policy. The military also pays for burial expenses and transportation of the remains, which can add

tens of thousands to the total. Indirectly, the military must also recruit and train a new service member to take the decedent's place.

The cost to society for a death is much greater than the government's direct and indirect costs. Stiglitz and Bilmes estimated these costs as $7.2 million per life lost.

The direct costs to the government for wounded service members can be substantially greater than deaths, since treatment in many cases will continue over the service member's lifetime. Disability compensation is another significant cost driver. Of veterans from the 1991 Persian Gulf War, in which 258 U.S. service members were killed and 849 wounded, 45% of the 700,000 that deployed have filed disability compensation claims. 88% of these claims have been approved, costing the U.S. $4.3 billion in annual disability benefits (Stiglitz & Bilmes, 2008). It would be easy to assume that a similar proportion from the current conflicts will file disability compensation claims at some point, at an average benefit of $8,890 per year.

Medical care for wounded veterans is difficult to estimate, since costs and lifespans vary depending on the severity of the injury. Stiglitz and Bilmes projected that 48% of current veterans would eventually seek treatment from the Veterans Administration and of these, 60% would seek short-term treatment (lasting less than 5 years) and 40% would remain in the system for the rest of their lives. Under these assumptions, the U.S. government will pay $121 billion for these veterans' healthcare and an additional $277 billion in disability benefits, just for the veterans of Afghanistan and Iraq.

Conclusion

More aggressive robotic development could lead to deploying far fewer U.S. military personnel to other countries; achieving greater national security at much lower cost, and most importantly, greatly reduced casualties. It is clear that robots cannot replace human soldiers at this time, but they can begin to take on the most dangerous and lethal tasks of war.

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Appendix A

Questionnaire

Note: The questionnaire was taken in an automated format; there were no paper versions used. The survey software automatically routed the respondents to questions based on their answers. For clarity, the routing commands are highlighted in red next to the answers that would trigger a re-routing.

My name is Michael Kolb, and I am a Ph.D. candidate in the Department of Advanced Studies at the University of Oklahoma. I am requesting that you volunteer to participate in a research study titled "Soldier and Robot Interaction in Combat Environments." You were selected as a possible participant because you may have worked or currently work with military robots. Please read this information sheet and contact me to ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study: The purpose of this study is to study how Soldiers and robots interact, both in and out of combat environments. The results will help the Army develop new doctrine in the employment of robots, as well as assist engineers who design and program military robots.

Procedures: If you agree to be in this study, you will be asked to fill out a web-based survey, which should take no more than 10 minutes.

Risks and Benefits of Being in the Study: The study has no risks to you. The benefits to participation are that your input will help drive research and development of both Army doctrine relating to unmanned systems and development of better unmanned systems.

Compensation: You will not be compensated for your time and participation in this study.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not result in penalty or loss of benefits to which you are otherwise entitled. If you decide to participate, you are free not to answer any question or discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled.

Length of Participation: Approximately 10 minutes.

Confidentiality: The records of this study will be kept private and your supervisor will not have access to your responses. In published reports, there will be no information included that will make it possible to identify you as a research participant. Research records will be stored securely and will be destroyed at the end of the project. Only approved researchers will have access to the records.

Contacts and Questions: If you have concerns or complaints about the research, the researcher(s) conducting this study can be contacted at (703) 695-4840 or michael.kerry.kolb@us.army.mil. The faculty advisor may be reached at (405) 325-4553. In the event of a research-related injury, contact the researcher(s). You are encouraged to contact the researcher(s) if you have any questions. If you have any questions, concerns, or complaints about the research or about your rights and wish to talk to someone other than the individuals on the research team, or if you cannot reach the research team, you may contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at (405) 325-8110 or irb@ou.edu.

Please keep this information sheet for your records. The next question will ask if you would like to participate in the study.

1. Do you wish to participate? *(please select)*

Yes, I agree to participate

No, I decline to participate (Go to Thank You page)

2. Please describe your current location: *(please select)*

Combat Zone

Non-Combat Zone (OCONUS)

Non-Combat Zone (CONUS)

3. In the last five years, approximately how many months have you spent in a combat zone? *(please select)*

I have not served in a combat zone in the past five years (Go to 11)

Six months or less

7-12 months

13-24 months

25 months or more

4. Service in a combat zone can have varying degrees of stress. Please rate the stress/intensity of your last combat tour: *(please select)*

Not at all stressful

Slightly stressful

Moderately stressful

Very stressful

Extremely stressful

5. Have you ever been attacked by the enemy in a combat zone? *(check all that apply)*

No, I have not been attacked by the enemy in a combat zone (Go to 8)

Yes, by indirect fire (mortars, rockets, ect.)

Yes, by a Improvised Explosive Device (IED) or mine

Yes, by direct fire or combined arms ambush

Yes, by a sniper

Yes, Other *(please specify)*

6. Approximately how many times have you been attacked in a combat zone? *(please select)*

0

1

2

3

4

5

More than 5

7. Have you received any of the following decorations? *(check all that apply)*

Silver Star

Bronze Star with 'V' device

Army Commendation Medal with 'V' device

Purple Heart

Combat Infantryman's Badge

Combat Action Badge

Other (please specify)

For the purposes of this study, a 'robot' is the primary effector of an unmanned system, including tele-operated devices. Other names for robots include but are not limited to Unmanned Aerial Vehicles (UAV), Unmanned Aerial Systems (UAS), Remotely Piloted Aircraft (RPA), and Unmanned Ground Vehicles (UGV). Examples include the Raven, Shadow, Gray Eagle, Warrior A, Packbot, MAARS, or TALON.

8. Do you currently work with a robot in your job or have you worked with robots previously? *(please select)*

I currently work with a robot

I have worked with a robot in the past (Go to 12)

I have never worked with a robot (Go to 26)

9. Think of the robot you most commonly use in your job. Is your primary robot a: *(please select)*

Unmanned Aerial Vehicle (UAV/UAS/RPV)

Unmanned Ground Vehicle (UGV)

I use both UAVs and UGVs equally

10. What model of robot do you most commonly work with? *(please select)*

Packbot/Warrior

MAARS

TALON

Grey Eagle

Shadow

Raven

Other *(please specify)*

11. How many months have you worked with a robot? *(please select)*

Less than 1

1-3

4-6

7-12

13-24

More than 24 months

12. Have you worked with a robot in a combat zone? *(please select)*

Yes

No (Go to 15)

13. What model of robot did you work with in a combat zone? *(please select)*

Packbot/Warrior

MAARS

TALON

Grey Eagle

Shadow

Raven

Other *(please specify)*

14. How many months have you worked with a robot in a combat zone? *(please select)*

Less than 1

1-3

4-6

7-12

13-24

More than 24

15. Have you named your robot? *(please select)*

Yes

No (Go to 17)

16. What is your robot's name? *(please specify)*

17. Have you ever awarded rank to your robot? *(please select)*

Yes

No (Go to 19)

18. What is your robot's rank? *(please select)*

PV1/PVT

PFC

SPC/CPL

SGT

SSG

SFC

MSG

1SG

SGM/CSM

WO1

CW2

CW3

CW4

CW5

2LT

1LT

CPT

MAJ

LTC

COL or above

Other (please specify)

19. Have you ever awarded a medal, combat badge or qualification badge to your robot? *(please select)*

Yes

No (Go to 21)

20. What medals or badges have you awarded your robot? *(check all that apply)*

Silver Star

Bronze Star

ARCOM

AAM

Combat Infantryman's Badge

Combat Action Badge

EOD Badge

Airborne Jump Wings

Air Assault Wings

Other *(Please specify)*

21. Which of the following statements do you MOST agree with? *(please select)*

A military robot should be treated like a piece of equipment

A military robot should be treated like a member of the team

Other *(please specify)*

22. How intelligent is your military robot? *(please select)*

Not at all intelligent

Slightly intelligent

Moderately intelligent

Highly intelligent

Extremely intelligent

23. How would you feel if your robot were destroyed in combat? *(please select)*

Not sorry at all

Slightly sad

Moderately sad

Very sad

Extremely sad

24. If your robot were damaged would you prefer to: *(please select)*

Have it repaired

Have it replaced

25. How much do you enjoy working with a robot? *(please select)*

I don't like it at all

I like it a little

It's okay

I like it

I love it

26. How useful are robots on the battlefield today? *(please select)*

Useless

Less useful than the average human Soldier

As useful as the average human Soldier

More useful than the AVERAGE human Soldier

More useful than ANY human Soldier

27. Do you feel that increased use of robots in the future will save Soldiers' lives? *(please select)*

Robots will never save lives

Robots might save a life now and then

Robots will probably save some lives

Robots will definitely save SOME lives

Robots will definitely save MANY lives

28. Do you have a pet? *(please select)*

Yes

No (Go to 31)

29. What kind of pet do you have? *(check all that apply)*

Dog

Cat

Bird

Horse

Rabbit

Turtle

Snake

Gerbil/Hamster/Guinea Pig

Other *(please specify)*

30. What is your pet's name? *(please specify)*

31. Have you ever named your car, truck, boat, or weapon? *(please select)*

Yes

No

For the next four questions, think about the team member you like BEST.

32. How intelligent is the team member you like BEST? *(please select)*

Not at all intelligent

Slightly intelligent

Moderately intelligent

Highly intelligent

Extremely intelligent

33. How would you feel if the team member you like BEST were wounded in combat? *(please select)*

Not sorry at all

Slightly sad

Moderately sad

Very sad

Completely devastated

34. If the team member you like BEST were wounded in combat, would you prefer: *(please select)*

They return to the team after treatment

Another Soldier replace them on the team

35. In your opinion, could a robot replicate the duties of the team member you like BEST? *(please select)*

Yes

Not now, maybe in the future

No

For the next four questions, think about the team member you like LEAST:

36. How intelligent is the team member you like LEAST: *(please select)*

Not at all intelligent

Slightly intelligent

Moderately intelligent

Highly intelligent

Extremely intelligent

37. How would you feel if the team member you like LEAST were wounded in combat? *(please select)*

Not sorry at all

Slightly sad

Moderately sad

Very sad

Completely devastated

38. If the team member you like LEAST were wounded in combat, would you prefer: *(please select)*

They return to the team after treatment

Another Soldier replace them on the team

39. In your opinion, could a robot replicate the duties of the team member you like LEAST? *(please select)*

Yes

Not now, maybe in the future

No

40. Please use this space to add any comments you may have about your experience working with a military robot:

41. Your gender *(please select)*:

Male

Female

42. Your rank *(please select)*:

PV1/PVT

PFC

SPC/CPL

SGT

SSG

SFC

MSG

1SG

SGM/CSM

WO1

CW2

CW3

CW4

CW5

2LT

1LT

CPT

MAJ

LTC

COL or higher

43. Your MOS or Branch: *(please select)*

11B

11X

12B

15W

18-series

19D

31B

89D

Aviation

Infantry

Engineer

Special Forces

Military Police

Other *(please specify)*

44. Your age: *(please select)*

20 or younger

21-24

25-29

30-39

40 or older

45. The highest level of civilian schooling you have completed: *(please select)*

High school diploma or GED

Some college, no degree

Associate degree

Bachelor’s degree

Master’s degree or higher

46. If you would like a picture of your robot to be included in the published version of this study, please email a photo to mkkolb@gmail.com Please indicate if you would like your name attributed to the photo.

Thank you for your time and participation in this important study.

Appendix B

Robot Names

172 respondents provided the names of the robots they had worked with.

Human names (male):

Bobby, Bob (2), Chuck, George, Percy, Herb, Timmy, Murphy, Roger, Winston, Chad

Human names (female):

Heather (A UAV named after a friend's cheating ex-wife because it would "go down" (crash) with most operators), Jennifer, Jenny (2), Helga (2), Betty (2), Shirley, Mindy, Betsy, Maria, Michelle, Amanda, Stacy, Sally, Becky, Lucy, Tamara, Sarah, Shelley, Gertrude, Elvira, Elizabeth, Tessa, Julie

Cartoon or movie characters:

Johnny 5 (26), Snoopy(3), Tweek (3)(an over-caffeinated scatterbrained character on *South Park*), Charlie Brown, Betty Boop, Bender (2) (cartoon robot from *Futurama),* Scooby, Stewie, Cujo, Ricky Bobby, Optimus Prime (2), Bumblebee, R2-D2, Chuck Norris (2), Terminator, Wall-E (3), Frankenstein (4), Kenny (*South Park* character that always dies), Godfather, Jack Bowers, Mr. Roboto (2)

Non-original names:

Warrior, SUGV XM1216, UASTD, Shadow, Shadow 200, Reaper, Hunter

Traditional military:

War, Famine, Death, Pestilence (set of 4 UAVs), Loki (sometimes assists the gods, sometimes makes problems for them), Black Betty, Old Faithful, Killer, The Italian

Stallion, Jody (traditionally a hypothetical man who stays home from war and steals your wife or girlfriend), Black Knight, Screamin' Demon, The Fighting Cock, The Secret Agent, The Dixie Queen, The Immortal, Slow Poke, The Beast, Acey-Duecy, Cajun Raven

Other:

Peeping Tom, Chopper, Pain-in-the-Ass, Little Boy, Timmy Rambeaux, Whispering Eye, Eyeball, The Penetrator, Sparky, Zero, Red, ReRe (urban slang for someone who acts like a retarded person), Mouse, Crunk (a form of high-energy southern rap music), Maximus, Tumper, Crash, Little John, Precious, Pin-up Girl, Sneak, Lawndart 9, Bleeper, Monster, SLM (Soldier-saving Lawn Mower), Chief Squats-To-Piss, Juggernaut, Sand Whale, Lil' Eye in the Sky, Herman the German, Sassy, Rerun, Kang, Reliable, The Sphinkter, Lawn Dart, Ol' Faithful, Grave Digger, Toto, Coffin Bird, Hanger Whore, Bitch Bird, Devil Bird, Old Sparky, Nineteen, Tryducefife, Pos-Bot, The Go-Getta, Boom Checker, Sticks, Spunky, Bat Bird (named for its tendency to hit bats upon launch at night)

Appendix C

Photos from survey respondents

Respondents were invited to email a photo of their robots. Where photo credits are used, respondents agreed to have their names used.

Figure 11: UAS Platoon, Company B, 3BSTB

From Matthew Wolf: Here is a photo of UAS Platoon B Co 3BSTB. This photo was taken early this month (September 2011) when we were recognized as having completed 10,000 accident free flight hours. Currently we are only the second unit ever to achieve this goal and we are still flying strong. Hopefully in the very near future we will pass the record holder in total hours and hopefully we will be the first to achieve 15,000 hrs 20,000 hrs and so on. Bravo UAS Platoon was the unit selected to field test

the (LDS) Laser Designation System as well as the CRP (Communications Relay Package) and has several additional accolades to their credit.

Figure 12: Raven used by B Company, 1-505th Parachute Infantry Regiment, 82nd Airborne Division

Figure 13: Raven aloft in Iraq

Figure 14: Launching a Raven in Iraq

Previous three photos: Raven used in Iraq 08-09. B Company, 1-505th Parachute Infantry Regiment, 82nd Airborne Division (Photos courtesy of SPC Nikolas Karahalios)

Figure 15: PackBot Delivering Pig's Head

Photo of 12th Chemical Company's (Schweinfurt, Germany) PackBot 510 with HazMat Suite. It was delivering the pig head during a field dining in to the Battalion Commander in order to open the mess. (Photo courtesy of Captain Jennifer Montgomery)

Figure 16: “Johnny Five” interrogates an IED in Afghanistan

Photo of robot, "Johnny Five." This is taken while three Explosive Ordnance Technicians were interrogating/exploiting an IED just outside FOB Tillman (named after Pat Tillman) in Paktika Province. (Photo courtesy of Travis Findlay)

Figure 17: Maryland ARNG and their Shadow UAV

The Maryland Army National Guard platoon and their Shadow TUAS RQ-7B's are currently serving in Afghanistan (as of September 2011) under the operational control of United States Marine Corps VMU-3 Phantoms. (Photo courtesy of Sergeant William Sowa)

Appendix D

Write-in responses from Question 5

1. Suicide Vest;

2. Complex attack incorporating VBIED (Vehicle Borne Improvised Explosive Device), SVEST (Suicide Vest), Small Arms Fire and Grenades;

3. Complex attack (Mortars, RPGs (Rocket Propelled Grenades), and SAF (Small Arms Fire) in the same incident;

4. Attempted ground attack on Kandahar Air Base;

5. Suicide bomb SVIED (Suicide Vehicle Improvised Explosive Device) / VBIED;

6. Physical attack/ hand-to-hand combat (2);

7. EFP (Explosively Formed Projectile);

8. Not sure; maybe sniper

9. VBIED(s) (2);

10. Close to, but not recipient of and IED and VBIEDs;

11. Due to OPSEC (Operational Security) I can't specify.

Appendix E

Write-in responses from Question 7

1. Air Crew Member Badge

2. Army Achievement Medal (3)

3. Army Commendation Medal (ARCOM) (16)

4. Bronze Star (11)

5. Combat Action Ribbon from USMC (3)

6. Combat Medical Badge (3)

7. Meritorious Service Medal (4)

8. Valorous Unit Award

9. Purple Heart (Pending)

10. I could have a Purple Heart if I turned in my medical records and statements

11. I didn't get any of that stuff, as you had to actually shoot at people to get a CAB when I was there; and when I was deployed as a diplomat I didn't carry a gun. I got $500 for taking a wounded Iraqi deputy minister to the hospital, does that count?

Appendix F

Write-in responses from Question 20

1. “Punisher Skulls” on aircraft that provided targeting for a successful strike
2. 3 AK 47 Shots couldn’t bring it down
3. Air Medal
4. ARCOM w/ valor
5. CIB, combat aviation badge
6. Hellfire decal signifying successful enemy engagement
7. I drew it on a piece of tape and put it on the side of the Raven
8. Purple Heart Medal (13)

Appendix G

Write-in responses from Question 21

1. Both. He/she is more than a piece of equipment and is a far better team member than any one will ever have. The robot is still a piece of equipment; it needs more attention than any other piece of gear that you have. And it's the best team member you could have. It doesn't complain it just does what you tell it to do, except if you have an old Packbot and it starts to ghost on you. Then it's a piece of crap and you want to beat the robot.

2. As a tool to save /prevent risk of danger to others

3. Both here are correct to me

4. I care about my birds, but also understand they are equipment.

5. It is a tool, an extension of my arms.

6. A military robot should be treated like a very, very expensive piece of equipment

7. Both

8. A military robot should be treated like an asset

9. Member of team until necessary, then equipment to save life

10. Should be provided the protection another team member would receive.

11. Depends on the level of AI I would say. For robotic systems that are 100% user remote controlled I go with equipment, but smart systems of the future that are able to speak back, I would say Member Of Team.

12. More than equipment, but less than a member of the team

13. Robots are a range of capability. Teleoperated ones I doubt would be treated like a member of the team. I would expect that once they can follow you like a dog without a

remote operator, then you'll start to see massive personalization of how the solders perceive robots.

14. Both

15. A military robot is a piece of equipment but is your life line and should be treated like you own it.

16. Both of the above statements are true; depends on the context.

17. Seriously, it’s just a robot

18. Member of the family

19. It should be treated as a piece of equipment depending on the situation that presents itself (i.e. life or death as far as human concerns)

20. It should be treated as both, depending on the use.

21. I think they are both.

22. Depends on the situation and Robot type. A robot that could kick in doors should be treated differently than a robot aircraft

23. Our robot failed on mission basis even after repairs were made

24. A military robot is a piece of equipment. However, it is a vital asset just like any weapon in my Arms room. It provides for lethal intelligence gathering to myself and my fellow Scouts. It gives us the ability to extend our eyes and ears further into the battle field. A military robot is equipment, but; it should be treated as if it is the rifle in your hand, it may just be the thing that saves your life.

25. A military robot should be treated in a manner consistent with its design and function.

26. Both

27. It is an essential piece of equipment that requires detailed care

28. A military robot should be treated like a piece of equipment and a member of the team.

29. A military robot should be treated as an extension of its operator

30. Both it is a piece of vital equipment for the combat team, care should be taken to ensure it is capable, it is not a being

31. A military robot should be treated better than an average piece of advanced equipment; however, it should not be treated like a team member because it cannot think for itself and ultimately requires human input.

32. I see no differences between the two, both are equally important for their purpose

Appendix H

Write-in responses from Question 29

1. Hermit crab (3)

2. Rabbits

3. Fish (23)

4. Chinchilla (2)

5. Aquatic life

6. Tiger

7. 2 dogs & 2 cats

8. Rat, chameleon

9. Bearded dragon (2)

10. Spouse

11. Plant

12. Lizard

13. Tarantula

14. Roomba

15. Gecko

16. Rats to feed the snake.

17. Toad

Appendix I

Additional comments from respondents

General

1. US Army Explosive Ordnance Disposal has led the Army community with regards to robotic employment since the earliest robotic systems were introduced to DoD organizations. They have a wealth of experience and input into robotic deployment in combat and use of robots by small teams. Recommend pursuing input from the Army EOD community. (Comment 3)

2. I think we are about 15-20 years away from a truly effective robotic system for ground combat operations. We seem to be much further along on UAV type robotics, and that may be an indicator of the importance of air space control and its impact on soldier survivability on the battlefield. (Comment 6)

3. I've not yet worked with robots in my Army career. As a machinist (91E),I have some experience with motors, servos, gearing etc. , and am fascinated by the UAV technology, and building RC planes and other vehicles. (Comment 13)

4. My experience was minimal, but would love to be involved in newer more advanced technology. (Comment 14)

5. I'm a EOD Tech, I work with robots on a regular basis and would love to see some improvements in the robot systems we use. (Comment 28)

6. The robot I worked with was well suited for indoor chemical RECON. Some upgrades were required due to loss of signal once vehicle entered concrete industrial buildings. (Comment 34)

7. I think there is plenty of room to improve on the equipment forwarded out into the field to save our soldiers lives. If that means coming up with a robotic soldier that can go places or was able to perform a task that a highly trained soldier could not perform. It would also behoove us to use the experience and combat/tactical knowledge of soldier when coming up with new designs for this subject. Give the soldiers what they really need not just a UAV that tells us what's going on on the ground or a robot that takes care of just IEDs. I would like to see a suit or a robotic soldier that these combat trained soldiers operate and control and watch the death tolls drop. I have been in for 10yrs now and watch a lot of changes in military tech increase to help us save lives and operate with more ease. (Comment 36)

8. I have just seen them in use with EOD. (Comment 39)

9. I work at Fort Benning, GA. I am the SUGV Master Trainer. Please feel free to call me any time. (Comment 40)

10. I have very much so enjoyed the time that me and Penetrator spent together watching the sunrise over Afghanistan. We have shared many moments together and I will always consider Penetrator a member of my own family. I wish all robots were just like Penetrator. (Comment 42)

11. Survey would not allow the options to select multiple robot platforms as I have experience with Talon, Packbot, RONS, etc. (Comment 50)

12. I think you like robots too much. (Comment 55)

13. At NTC I had a brief chance to work with a robot. I did not feel it necessary to mark the box that said I had previous experience because it was so short lived. (Comment 83)

14. I am a prior service soldier who has voluntarily re-classed to work with the UAS/UAV systems. I am in the school house learning how to maintain the Shadow equipment. (Comment 85)

15. I served as the commo lead for a UAS node in Iraq. Loved it so much that I am scheduled to reclass my MOS to UAS operator in November. I am extremely eager to be involved in this field. Astonished that my future career will take me where my childhood only dreamed. (Comment 88)

16. Military robots are not the same as the AVERAGE human soldier therefore should not be compared to the AVERAGE human soldier. Furthermore, requesting initial entry training soldiers to participate in a survey about a combat zone in which he/she has never been to or asking him/her to rate the usefulness of a robot that he/she is not fully trained to operate discredits this survey and any hypotheses generated from this survey. (Comment 90)

17. The as useful as the average human soldier was a hard question. A UAS can fly and see more and outperform a soldier on the ground in most aspects, and can even outperform manned aircraft due to ease of use, loiter time etc. Human intelligence and being able to go into buildings, and interaction with locals outweighs that of a UAS, and UGV technology is nowhere near able to replace that yet and maybe never. (Comment 94)

18. On the question, "How useful are robots..." I didn't truly agree with any of the answers. Robots are VERY useful on the battlefield, but in a different way than the average soldier. It was hard to compare the two as they are suited for different jobs. (Comment 98)

19. Our technology is old, we need quantum chips! (Comment 101)

20. I have some experience but not a lot with working with military robots. But I am starting to get more and more interest with them. (Comment 105)

21. Want to work with more. (Comment 106)

22. It is fun to work with (Comment 113)

23. The robots are good, but the software platforms are not fully reliable and very slow. (Comment 114)

24. Get better software (Comment 120)

25. This survey is coming from an Army EOD Technician. I have worked mostly with the Packbot and Talon. I have used other robots regarding explosive ordnance disposal. Hope this helps. (Comment 134)

26. I believe that UAS is difficult to compare as a squad member. (Comment 145)

27. I have no idea why I am participating in a survey where people would name a piece of equipment. Hope this information was helpful. Actually not sure why anyone would need this info. Not answering personal questions so that I can be singled out later. (Comment 148)

28. The robots I worked with in Turkey were German made, we had different names for them even though i didn't list them. The assembler was "Adolf", the sensor was "Stalin", the movement bot was "Winston", and the processor was "Teddy". Due to the era, the names were supplanted for that reasons. (Comment 150)

29. I don't have any experience with robots, however I have worked with unmanned aircraft which can function like robots (Comment 157)

30. I know this is a survey but I feel like some of the questions were worded very poorly and I couldn't choose an answer that best stated my opinion. (Comment 161)

31. Well I am really surprised to hear of this survey on AKO. I currently work for the RSJPO from Selfridge and I am a site NCOIC for the Joint Robotics Repair Detachment in Kandahar. I would think that something like this would come through us because we work hand in hand with the Soldiers, Sailors, Airman, and Marines who put these platforms through their paces on a daily basis in a hostile environment. We would be happy to assist and would like to know the results. (Comment 192)

32. I was an Explosive Ordnance Disposal tech and we used robots to disrupt ordnance or identify ordnance. (Comment 198)

33. I am the grandson of Rear Admiral Carl J. Seiberlich, Commander of the USS Hornet for the Apollo 11 and 12 recoveries. I have had the opportunity to experience various equipment such as robotic arm simulators and things like that growing up. Also, I am an avid XBOX360 player... with games like Call of Duty and Battlefield Bad Company 2 which simulate weapons and robotic equipment in gameplay. Lastly, I am a commissioned Army officer and am currently assigned to Aberdeen Proving Ground, (Army Test and Evaluation Command)... a R&D activity, although, my current job function does not involve interaction with robots. (Comment 270)

34. I have not had any previous experience working with a military robot. I would however, like to see some of these robots in action and have some sort of formal training prior to working with them. (Comment 284)

33. I mostly observed the use of ground EOD robots in Afghanistan, although I did work with the EOD teams, so I suppose, I also worked with their robots. I work with

and advise our UAV platoon and am particularly interested in the Class 3(fuel) issues involved in supplying UAV's with aviation gasoline overseas. Some of these questions are silly, but I suppose you are trying to see how much Soldiers view their robots as more than equipment. (Comment 211)

34. I work with the FLETC (Federal Law Enforcement Training Center) in their TID (Training Innovation Div) We do a lot of usability testing, trouble shooting, and advanced function evaluation in my dept. Mostly Avatar and Simulator based technology. I am very interested in the aspect and potential of Robotics in combat and noncombat environment. (Comment 288)

35. Was the Army's first UAV Platoon Leader in 1987. Served two years in that position, and later retired at Ft Huachuca to become a Pioneer UAV instructor. I've been working with unmanned systems since 1996. (Comment 295)

General Positive

1. I believe they can be a very valuable asset and look forward to further robotic units to be integrated into my squad. (Comment 2)

2. I think robots could be a great addition to the military, especially with the rate that technology is evolving. I would love the opportunity to help with the advent of technology and robots assisting in the military today and in the future. (Comment 4)

3. I am currently the Robotics instructor at the 10th Mtn (LI) IED-Defeat center. Robotics play a very important role in counter IED and are a great battle field multiplier. (Comment 5)

4. Handy for dismantling IED's and handling surveillance (Comment 10)

5. USEFUL TOOL WHILE CONDUCTING ROUTE CLEARENCE (Comment 12)

6. The use of them in combat is beneficial in many ways. The optics on them can see things that would normally not be visible. It also allows for safer travel into danger areas. (Comment 17)

7. I worked with military robots in Ft. Benning in a company that tested equipment..(like robots) for combat use. We ruggedly field tested them and graded their performance for use in the field during mock field exercise with Opfor. Our primary interest was being able to change the 1-3 combat ratio to a 1-1 combat ratio (soldiers vs combatants) by implementing robotics and advanced equipment to reduce the risk of loss and injury to soldiers. Robots are cheaper than humans and more expendable. They would give us intel that we could use to pinpoint the location of the enemy so we could effectively engage the enemy with unmitigated risk. My team worked with the Packbot remote control vehicle and cameras and a remote control integrator. It was a remote control vehicle that could follow waypoints that were pre-routed and also had a seeing-eye sensor that could detect movement and follow soldiers. The idea was you could use to resupply, evacuate and several other support features so less personnel would be needed to complete such tasks. So instead of needing 8- or ten people plus a security detail...all you would need for the movement was the security detail and the vehicle operator. (Comment 21)

8. I was the robotic NCOIC for A CO. 1/29 INF RGT (EXFOR) in Ft. Benning, GA. I worked with M.A.A.R.S mainly but also worked w/ Skylark, air robot, R-Max Helicopters, R-Gator, and a few other platforms. As far as robot integration into a line unit it would take the hundreds of hours of training like I received but would be well

worth it. I just got back from deployment 9 months ago and I would have gave anything to have a few M.A.A.R.S robots with us. I along with 2 other soldiers came up with and developed the TTP's for the M.A.A.R.S. Any other questions feel free to email me. (Comment 23)

9. I love the idea. Perhaps we can save some money and lives by using robots. Obviously replacing a man will take a while, but apparently we already successfully employ UAVs and bomb robots; other types are sure to come - especially with all the new technologies being developed. (Comment 29)

10. I don't use robots in my job but I am the guy who repairs robots for the guys who use them every day. Every time one comes in for repair the soldier wants it fixed ASAP because it helps them so much and is a great part of that team. (Comment 35)

11. They do play a vital role in the Military operations today and need to continue to grow in the civilian sector. (Comment 41)

12. - Military Robots will evolve from being a tool for the Soldier to becoming a member of the manned/unmanned team. - The number of armed robots will increase as trust and confidence increases. - Unmanned Systems will greatly improve the persistence, endurance, and protection of the Joint Force. (Comment 45)

13. UAS is a great asset to the military and our country (Comment 46)

14. Robots have their place in combat zones. I manly use them for recon work to get eyes on faster because of the lack of troop in the area. (Comment 52)

15. Current Military robots I have worked with have great capabilities and potential for unlimited use. There is still room for improvement and modifications to increase the robots use in combat. (Comment 59)

16. I have seen robots used in theater, Iraq, to obtain intel or disable IED's. This makes the effort safer for soldiers. (Comment 66)

17. Invaluable asset so long as they’re durable, long lived, not cumbersome and cost effective (Comment 67)

18. I like them because they allow greater standoff and scare people. (Comment 72)

19. I have spent the last nine years focused entirely on unmanned aircraft, spanning Group 1-5 UAS, on six continents and with four services. I have integrated UAS with Unmanned Ground Sensors, as well as Unmanned Ground Vehicles, in combat and imminent danger zones. Prior to that, I spent ten years as an infantryman and four years as a scout pilot. I continue to be amazed at the way that military robotics has augmented the soldier, and extends the range of influence of the individual and unit. (Comment 82)

20. Two deployments to Iraq with the Shadow system was amazing. (Comment 91)

21. UAV's have served as excellent targeting, surveillance and observation platforms and are invaluable. (Comment 92)

22. I love to work with the UAV systems. I believe that one day they will advance even further and prove to be even more useful than they already are (Comment 93)

22. They are useful right now but they will have better systems in the future and be better equipped for combat. (Comment 109)

23. Robots could help all units and its Soldiers by doing tasks that are time consuming and less relevant and/or more dangerous. Robots are maybe the answer. (Comment 119)

24. Robots are an essential part of life nowadays. They should be integrated into most dangerous jobs to limit injury and death. (Comment 123)

25. Robots will help you in blind spots. You will complete your mission in easy ways with the robots. (Comment 124)

26. This field is growing fast, and will be the most important job in the future (Comment 129)

27. Ummm they're cool (Comment 131)

28. I think that if a robot can do it then we need to proceed with this new way of military life. (Comment 132)

29. The chance to use military robots is the best thing I ever could have done in my experience in the military (Comment 136)

30. I believe the technology exists now for a robot to replace a soldier on the battle field but it would be too expensive to deploy such a complex system. (Comment 137)

31. HazMat military robots are outstanding additions to HazMat Response (reconnaissance) platoons and play an integral role in safety and presumptive identification. They are also extremely useful to the DES community on Army garrisons. (Comment 138)

32. I believe the robots are a good help with EOD and other lines of jobs because they help keep soldiers off the battle lines, they are very beneficial to the army and keeping numbers up, jobs available, and are very useful from UAVs stealth is the key and with the TALON keeping bomb technicians out of harm's way. (Comment 139)

33. I was assigned as an APM to Robotic Systems JPO from 2001-2004. During this timeframe, I fielded the initial ENG and EOD units will the small robotic systems. I established the base operations at Lost Lake at Camp Victory, Iraq. I returned in 2009 to see the operations still ongoing and had expanded from what I had in 2004. "Out front

in harm's way" says it all. Back in 2004 it took three months to build a new Talon or Packbot. I don't know how long the production lead time is now, but it still takes 18 years minimum to grow a Soldier. (Comment 142)

34. I have spotted many IED's with the Packbot, and the Talon in areas of operation. They are very useful to see and disarm bombs and to clear houses. (Comment 151)

35. I have enjoyed using my Raven to aid in the completion of the mission to help keep me and my fellow soldiers safe. (Comment 152)

36. In an ever growing need and demand for specialized equipment such as UAVs etc. If something works well and can be dependable< the soldiers will use these systems with great confidence, if systems are faulty they will be brushed aside and have a negative reputation. This is a crucial time for automated systems. (Comment 153)

37. It's better to send a robot into a potentially lethal, static situation than to send a human Soldier. (Comment 166)

38. Robots are awesome and a huge asset to the military (Comment 167)

39. Dealt with the Talon robot in southern Afghanistan in 2009-2010 while conducting route clearance operations. When utilized properly, it maintained the safety of the men in my squad. Deploying the robot took time initially, and the PL would get frustrated, but if it keeps my men safe, I'll gladly take that time to deploy and interrogate the suspected IED. (Comment 168)

40. I love the idea. I believe technology gives us a leg up against the enemy and we should use every advantage possible. (Comment 177)

41. They're pretty sweet, I watch Future Weapons. Put some tubes on that thing and make some craters, yo. (Comment 181)

42. They are pretty cool, just need to work out the kinks (Comment 182)

43. They are good. (Comment 185)

44. Very useful. (Comment 186)

45. I have yet to work with "Military robots," but, I am excited about the future functions and progress that they have come through. (Comment 188)

46. They are an amazing asset the video and the mic attached to them help alot the range on them sometimes sucks but we have vehicles that are capable of taking a good hit so we can mitigate that with angles of approach while approaching a danger area. (Comment 189)

47. I work with the MQ9 Reapers, even though we are located in Nevada these birds are flown in combat zones on the other side of the planet. They allow us to directly support the warfighter from home. They've allowed me to go home at night to my family and nothing is more precious in this age of high OPTEMPO. (Comment 201)

48. They are the future, they very diverse in air, sea, and ground maneuvers. I've worked and instructed the utilization of UAS for about 6 Years, to include holding a degree in the UAS field. (Comment 203)

49. The robot we used was a remote control one that we attempted to use to check for an IED, the robot's arm broke the first time we tried to use it. We were able to verify that the suspected IED was a bomb, even though the robot broke I could see how useful it was, had the IED just been some displaced rocks we might have waited for hours for EOD to show up instead we were able to verify the IED without putting any human lives at risk. (Comment 210)

50. I came from working on AH64A to work on UAV/UAS and I find that it has been the best choice I have ever made in my military career. They are fun to work on and because they are so new I feel I am challenged to learn more and do better when working on them. (Comment 219)

51. This is the future (Comment 224)

52. EOD use would be extremely useful, attached one bomb sniffing robot to the front of the vehicle to detect IEDs before you roll over them and get injured. Robot will stop the car or increase armor protection with titanium plates that are retracted and expand when the robot detects danger. (Comment 228)

53. Unmanned systems with human operators are at least as useful as the same system manned and in many cases would be more useful. Completely autonomous systems don't have the flexibility or the situational awareness to be useful yet. (Comment 231)

54. Because of my Job (EOD), I have worked with many ground robots and have a few been blown up, better them then a trained soldier. I have had a UAV in the air while doing dismount operation and it gives a warm and fuzzy feeling knowing you have someone watching. (Comment 237)

55. I believe it is a very innovative step forward for the field of Robotics. I sincerely hope that this will help the US Army greatly. (Comment 241)

56. The raven is one of the best tools I ever used in the military to date. I have over 18 years and this is the one I love the most. (Comment 244)

57. I worked with a robot for about 2 months during an experiment for the chemical corps. The robot was outfitted with all the chemical agent detectors and could enter an environment that would normally be difficult of a human. (Comment 256)

58. It's the way of the future. (Comment 257)

59. As an engineer, doing route clearance in Afghanistan, we used the Packbot, Talon and PUMA and T-Hawk quite a bit. They were very useful in gathering intel down our routes, and flying the PUMA at 500 ft and ahead of our convoy was very, very useful in keeping an eye on our route ensuring no one placed IEDs ahead of or behind us. (Comment 263)

60. Military Robots are amazing. I've handles the Ravens, and the EOD robots. I cannot wait to be a part of the future of the United States ROBOT ARMY. It will be epic. (Comment 267)

61. It's the thing of the future and I want to be part of it (Comment 283)

Robots Save Lives

1. I am an Explosive Ordnance Disposal Soldier in the United States Army and have been working with different robotics platforms from the Talon to the Packbot and several others that are not mentioned. Robotics platforms have saved many EOD Soldiers lives. We use them every day to disarm IEDs inside the United States and on deployment. (Comment 1)

2. Robots save lives. Make them simpler, lighter, and more powerful. Control should be intuitive. Make them more autonomous. (Comment 7)

3. The Shadow 200 UAS can and will save lives when used properly. The battle that the system is fighting now is having to be directly attached to IBCT's. The system must be treated like the aviation asset it is and not just another Brigade asset. This is a special system and needs to be used to its fullest potential. I understand the success it has had has been enormous but there is so much more to this system than the Army world has seen. (Comment 22)

4. As an EOD soldier, I believe robots are invaluable. Robots have served our units time and time again in positions that no human, team member, or soldier can or should do. There are several times I can think of that a robot has saved my life or the lives of my team members. (Comment 31)

5. I think robots save lives. I think it’s better that we have more robots on the ground than the US Soldier. I rather see a piece of metal get blown up than a human being. I can fix that robot and send it back into danger than try to put a human being back together and send back there. (Comment 49)

6. I spent the majority of an 18 month deployment to Afghanistan, and Germany (6 months), as a robotics repair technician for RSJPO (Robotics Joint Project Office). I worked with robots on a daily basis. I was either repairing, maintaining, or instruction of the use of Robotic Platforms. I am a firm believer of robotics used in combat. I have seen them save lives and hope we continue to improve on what we have now. (Comment 51)

7. EOD needs great robots in order to continue saving lives (Comment 53)

8. Robots are great for finding explosives and easier for soldiers to deploy a tool to find one. Especially with complicated IED in combat zone, more robots to save lives upon approaching a device. (Comment 61)

9. I think the idea of robots in the military is a great thing. I believe they can and will save human lives. The work I have seen done with UAVs in the military is a tremendous life saver not only for the soldiers on the battlefield, but also for the lack of a pilot in a cockpit in the event of an emergency. (Comment 62)

10. My experience has taught me that robots, when used properly, are a safe alternative to placing soldiers at risk/harm's way. Robots save lives. (Comment 69)

11. I enjoy the work I do with the shadow 2000 UAS. I am a maintainer so I know the bird inside and out and know for a fact that my Shadow can, will and has saved lives.

12. They are definitely the future and can possibly save many lives in combat and various situations (Comment 73)

13. Crow System is also the "Bomb." Iit would be nice if we could put it on the back of the MRAP so we could have two turrets on top of the gun truck one human in the front turret and one machine turret on the back. Thermal cam on the robots have saved people's lives with IED when used right. (Comment 74)

15. I feel that robots in the Army are going to fill a very necessary role in controlling combat losses of human personnel. (Comment 80)

16. I have not had the chance to work with robots, but I believe they are the future of combat zones and will aid in saving many lives in battle. I am very excited to see what they can do! (Comment 84)

17. Robots are proving themselves more useful as time goes on. It will be nice to send more robots into a combat situation than the soldiers themselves. It will save lives and will make many families happy. (Comment 87)

18. Military robots are great asset to have, they assist in saving lives and reduce the risk of life of our friendly soldiers by not having them out on the battlefield. (Comment 96)

19. I was a Team leader in the 82nd ABN in Iraq. I operated the Raven for a year there in support of multiple missions. It is a very useful system at a Company level for overhead eyes. I am now an EOD tech and use the Packbot and Talon. Both can and do save lives and are very useful when practical for use. (Comment 97)

20. I have worked with UAS systems for 8 years now and they are the way of the future. They will definitely save more lives the more they are used. (Comment 103)

21. Robots are the way of the future and they already save the lives of many soldiers! (Comment 108)

22. They're a very creative and innovative way to save lives....should've been thought of sooner! (Comment 110)

23. Military robots are the future of combat. They can and will save thousands of lives. (Comment 111)

24. I think that robots could be very useful to the military and may save many lives. (Comment 116)

25. I think that robots are a great piece of additional equipment to a team to help further the success of the mission and lower the potential risk of personnel loss. (Comment 118)

26. More UAVS should be weaponized to help save lives (Comment 127)

27. I work with the Shadow (UAV) and I like the field of training and what the shadow can do for us. And also the advantages it gives in the combat zone, it does help save lives in the combat zone. (Comment 135)

28. I have used robots to defeat IEDs on three occasions, I feel that it saved my life or at a minimum made my job far less stressful. I'd rather blow up a robot than myself. (Comment 144)

29. I have only worked with UAVs and the fact that if one of those crash no lives are lost which I think is great. Also for the most part the quiet and move pretty fast and the fact they can take pictures or video is even better. (Comment 158)

30. They are necessary in today's battlefield environment to save lives and find the enemy. They need to be used and developed properly, however. Extending an airframe, for example, outside its original intent when there are currently other platforms developed for that purpose it creates unnecessary expense and development. Not to mention a potential for incidents as the training cannot happen fast enough at times forcing units to utilize the equipment prematurely. They are a cost effective way to replace otherwise expensive options. (Comment 163)

31. I think the "robots" of the military are great ideas and save 100s of lives daily. (Comment 164)

32. I've worked with shadow UAS for a very long time now, 2003, and it has proven extremely useful providing aerial surveillance while posing no threat to human life. Not only does it keep the pilots/operators safe, but it is also potentially saving human lives

and providing a capability to commanders allowing them to have "eyes" over their team. (Comment 169)

33. Robots used for intelligence gathering gives our soldiers in the field a large advantage in changing environments, enemy movements, and minimizing the amount of wounded soldiers in combat. (Comment 170)

34. I work with UAV's; they are an irreplaceable asset which allow a piece of equipment to take the risk instead of a human. (Comment 171)

35. Working with robots is the way of the future, and it will in turn save many lives. (Comment 184)

36. I have worked with Packbots and Ravens over the past 5 years and the technology that has been placed within that equipment is priceless. They keep soldiers out of harm's way and they are able to provide the team with a valuable asset as far as a birds-eye-view. We used our Packbot for surveillance before entering and clearing buildings to ensure a safe entry. We used out Raven immediately following an indirect attack on our base to catch the person launching rounds. I personally was able to launch my raven before Shadow or Air Weapons Teams were able to make it to the scene and basically do a battle field handoff to the next weapon. (Comment 190)

37. I have worked with military robots since 1989. I have watched them into good fighting force multipliers but they have a way to go still. I am currently a DA Civilian working to field the UGVs and know they save many lives but we can do better. (Comment 191)

38. Robots will advance the military and aid in saving the lives of many. The test is hard to take because of the many variances of robots and human interactions. The questions could apply to many situations. (Comment 194)

39. They have definitely saved lives when working with IED's. They've also provided information about them that couldn't be safely gathered at all by a person. UAV's have been incredibly helpful throughout my experiences as well. I'm greatly appreciative of our technological initiatives. (Comment 195)

40. Robots integration should be the future of the Army. They save countless lives and can be placed in harm's way instead of soldiers. Future Medic robots, better EOD robots, or better unmanned air drones like the Predators, will give the US Military the edge we need with our current small force (man-power). It is amazing to me the things we can do with only 500K soldiers. But we are spread thin. Robots will reduce casualties and increase our flexibility down-range. Robotic prosthetics/implants for soldiers should also be looked into. (Comment 196)

41. They save lives and help seek information without the risk of soldier. Robots have equally share our lives that help us return to our families. Robots should be rewarded for their service in combat and model others robots and operators to do the same. (Comment 207)

42. They have a great role in today's battlefield. One day I hope they will have more AI features, but for now the skill of the user mixed with the capabilities of the robots are saving lives overseas. I have had a chance to see this first hand and it is awesome to think that things will only get better in the future. (Comment 209)

43. I am an EOD Soldier. I have been working with robots for over 11 years in the Army. I have extensively used the Remotec Andros, the Foster Miller Talon, and the iRobot Packbot. Although my team and I seldom named our robots, they each have a personality of their own, a unique way that they are better than the others, and unique ways that are less practical than others. I will always appreciate what they have done for me. I personally owe my life to around 30 different robots that have been hit by IEDs in my place. Although the death of each robot is sad, in a way it is a happy event... that one of my team didn't lose our lives. So yes, we Soldiers who value our lives LOVE our robots like they are one of our team... the disposable one! (Comment 217)

44. I currently work on the Shadow UAS system I have deployed with the system as well as worked with EOD to stand up one of the Army's first CIED platoons ware I was able to work with the Talon and Packbot robots. All the systems I have used have been extremely useful in their own fields and thou the talon and Packbot have saved countless EOD members lives the Shadow and other UAV systems save lives every hour they are in the air. I don't have the statistics but I know it's something like 80% of operations that are covered by Air Support in one shape or another are about 90% less likely to be attacked then operations without Air coverage. Like I said the numbers may be off but they don't lie Robots have and will continue to SAVE SOLDIERS lives on the battlefield every time they are employed. I look forward to seeing the advancement of these and future robots to see how much more they will be able to do. (Comment 232)

45. I have worked with UAV (Shadow 200) for nearly 10 years now. I have flown them in combat with unit that has a high OPTEMPO. The UAV has helped greatly in

many ways from tracking targets, to surveillance, even as far as helping the ground troops from injury by relaying messages about enemy movements in close proximity. (Comment 243)

46. The robots gave us the ability to deal with IEDs without risking a human life, I had 2 robots blown up and if those weren't robots it probably would have been me blown up and most definitively killed. (Comment 246)

47. Military working robots are the next generation. They can go into places humans cannot afford to go, they can removed piles of wires and moved strange objects and if they go off, we'll, we saved a father, a son or a soldier...a robot could be repaired back to duty, functioning well with no problems, or it can be replaced, while a soldier wounded in combat is a loss for the entire team and it affects unit readiness and morale overall. A robot can lift certain amounts of weights that a human cannot. Robots one day will work together with our soldiers and destroy the enemy and save innocent lives, Mr. tony stark already have proved it. They should be treated as part of our army family and when we get a chance to work with one, we should take great care of them when something malfunctions. Robots right now do not have feelings, but we are not far from building one from figuring out puzzles to competing in certain sports, not just chess. The perfect example of a humanoid is the robot that is in the space station right now, created by NASA and GM, robots like those, will continue to be built, until they are just part of society, and everyday life. By the year 3025, robots will be part of our everyday lives and our environment. A great example of a flying robot is our current UAV Predator, armed with hellfire rockets, this "robots", controlled by a human, located miles and miles away, at an undisclosed base, are able to monitor, gather intel, data and

strike key enemy leaders or militants, that human intelligence cannot do. In conclusion, robots are an essential part of our efforts to protect freedoms and fight terrorism. (Comment 252)

48. It made me feel good that i was doing something that could save huge amounts of lives. If I could do it again I would. (Comment 253)

49. They're good for IED'S. I would prefer for one of those to blow up rather than a soldier. Every life counts. (Comment 255)

50. In the right situation i.e. looking for explosives, and placing explosives charges on IED's the right robot can save lives when used properly. Stand-off Detection and Neutralization should always be the primary means to investigate a potential threat prior to sending a Soldier forward. Robotic technology is a part of the Military that should continue to advance and be integrated into any area that will assist in saving Soldiers lives. (Comment 273)

51. I'd rather lose a robot than a brother. (Comment 276)

52. Work with robot's in Afg. I ran a C-IED Team and the robot the life of my EOD team more than once. I would send the robot out to look at an IED before I would send any Solider. The robot can be replaced, not the Solider. (Comment 279)

53. I have used the HAZMAT Versions of the TALON and I Robots. These are critical in first entry and atmospheric detection of confined spaces and buildings, I would rather lose a 200,000 piece of equipment than a human life. (Comment 280)

54. Provided much in need situational awareness for foot soldiers. It was an incredible feeling to know that your work in making a "life or death" difference in some distant battlefield. (Comment 281)

55. Achieve precision well above human abilities, along with adaptable databases to assist on mission. Human error is often the leading cause of mission failure, with human casualties. Autonomous use limits the variables associated with the mission, making a more controlled environment. Failure results in equipment loss not human life lost, with replacing an easy option. Functions as a worry free device to rescue, recon, or destroy set objectives. One final advantage that is often overlooked is that humans are humans. Sure we can throw on some camo to hide our figure, but robots we can design them to look like everyday objects to not pick up attention. Crinkled soda can makes a perfect recon bot. (Comment 285)

56. I used the robot to instruct others, in a school house environment. It is my belief that with a greater understanding of the capabilities of these systems we can gain a greater advantage against our enemy and in turn use this knowledge to better prepare plans and tactics with a third order effect of saving Soldiers lives. (Comment 287)

57. I absolutely hope the army considers using more robotic technology in the future and that the DOD comes to an understanding that the use of them will considerably change the face of the battlefield especially in Afghanistan and that it will greatly reduce the casualty rate of these conflicts, metal or flesh one is more easily replaceable. I hope you agree. (Comment 297)

58. Worked with Robots prior to being deployed. They are great, takes the human out of harm's way. SWAT have been using robots for years to find bombs, finally the US Military is doing the same thing. (Comment 300)

59. The future and current use of UVs allows lives to be saved (Comment 302)

Robots Save Lives but Can't Replace Humans

1. Robots allow users to remotely enter dangerous areas; e.g. IEDs, limited visibility, bunkers, caves. However, currently there is no replacement for the human eye and ear in reference to recon. Sometimes you have to go down and investigate the device on foot. The robot when used properly can save countless lives, but improperly can cause laziness and loss of skills to occur. (Comment 11)

2. Robots are one of the greatest tools we have. We are able to use them in place of a human soldier saving countless lives. The future of robots will need to have more agility, mobility, better dexterity. They will need to be lighter, smaller, yet stronger. It is very unlikely that a robot will be able to do what I do. However; we can use them remotely to continue to keep us safe. All robots have a specific task and should be designed for such task. (Comment 19)

3. As a bomb tech (EOD) soldier I have used robots for many years. I was in Germany when we were fielded our first unit (non standard off the shelf). Our second model was the Ron D at that time it was limited and we were told we had to use this one so that we could prove we needed equipment with grater capability. I went to the British Bomb Disposal course and was trained and used the Wheelbarrow both wire and wireless. The benefit of the British system was that operators in the field could come up this and ideas prove it out and field new equipment in months not years. The only thing I can say is that this type of system allows soldiers to meet the current threat now and not years from now. Robots are a tool like a gun and need varied capabilities. In EOD the robots save lives and when we were originally shown a new vehicle in Germany the engineer vehicle "Unimog" it could be remote via cable or wireless. Because of cost we

were given the truck not the remote package. Bean counters think money and operators think lives. I have been involved in ordnance (UXO) range clearing operations in the last year and the USAF has several robotic vehicles for clearing operations that insure people are safe and if anything does happen it's the equipment not the person that takes the hit. Long and short of it is Robots save lives. (Comment 26)

4. I am a maintenance technician for the robotics program. I believe robots save lives every day and are a useful tool, but should never take over for real soldiers. (Comment 63)

5. I was NCOIC of the Robotic Systems Joint Program Office from Aug 2005-Nov 2007. RSJPO during this time was responsible for fielding, initial training, and repair of all robots issued for combat use in Theater, in addition to its traditional role of evaluation, research and development of robotic systems for military use. During this time I spent app. 4 months in Afghanistan and Iraq as a repair facility manager. 2008-2009 I was in Iraq with an engineer Brigade, whose duties included coordinating the route reconnaissance element for an infantry division. My robotic experience is not quite the same as the typical user, in that I did not spend a lot of time with a single system. I did get of broader overview of robotics than the typical user, including route recon, surveillance, IED/UXO disposal, and demining operations. Robotics are a very powerful tool, and will become more so as technology advances. They have already saved many lives. However, I don't believe they will replace the need to have a Soldier as the "brain". Robotics are like any computer system in that they are very good at routine tasks. They are also very literal and don't adapt well to the changing conditions of a battlefield (at least at the current level of technology). They do allow the Soldier to

remain at a safe(er) distance from the danger, and expand the soldier's capabilities to perform his mission. Just like any other good piece of equipment. (Comment 71)

6. The Raven that we use is a great asset. We can keep overwatch of an area of interest for an extended period of time without putting soldiers in Danger at an OP. The Raven has many outstanding capabilities. During an exercise at JROTC we flew the Raven for 7 hours straight only bringing it down to replace the battery. This was during the C.O.B. defense exercise. The Raven was key in positively identifying the enemy and walking in ground troops to eliminate the enemy. The Raven was also a great tool in early warning system with being able to see the enemy's movement and flexing the defenses to repel the attack. The Raven is a great asset. Being a 19K the Raven could not replace any of my soldiers but it is an outstanding tool if used correctly and can save many lives. (Comment 100)

7. Robots are very important to the development of our technology. They will someday become as useful as humans but never be able to have the gut reactions that humans embody. They will never have a true intuition that would save their lives or the lives of other humans or robots. (Comment 104)

8. I feel like military robots are useful and can save many lives, but are not as reliable as a human soldier because of software malfunctions and technical problems, but as time progresses I feel like there is great potential for them to be an even better asset to our force. (Comment 115)

9. Military Robots are extremely useful and will save many soldiers' lives but you can never have a group of robots do the job of a group of humans. It's not wise too- we have all seen Terminator. (Comment 121)

10. Robots, Androids, even Cyborgs might someday save the lives of countless soldiers with their help it would give us the definitive edge in combat but has science come too far though? Can you really replace the best weapon of all- the mind? Robots are the future but we shouldn't become complacent in technology. (Comment 128)

11. Robots are used to do remote operations that any one of my team members could do, but it’s safer to send the robot. Robots will never replace a team, just make a team safer. They also can only be used in certain scenarios; robots cannot be used in all cases. (Comment 146)

12. I have been working with robots for over 15 years. We need a range of robots to do different jobs. You cannot replace everyone with a robot, you still need troops on the ground. I have seen many improvements in robots over the years but there is still a lot to be done. We need better cameras and better equipment to be used with the robot. The Government also needs to own the data rights to the robots so we save tax payers dollars and can put all of industry to work on better equipment. Also some of the questions need to have other as a category in this survey. I would repair my robot if I could and if not then replace it. It is a matter of saving tax payers money then being in love with the robot. It is a piece of equipment that at times is a member of the team when it can be used. During those times when it is used it is my life line and that is why it needs its maintenance done at all times to the highest level which will help save my life and others. (Comment 155)

13. I have high hopes for robots in the military's future. I like the concept of using robots for situations in combat that have the potential to severely injure a human being (bomb diffusing and flight operations). However; I also understand that there will

always be dangerous combat situations that require the rational thought process of a human being. With the technology available today I don't think robots should be able to make decisions in combat (i.e. clearing rooms in raids and such). I am really looking forward to seeing how combat (combots!) robots progress in the future. (Comment 160)

14. In the survey there were a lot of questions about ones attachment to the "robot" and in my opinion ones attachment to objects such as these will be gained in time, much like ones favorite toy as a child or weapon as in some military cases. With that said I believe "robots" can do their specific task better than any human because that's what they're designed to do i.e. shadow is better at surveillance than I could ever be, but the presence of a soldier will always be needed and I don't believe one could ever replicate the diversity of ability and mental capacity of a human. A "robot" can only do what is programmed while a human has the ability for critical thinking, judgment, and understanding of situations that a soldier has to have and a "robot" cannot be programmed with. There is a need for "robots" in theatre and they will save countless lives on both sides of combat, but they can never "replace" a person. (Comment 187)

15. Military robotics definitely has a place on the battlefield and has the ability to save soldiers lives. A robot cannot replace the soldier; due to most robots not having all five senses with the ability to process this information. One way or another the human factor will be involved in military operations but in the front line robots are a huge advantage. (Comment 193)

16. Robots are life saving tools that can be battlefield multipliers! They are only as good as the people that operate them until they can learn to think by themselves. (Comment 199)

17. My Military time has spanned over three decades and three different branches, USMC, National Guard, and now Active Army. I have seen drastic changes from the Gulf War up to OIF & OEF. Robotic technology defiantly enhances soldier readiness and provides unique perspective on the battlefield. Robots disarm IED's and UAV's track and target enemy activities. There is no question that they save lives and provide critical battlefield intel. Additionally a Shadow flies for 6+ hours on 44 liters of fuel. What aerial asset do we have that can perform the same task as efficiently? Robotics should NEVER replace the soldier but it is defiantly a shoulder to shoulder asset! (Comment 216)

18. Robots are a great addition to the military and save countless lives but caution should be used when comparing them to humans. One reason is that they provide no loyalty or comrade support. They can only react with what they are programmed and not any other scenarios. Humans have a natural instinct. (Comment 275)

19. Can robots take the place of a soldier? I think is the wrong way to approach welcoming the idea of implementing robots in the military. Why not ask how we can maximize the robots potential in not only working with soldiers but also contributing in saving lives. Robots in this present time frame cannot connect with soldiers emotionally for the most part, but they definitely can contribute in other areas. I think that robots would be great for use in dangerous situations that pose potential fatal threats. Situations such as clearing houses with potential bomb threats. Possible IED's, entering houses with potential terrorist activity. Use of the robots as bait to give soldiers a better idea of what they are facing. In combat the bond that forms between battle-buddies is

something that a robot just can't connect with, but it doesn't mean that robots can't help keep the bond between soldiers alive. (Comment 296)

20. I see robots as very useful in combat to soldiers and to save lives but they will not replace a well trained soldier as the soldier can adapt to anything and can interpret emotion and other factors robots cannot. On the other hand robots can still do things that a soldier cannot like carry heavy equipment and other tasks so they are very helpful to soldiers. (Comment 298)

21. I have worked with UAV's / UAS systems for more than a decade and have seen them change the way we the Army fights. Before any "task force" goes into a raid or battle they ask or demand UAS support. Ten years ago it was make-believe that we had such systems. Now with weapon equipped systems the person giving the order to take out the target or piloting the UAS is not even in the same hemisphere. Which brings to light another question with the increased use of "robots." Does the use of these machine and lack of human life damage make War easier? I don't know the answer but have seen in my time that no matter how good the surveillance one can never replace good reliable human intel. Osama bin laden raid is a prime example. Robots will never replace humans but surely can aide humans in their job. UAS systems do in fact save lives but their overuse as an offensive weapon can be counterproductive. Good Mr. Kolb! (Comment 299)

Robots are Tools/Equipment Only

1. I have no real feelings in regards to the UAVs that I have worked with other than the pride that I took in maintaining my equipment and being better at my job than others. (Comment 8)

2. Robots are excellent tools to save soldier's lives, but can never replace a soldier. Some work of a soldier can be delegated to robots. (Comment 9)

3. A robot cannot replace the camaraderie of a unit nor can it replace the bond between soldiers it is simply a piece of equipment that is a combat multiplier they can be useful and useless in the same sense and can save and risk soldiers lives in the same way, just like any other piece of military equipment. (Comment 15)

4. Robots are great tool in the tool box. They cannot replace a human or soldier. They are a great asset. They can keep a human from environment danger or death. If I get the robot blown up, I do not have to write a letter to a wife and bury a friend. My robots were run off repeaters for some distance. I worked at DTRA. Robots are great tool if used right. Must have team that understands the mission , what you want the robot to do and limitations of frame. Have tm that can operate, maintain and do maintenance. Also support that can repair software and hardware, and the physical robot itself. Bottom line up front great tool, but not concentrate so much on machine but the mission and end state. (Comment 16)

5. I regard military robots as a weapon system, a force multiplier. They should be employed to mitigate risk for humans. Robots will never totally replace soldiers in combat, rather they will be members of the small unit combat team. Uses would include recon, search and rescue, medical, intel, and fire support. They would be most useful in a an intel and recon role through the use of problem solving and adversarial reasoning

for course of action development. They are also useful for problem solving in an urban environment, i.e., cybernetics, Claude Shannon's mouse in a maze. I witnessed this first on working with a foreign technology. (Comment 20)

6. This is a terrible survey that is a complete waste of time. Robots are MACHINES that assist the human in getting a job done, period. I am sure government grant money was awarded for this survey.....sickening. (Comment 32)

7. Robots have been an excellent tool and part of the team but I get only action, not feedback. The robot does what I tell it to do, but it has no thoughts or ability to assess and report back. I need a human eye and brain to see the whole picture. (Comment 37)

8. Comparing the intelligence of a team member to the intelligence of a robot ... or trying to compare how someone would feel about losing one versus the other is like comparing apples to llamas. Robots are good at what they do (for the most part) and will continue to improve. I worked on a team that developed augmented reality software to make robots "smarter". However, their increased capabilities did not make them smarter ... just easier and more natural to use. (Comment 57)

9. I am an EOD Technician, and as such robots are our tools. They exist to reduce the danger to us, and I am more than willing to see my robot blown up than myself or a teammate. In regards to one of the questions, would you rather have your robot repaired or replaced, the answer is whichever is quicker. Each robot does have its own idiosyncrasies, but at least they don't change like people do. (Comment 58)

10. They are computers. That's it. (Comment 60)

11. I have 3 combat tours using robots in EOD missions. Robots are a great tool for doing things remotely, and not mitigating the risk to soldiers. (Comment 65)

12. I say that robots are programmed to do things. They have no feelings like humans do. Humans have emotions and instinct. Humans I just trust more. (Comment 75)

13. These robots are simply combat multipliers for the war fighter. They are machines their sole purpose is enhance a Soldiers capability and allows him/her to fight another day. (Comment 78)

14. Team members are irreplaceable while robots are tools we used in dangerous situations. If the robot blew up while disarming an IED then it saved a team members life or limbs who would have been doing the dangerous work instead. I am not personally attached to any one robot as they are switched out and repaired often. They are very advanced tools that do not poses intelligence in themselves but allow the operator remote capabilities to stay out of harm's way. Robots are absolutely vital in the efforts of Explosive Ordnance Disposal. (Comment 81)

15. I think robots will be an enormous asset to the force, however I think we should be careful not to lose sight of the need for human involvement. (Comment 95)

16. I don't see the UAV (shadow) regarded as a robot. I do see it as an aircraft (equipment) vital to the mission we perform (Comment 122)

17. They are a useful tool for the military, yet will not replace a soldier. (Comment 130)

18. Machines like any tool can turn the tide toward victory for the warrior who poses it and defeat for the one who does not. (Comment 159)

19. It's a robot, not a team member, not a person, it's a piece of equipment. If you got money out of the government to conduct this survey you should be charged with Fraud, Waste and Abuse. (Comment 162)

20. Any kind of emotional attachment to a piece of equipment seems to me to be completely ridiculous. It is simply a tool that was developed to help save lives and aid in the completion of the mission. The tool follows the two basic troop leading procedures: Accomplishment of the mission, and soldier welfare. (Comment 183)

21. Military robots are great force multipliers... I know; I sound like an FM on leadership there, but they really are. They are nothing more than tools to be used by the Soldier however. A soldier is quick, agile, smart, and can do things that frankly, a cold unfeeling hunk of plastic and steel could never accomplish. A human can make the decision whether or not to shoot someone based on what the actual situation is AND what his instincts tell him. A robot trying to make the same "decision" would only be following its programming. Not good when you have a crowd of children and one of them is pointing a loaded rifle at you. A robot would see the gun and immediately kill the child and possibly slaughter many other children in the crowd as well. A Soldier would see the gun and do everything he could to protect both the lives of his men and himself AS WELL AS the children. A Soldier's instincts are his greatest weapon. Robots do not have instincts. They can never be intelligent. No matter how much programming you put into them; no matter how many gizmos and bells and whistles you put on it; no matter how many tasks it can complete all at once; it will still always be a cold, heartless, unfeeling, non-living... machine. The producers of the Terminator movies have it exactly right. If the military attempts to build a robot or series of robots

that could be smarter than human beings... it will destroy either the world, or itself. Period. The battlefield will always be a place of human death and destruction. There is NO way to avoid this fact. Soldiers will always be needed, until the end of days. A soldier's life will ALWAYS be worth more than ANY piece of equipment. (Comment 205)

22. Until taking this survey, I had never considered my robot being anything other than an aircraft. It's not a pet. It's not a person or pet. It's not R2D2 or C3PO. It's an aircraft. I like it as an aircraft. After it lands, I like to go over to the hanger and see how it fared. If it had a rough flight and got some scrapes or broken parts, I feel bad. But I never think of it as a "being." I don't feel an attachment to it like I do toward people and pets. (Comment 206)

23. Robots are a good TOOL to reduce exposure to the soldier. However the soldier can never be replaced. Not to mention in my opinion a robot is to impersonal to take over a combat role. (Comment 214)

24. Robots are useful but the trend seems to be sometimes becoming over-reliant on them. For the most part, they simply cannot replace human beings. (Comment 225)

25. I have been studying military robotics and UAV/UGV programs that are in existence as a hobby for some time. I see how the systems have extreme potential in the future, I understand how the systems are useful for today, and I see how we as a nation are falling behind our allies and enemies around the world in the production of these devices. It was my intent to transfer into the field of UAVs but was declined for "Saving that MOS for the young bucks." In the field of medicine, where I am currently studying, Robots and UGV's can have a significant impact in battlefield recovery, onsite surgery

and trauma care, and remote surgery. The weaponization of UAV's seems to be as logical a conclusion as the first pilot who carried a hand held bomb in his plane in world war one. Robotics holds a significant impact in helping out wounded soldiers get back to everyday life after they have been injured on the battlefield; through the use of advanced prosthetic that have their start in robotic limbs. Along those lines, who is to say that a robot companion cannot monitor a patient long after they have left the hospital instead of constantly coming back into the doctor every few weeks or months for a check up? Robots can make great tunnel rats, logistic long haulers, communication relay, fire support units (direct or indirect), and can augment almost every job in the military today. They are a tool that can be utilized by the military and the civilian sector if the technology is available. (Comment 227)

26. I am the Standardization and Instructor Pilot for a UAS platoon currently deployed. I feel that although UAVs are the best kind of combat multiplier they are no replacement for an actual person on the ground. As aviators we support the ground-pounders (Infantry) and in return they protect us and enjoy the intelligence we gather for them while providing security. We are their spy planes and I do not think there is a replacement for the actual operators who fly the AVs (air vehicles) Feel free to ask any further questions in regards to your studies by emailing me. I have over 2000hrs on the Shadow System and this is currently my third deployment. (on a more personal note I hope the Longhorns win this year) (Comment 230)

27. Well the Raven was the closest thing I had to work with with my hands but I work with UAV pilots and I think ground and air UV would help out a lot for recon over watch, carrying equipment or a mobile radio system retrans something like that but

if you could put weapons on it too go for it also. Something with laser range finder and most important would be able to designate for 13 FOXs because I'm one and if I could have a mobile FS3 system or LLDR with RWS that would be a huge force multiplier. (Comment 234)

28. Robots will serve their purpose in duties previously employed by humans such as recon, but a good pair of polished eyes cannot be exchanged for a mechanical device. I've had many years of programming robots and yet they are still somewhat limited in their ability through either programming or mechanics which cannot replace the regular soldier at present. Though given the 1000 percent increase in technology at the present pace it will be no time before we will see robots upon the battle field take on more arduous tasks that where once performed by soldiers. (Comment 235)

29. While computer systems can be programmed to work in certain ways and can sometimes be counted to perform tasks with supposed unmatched precision. When they fail, they tend to be completely useless. I believe their abilities will always be limited. The human element, while difficult to pinpoint and fully describe, is irreplaceable. The ability to read a comrade's facial expression. Sense a mood out of another's subtle tone change or very particular choice of words. Take the illogical risk or to be able to sense what can't be seen cannot be synthesized by any mechanical means. Good luck with your study and I hope my survey helps. (Comment 242)

30. It's a computer flown plane. It protects and assists soldiers on the ground. That's it. I enjoy the helping others part of flying it not because of attachment. It is a job not pet. (Comment 245)

31. My last deployment, the Raven was an extremely useful tool. Robotics is not yet at the point where we could start to consider them "human" or have similar abilities. I will (once I stop deploying) strive to earn a Robotics Engineering degree, and I am a resident of SE Oklahoma. (Comment 247)

32. I have never worked with military robots, but I think there is a lot of potential. The piece that a robot cannot replace right now is the judgment piece of decision making - or sensing the environment. Hard to describe in words, but there is an abstract piece that humans bring to the equations that robots are not able to replicate. (Comment 250)

33. In my duties as an intelligence analyst the use of UAVs has been a potent force multiplier directly enabling direct action multiple times. I much prefer having a dedicated UAV operator on my team to nearly any other asset available. (Comment 259)

34. I worked with a TALON robot in Iraq for 12 months conducting route clearance with my Engineer Company. In lieu of an actual pet, the robot became our mascot and everyone was proud of the robot. I was the actual handler and I taught others in my unit how to operate the robot in my absence, however it was still my robot and I treated it like a more disposable limb. It was the hand I used to pull wires, the eyes I used to inspect a suspicious package... It was a very important piece of equipment, but naturally, I personified it because it helped me respect the robot more. (Comment 261)

35. Robots are a tool; like an e-tool or a weapon. Nothing more. I don't think it is good to ascribe human or pet-like characteristics to a robotic system. (Comment 266)

36. As an Explosive Ordnance Disposal (EOD) Team Leader I do believe that robots have their place but they are a tool. I still need team members that can freely think and make useful decisions in split seconds. I have used many robots in Iraq and Afghanistan including Talon, PackBot, PackBot 310 and the PackBot 510. (Comment 274)

37. As an EOD Team Leader there is nothing that could replace me or my team members. A robot is an extremely valuable tool (emphasis on it being tool) that I would not want to conduct my mission, whether it is CONUS or OCONUS, without. There is no tool I can use that allows me to remain as remote as a robotic platform allows. I believe a robotic platform is a must have for the types of missions my team and I conduct. There is perhaps no other tool I can use as valuable as my robot. The robots I've used have been moderately reliable, so long as the most current software and hardware updates are available. (Comment 277)

38. Feelings should not be attached to Military Robots. It hampers the individual's ability to do their job effectively. Plus, they are ROBOTS. (Comment 278)

39. Robots are force multipliers but not force replacements (Comment 286)

40. Robots complete assigned actions on our enemy's soldiers and save the feelings of regret and remorse of a soldier who would otherwise have to take the life with his own hand. (Comment 291)

41. Military Robots are very mission/Job specific making it difficult for them to replace a soldier who can perform many different tasks (Comment 292)

42. Robots are just another great tool, but don't think it can replace a soldier (Comment 294)

43. Military robots are great tools to aid soldiers in completing mission. They can accomplish tasks that are either too dangerous or unreachable to the average soldier. The military couldn't do the jobs that these robots have provided without causing injury to soldiers. Robots have been a great addition and I cannot wait to see what waits for them in the future of combat. (Comment 301)

Robots Are Only As Smart as the Operator

1. I have worked with a few different systems. These systems were controlled by a Soldier and not fully autonomous. These systems keep Soldiers out of immediate harm, but still require a Soldier to be in an area that provides the risk of being hurt. (Comment 27)

2. The UAVs I worked with in Iraq were very valuable to the unit's mission and are great assets to have, but the UAV is only as good as the operator flying it or the payload operator that can optimized the camera. (Comment 33)

3. The UAS platforms I have worked with are only as smart or useful as their operator. Being properly trained on these systems and knowing how to effectively employ them is imperative to being successful on today’s battle field. (Comment 43)

4. I have worked with the Shadow UAS for a couple years now. It has its advantages and disadvantages. In theory, it is a great idea and would serve the battlefield commander well. However, it is only as good as its operator. If it were totally autonomous, like the fire scout, it may be a better system. But with its limited functions, strict limitations to fly with moisture present, and lack of any kind of ammunition, it only has one purpose in life and can’t always complete its mission. Future BCT level

UA need to be completely environmentally sealed so they can fly in any weather condition as long as it is safe for a soldier to be in. If we cannot put an airplane (or other robot) in the air (or ground) while the troops are on the ground, what is the point of having that asset in the first place? Some and most robots in use are a great asset to the ground troops and can save many lives, like weapons mounted on UGV's, but others like UAV's rely on the intelligence of the AO or PO... and if they are not up to par, the old adage of "its only as smart as its operator" comes into play and has all the effect of the mission. (Comment 47)

5. Robots are useful tools, but they should also be deployed with human abilities behind them. A robot is only as smart as its human operator. (Comment 58)

6. I am an Army EOD technician and a SFC. I have 21 months performing EOD duties in a combat zone using robots and have completed many missions CONUS using robots. I feel that robots are used as sacrificial equipment in my job field, intended to take the blast so I do not have to. They are not smart. If it were not for the EOD tech the robot would just be a cool toy on our missions. (Comment 68)

7. Robots will never be able to completely remove human interaction; they can only be as good as their operator/human counterpart. (Comment 79)

8. The robots are only as good as the people you place in handling them. In my experience with UAV is at least once a rotation through training a unit squad lost the robot, recovered later. With the troop levels decreasing, it’s time to make a hard push for robots, in all types of areas overseas. I don’t think anyone would knock a proposal of switch robots with people. (Comment 86)

9. They have come a long way technologically but they still have a long way to go before they are capable of matching human performance. Soldiers on the battlefield need to be capable of making quick, intelligent decisions in the heat of battle, and also to be able to improvise those decisions as necessary in order to complete the mission. Robots cannot think and only do what they are told to do. (Comment 99)

10. I work with UAVs and UASs. They are more remote control than robotic. (Comment 112)

11. I'm a civilian that just love the Robotics and I had a chance to slightly work on them. In my opinion a Robot must to obey human commands. We as a humans must to be the smart ones to operate them. Thanks Interesting quiz... (Comment 133)

12. I enjoy working with military robotics and find them to be an indispensable asset to the modern battle field. I personally cannot wait to work with future systems. However, the human element is also indispensable and should always have some form of control over their robotic counterparts. (Comment 143)

13. UAVs/UAS are only as intelligent as the operator on the ground controlling them. (Comment 147)

14. Most "military robots" are controlled very closely by humans. Their "intelligence" is very limited. "Robots" are used as more of an "appendage", than a member of a team. An extra layer of protection between the soldier and the opposition, whether it is bomb disarming, or overhead surveillance. The "robot" gets shot at, and not the human. (Comment 149)

15. Military robots (in my case UAVs) are a great technological advantage, they are very useful in the battlefield and they will be even more useful in the future, however, it

takes a talented human been to ensure the UAV is operating the way is supposed to, that is the reason why I don't think the robots are better or more important than their operator/maintainer. No matter how advanced you make a robot, it will never have common sense (nowadays a lot of humans lack this as well) this is why you will always need a human to operate it. (Comment 165)

16. In the UAS world, human interaction is invaluable. (Comment 172)

17. My only experience with robots is working with the Shadow 200 and Hunter UASs. I think they serve a specific purpose and are therefore designed with limitations to minimize costs of operation and maintenance. I have also worked with manufacturing equipment which is automated. They do exactly what you tell them. However, they all have to be respected because if they are not cared for they can become hazardous to work around. In another sense, I believe that robots will never truly replace a human being because they lack a soul, not to mention the complexity of the human reasoning process. (Comment 174)

18. UAS should not be considered robots as, while there is an autopilot, it requires massive amounts of ground control to operate both the camera and the AV itself. (Comment 175)

19. Working within the realm of UAS Operations I think that the robots are only as intelligent as the person using the system. (Comment 176)

20. The majority of my work was with prototype robots while stationed at Ft. Benning. The robots were useful, but they were controlled by humans and were only as smart as the dumbest operator, albeit with enhanced sensory capabilities. Unless we're talking Skynet/self-aware Terminators, I believe that robots will continue to be a useful

tool in the arsenal but not a replacement for a well-trained and motivated Soldier. (Comment 180)

21. Currently, military robots do not possess any form of artificial intelligence. They act as they are programmed to do, and as directed by their human controllers. In the future, I see robots with limited AI performing increased roles within the military, specifically for combat operations. Military robots should be used to enhance, rather than replace, a human soldier. (Comment 208)

22. UAS requires an operator. It serves its mission only as effectively as its operator. The systems do save lives and provide an inexpensive way to do what traditional observation aircraft have always done. They will never replace humans; the system is dependent upon human input. They are in no way autonomous as the questions seem to assume. (Comment 215)

23. UAS assets are very efficient and highly useful in combat; however they are only as smart as the operator controlling them. Regardless of how much automation and knowledge we impart on them, they are still controlled by a pilot and payload operator. The autopilot is great and the autosearch feature on the camera works, but to effectively complete the mission, the human aspect of the pilot and cameraman needs to be there to analyze and adapt for the mission. My platoon formed bonds with each of our aircraft, there were some we liked more than others and each of us had our favorite, but they are still more replaceable than soldiers. As much as I loved my aircraft, I would have crashed one in a heartbeat with no hesitation if it would have saved a single soldier. (Comment 218)

24. I liked the idea of a robot in combat, but it still takes human thought to know when and where to deploy the robot. (Comment 220)

25. In my experience, a robot is only as effective as the person operating it. (Comment 221)

26. Used the Talon for interrogating IED's in Baghdad in 2007, 2008. It was viewed more as a tool because it did not utilize artificial intelligence. It really only did what the operator made it do. The judgment and knowledge was still dependant on the operator, not the machine. (Comment 229)

27. At our current level of "robot" technology, these very useful machines are extensions of their human operators. Once technology evolves to the point where these machines have some level of integrated artificial intelligence that enables them some level of autonomous operation, we will have to revisit our relationship with these machines because they will have a semblance of sentience we must acknowledge in order to continue our cooperative relationship. (Comment 238)

28. Most robots still require some sort of human interaction. Some robots allow a visual extension, but are generally limited to the ability of the sensor or capabilities of the robot to gather the information. (Comment 239)

29. Robots are only as effective as the person operating them. They are but machines and should never be viewed as more than machines. (Comment 251)

30. My use of UGAV's and Robots has always been in Explosive Ordnance Disposal Operations. A robot is only as smart as the operator using it. But regardless a robot lost nothing compared to life/limb lost. (Comment 260)

31. The future of robots on the battlefield is that of fodder. They are used for their eyes and their ability to increase standoff distance. I have seen some tests where a saw is used on a camera mounted platform. For now, the need for a man-machine interface is required for you need a human behind the decision point whether to engage or not to engage. (Comment 268)

32. Your questions are silly. Robots are not people. They cannot and should not replace people. At the very least, one soldier needs to observe a robot at all times. Therefore, it will not replace any part of the team. (Comment 271)

33. I am a UAV (Shadow) Psg and we do not treat them as Robots or entities, just a remote controlled aircraft with a camera payload that can provide us with imagery. They do not think, they just act on our instructions. A lot of what was asked was designed toward an entity that can interpret and respond to it own direct input. True our plan flies at altitude and adjusts for climate; winds etc. but is still not a thinking being. It is a machine, affording us the capability to look at targets without having to risk the life of a soldier. (Comment 272)

34. Military robots are a critical tool to Explosive Ordnance Disposal technicians. They allow us to mitigate risks to Soldiers by allowing us to remotely interrogate situations where there is an extreme level of risk (rendering safe an IED). Robots, however, are only as "intelligent" as the Soldier using them. In my opinion they will never be able to function autonomously and will always require a trained and proficient operator, in the EOD career field at least. (Comment 289)

35. Military robots serve an extremely important function. However, they are not thinking organisms that can react to a huge variety of situations, and adapt to new

situations, as a human can. They must not replace people on the battlefield until they can think and react to many varied and new situations, cannot be turned against us, are as robust and flexible as humans, and are completely trustworthy. (Comment 293)

Doctrine/Training Needs to Be Improved

1. Commanders need to better understand how to properly utilize UAVs and the types of support they can provide. Military operators and maintainers are generally not committed to the job. Each deployment I was on, saw the aircraft making more flights then units we replaced or were replaced by. Our Hunter unit could maintain at 2 birds in the sky for 24 hours a day. Our Shadow unit was able to keep eyes on target 24 hours straight if needed. The only limiting factor we experienced in operations were shortages of competent maintenance personnel and replacement parts. (Comment 56)

2. I worked with the Raven for about one month but my leaders didn't like the idea of a Raven because if the fuse blew we would have to send a search party out to go find it before the enemy did. And for some reason old leaders don't trust new technology and I believe they're sacred of it sometimes. I was shot at twice, once knocking my eye pro off my face. If we would have had a Raven in the sky we would have been able to capture the guy but instead my NCO gave the command to raid a building that was two buildings too far over. If the Raven would have been in the air we would have seen the sniper on top of the school roof. (Comment 74)

3. Using the Raven allowed us to have a different perspective on combat operations and allowed us to view areas that were potentially very dangerous. More of the Ravens

need to be available to more of the units, not just Infantry. The UAS' could be very useful in a base defense operation if you can use it in orbit points. (Comment 76)

4. In my experience working with "robots" so far, the limiting factor is not the machine itself, but the training of the operators and the stubbornness of command. I operate the Shadow UAS, which is a capable system. The Army trains persons to use this machine at the very, very basic level. Essentially most operators are button pushers and have no idea what the system is fully capable of or how to utilize it. The training falls to the NCO's as usual, but the field is still new enough that most of us are MOS transfers. We receive no higher level training that the recruits we are suppose to take beyond the basic level. We have countess parts of the system that are never used because no one knew how to set them up or properly use them. Even the field reps from the manufacturer often don't know how to use them. We need a longer and much more in depth training period if we are to ever use these machines at the level they are capable. Second, we are surrounded by a command who refuses to listen to the men and women who do know the capabilities of the system. In our case officers believe the Shadow is their personal camera in the sky, and won't allow the operators to use it for anything more than watching roads or convoys. While these are necessary missions, there is much more it can do. Officers who have received no training in the utilization of these ISR assets refuse to overcome their arrogance and listen to the warrant and enlisted advice. What good does it do to spend millions of dollars on these aircraft when we don't spend the time properly training operators or using them to their full capabilities? (Comment 89)

5. As a UAS Operator, Aircraft Commander, and Mission Coordinator, I see that vast abilities that my platform and other platforms can perform. The problem is that we are not correctly or effectively utilized. If leadership had a better understanding of what we can do, how we can do it, and how it can support the mission, the potential of our system can be truly put to use. (Comment 102)

6. Very useful, wish the training was more fluid (the classes don't line up very well) (Comment 117)

7. An extensive education campaign is necessary for the increased use of robots - as with anything we have the 25% "zealots" and the 25% "naysayers". We need the 50% in the middle to "get" why we use robots and provide proof of usefulness to move the 50% closer to the group of "zealots" and ensure proper employment of the equipment. (Comment 197)

8. Military robots have proven to be great tools. The main issue facing us in Afghanistan is limited technical range. The secondary conflict is the political fights between certain levels of command on the officer side. Some CDRs assign assets to where the New York Times reports they're needed instead of the needs of battle space occupiers. Those who control assets should listen to the needs of the ground over possible personal career boosters. (Comment 222)

9. I work with the unmanned aerial vehicle, Hunter MQ-5B we have been around going on almost 20 years of service. I have worked as a systems repair for the last 3 years. It's a great platform that serves its position but it not used to its full capabilities both unit and the ground unit request support. People need to know what we can do and

how to get us, until then don’t matter how great a robot type system is it is still lacking until applied properly and fully. (Comment 223)

10. All military robots do have a purpose; but if this type of equipment does not reach the lowest levels, (field units such as EOD, Engineer Units, Chemical Units in all components: Army, Army Reserve, and National Guard units); it becomes a waste of technology because by the time Reserve or National Guard units are deployed and soldiers exposed to the technology is a little late due to the fact that the "user" does not have the proper exposure to the equipment to find innovative ways to "fulfill" his combat mission. (Comment 233)

11. Part of the issue with having robots imbedded with infantry units is without a change to current MTOE a company essentially loses a fire team to operate a robot. Also before a robot is fielded to a unit all echelons of that unit need to be briefed on capabilities and employment methods of the system quite often we were using our robot very little when it could have been used and when we did employ it, it was employed in a way that limited its abilities. Bottom line give a company a dedicated robotics section at the company HQ platoon and teach senior leaders how to utilize robotics and UAS platforms!!!!! (Comment 236)

12. I love working with robots but don't feel that soldiers are not given enough opportunity to train with or use in field robots enough. (Comment 248)

13. Commanders need to better utilize UAS systems in combat. (Comment 264)

14. Military unmanned systems are not properly integrated into operations. Many times, S3s do not have any experience in using them and have been indoctrinated to believe that they belong to the S2 for collection purposes only. Usually only included in

operations as an afterthought. These systems need to be integrated into operations more and additional training needs to be provided to Operations Officers in how to maximize the use of unmanned or remotely operated systems. (Comment 282)

Critique of Specific Systems or Military Robot Design

1. I worked route clearance using the Talon and the Packbot. I preferred the Talon over all others. We primarily used the Talon for charge placement and as an interrogation tool for areas the buffalo arm would not reach. The Talon was a great asset for all operations of a Combat Engineer. We never lost our robot, but if we would have it would have definitely put a bad vibe through the Platoon. We would have had to manually approach UXO's and IED's to place charges. The Packbot was not quite large enough on the tracks for the terrain we were in. We never had the controller that I have seen recently, and the controls were not as simplified as the Talon. It seemed to take too long to actually become proficient with the Packbot. Overall the talon was great for the job, especially after we had a carrier system attached to our vehicles. (Comment 18)

2. The Talon we have is great. It is rough, rugged, and strong. However, the OCU for it is heavy and weak. The system takes up too much space and does not allow the robot to travel long distances. The Packbot is able to climb some terrain and reach into areas the talon is not. But the Packbot is overall weak and the controls are often times difficult to work with. Some general rules of robots: strength, field of vision, vision clarity, are key, as well as ease of controls. (Comment 19)

3. Packbot controls are difficult to get used to and it's not very strong, especially when compared to the Talon. There have been some major improvements recently,

especially with some of the semi-autonomous features recently added to the Packbot. The Talon, which I admittedly haven't used in 2 years, was plagued with lag times which made fine control extremely difficult when trying to manipulate IEDs, which naturally was when fine control was the most important. On the positive side the Talon was significantly more powerful both in grip strength and towing power when compared to the Packbot. It would be great if there was one robotic platform that would integrate all of the strengths from the Packbot and the Talon. In my recent experience, iRobot seems to be doing the best job of allowing the end user to test new innovations to see what works on our end, and more importantly, what doesn't. Both iRobot and Foster-Miller solicit input on a fairly regular basis. Disclaimer: I don't own any stock or other interests in iRobot or Foster-Miller, nor have I been offered future employment by either company. (Comment 24)

4. I am an EOD tech in the army and have worked with robots and IED defeat since 2005. My robot of choice for IED's both deployed and home station for police support is the talon. The controls are simple and it has the strength and endurance to handle most missions. The Packbot is too weak and the controls are too complicated for the average user. (Comment 30)

5. They are way too expensive to repair and they are pretty simple to understand if you have an electronics background. With that understanding of electronics you quickly realize that these things are extremely overpriced. I used the TALON and when the batteries are discharged fully they cannot be recharged. WHY!? The batteries come with a nice round price tag of 500.00 each. If you don’t discharge the battery all the way then you can recharge it again which makes no sense at all. The controls are great but

can be much easier to use and learn. I like using the X-Box controller. The controls for the arm could be made better by actually fitting a controller on the soldiers arm and having the robot mimic the movements of the human arm using analog input like the X-Box thumb sticks except they are receiving input from the soldiers elbow and shoulder movements and some grip device in the soldier's hand. It comes more naturally. (Comment 77)

6. At this time the application of robotics in the EOD field is highly dependent on the skills and training of the operator and the limits imposed by the platforms and their controls. The Talon robot is robust, easily controlled and deals with rough terrain well but has a lack of versatility and dexterity. The Packbot system is much more versatile and dexterous but lacks power and is difficult to control. The PS2 controller upgrade has made it easier to control but it has still not been fielded out to all EOD units. A good middle ground with power and dexterity that has some built in intelligence would be a great change. Being able to designate a target to grab like a wire or water bottle and have the robot use sensors to grab it could shave 30 min off an incident and make it so that soldiers will not have to enter a danger area. At this time my robot partners are still a tool that poorly replicates a human and are only used because the environment is to hazardous for me to enter myself. Neither system brings enough to the table rationalize taking it on a dismount operation for EOD usage. (Comment 126)

7. I used robots for EOD duties. I used the RONS 1996-2004 in CONUS and Kuwait 1999-2000. The RONS never let us down. We had very good relations with the factory and even major repairs were handled with ease by soldiers and the factory. I have also used the SEOD 1990-1995 before commercial robots were available. My unit

brought the RONS to Afghanistan 2002-2003 but were issued Talons in country and used the Talon when we could. The Talon took some abuse, but we were able to repair it. We were also issued PackBots but favored the Talons. Both the RONS and Talon were very easy to use and maintain for most EOD soldiers. (Comment 140)

8. I am an Explosive Ordnance Disposal Tech and we use robots on a daily basis. The main platforms we use are the Talon and the Packbot. Many of the other techs that I have talked to prefer the Talon over the Packbot, but there are many things that the Talon doesn't do but the Packbot does. If there were a way to take the two systems and combine them it would create an all around robot. (Comment 178)

9. Robots are great for standoff; I use the Talon and hate it. A rugged Packbot would be better. Talon is jerky and imprecise. (Comment 179)

10. 2006-2007 I cleared 1127 IED's, Robot technology needs to have been changed yesterday. Robots need to have sonar. Be manned from a vehicle behind. Have an asphalt cutter such as what's used to cutout window holes from a foundation of a house. Use re-generative technology. It's quiet and functional. Use high pressure air for cutting out IED placements. Have an arm with grapple that can be used to grab and stow IED's for forensics. Also, have an IED stowage center. (Comment 200)

11. They need a better power source. (Comment 212)

12. The designs need more functionality. I have designed or witnessed designs that have more interaction and use versus some of the models available in the military. Physical functionality seems to be lacking in some of the designs the military uses, though feasible in their duties, the designs could be improved. Armature and locomotion should be more intuitive. Locomotion in particular should be more

modularized such that the method of travel could be easily swapped per what the mission and terrain dictate. Software should also be upgraded in such that search algorithms and movement controls are more predictable to the robot. (Comment 213)

13. My experience in dealing with the PACKBOT, was that it was slow, bulky, often unresponsive to command when the DUKE system was armed and had a limited field of view. (Comment 220)

14. I am a Test officer working on testing chemical sensors which are being mounted to UGV's. What I am finding is that designers need to ensure complete engineering solutions both in hardware and software with the soldier in the loop. Without early user participation designers may develop a path not needed. (Comment 226)

15. I have 4 years on a FIRST robotics team in high school and am designing a robot for Senior design (I'm studying for a BSME). We need to work on creating more hand like manipulators for robots because all they are now is a gripper on wheels or a camera on wheels. We need something that can open and search through a duffle bag or use a screw driver to open a box. A robot with a gun on it could drive out into a firefight, shoot the enemy and save lives also. (Comment 240)

16. At this point I have worked with robots that were extensions of human operation and did not have much if any Artificial Intelligence. The Talon was awesome at approaching IEDs and dealing with them. The Packbot was great for dismounted ops and checking out high threat areas. We also had the UAV that looks like a flying trash can in our company but it always had problems. (Comment 246)

17. The only issue I had with my Packbot was the range. I found it extremely difficult to exploit a situation with such a minimum range before it lost communication....I have also worked with the Talon. The Talon is an extremely agile, intelligent and over great machine (Comment 249)

18. I found it difficult in Afghanistan to operate theTalon in some of the terrain it was in. It would have been easier to place the charge manually. (Comment 254)

19. I worked with unmanned systems as part of the Army's FCS Program. A bit different context than the survey, but I have an understanding of what the Army wanted from its unmanned systems. Cost is a huge issue, especially now. Army's expectations need constraining to remote operation versus autonomous behaviors. Size, weight and power are the engineering challenges. (Comment 258)

20. The T Hawk was somewhat beneficial, but its greatest limitation was its short flight time and altitude limitations. We gained a Puma later on in the deployment and it was a much more valuable asset. Quieter and could stay aloft 4x longer and had a much farther range and altitude capability. (Comment 303)

General Negative or Possible Ethical Conflict

1. I feel that we're treading on dangerous ground by enabling machines to carry out combat. (Comment 25)

2. My experience is strictly in a maintenance environment. Purpose built robots should be studied and further developed for their specific rolls. Robots will never replace humans on the battlefield without autonomy (e.g. AI). Furthermore, should

sentience ever be implemented in a medium other than biology, its decisions should never replace those of a person. (Comment 38)

3. Robots cannot replace soldiers. Consider old landmine doctrine which describes the differences between wounding a soldier and killing a soldier. The cold hearted math states, wounding enemy soldiers is preferred because the added drain on it force requires that able-bodied soldiers care for wounded soldiers. Also, have a maimed soldier yelling out in pain saps morale. Fast forward to today's robot craze and we reverse the concept. Robots add enormous drain on soldiers. Not only does a soldier have to operate the vehicle, but now someone has to lookout for the soldier who is operating the vehicle still a third needs to scan the area for hazards. Robots operate slowly and have limited observational skills. Robotic platforms cannot replace the fact that soldiers need to be put in harm's way. (Comment 44)

4. Deployment of robots seem slower than having a human do the task. If in the future the robot can be more mobile, maneuverable, and more controllable this would be ideal. (Comment 48)

5. I firmly believe that robots should be CONTROLLED BY HUMANS and never given complete autonomy. (Comment 54)

6. We're not using "robots", they are not autonomously controlled devices. What we're using is unmanned devices; controlled remotely by a human operator. It would be a terrible mistake to take the human element out of decision making when it comes to delivering fire on a target. (Comment 64)

7. I don't believe that machines can become decision makers. Robots are amazing tools, and they can increase our (all humans) capabilities many, many times. I envision

one human doing a job, both in the civilian and military arenas, and having many robots workers around accomplishing tasks. But I don't believe in the "singularity" idea where computers will become sentient. Someday robots may become so advanced as to put even system designers and advanced jobs out of work. But the only decisions they can make are the ones programmed into them. A human on the battlefield brings the soul of humanity there, as well as discrimination and decision making. Making people afraid to fight you because your robot legions would destroy them if they tried to attack you seems like a great idea. But it removes the public ever farther from having to conduct the fight themselves, and makes the US as a nation ever more willing to "just bomb them." War is hell, and we shouldn't even be willing to engage in it because only the other side will get killed. Once we as a people no longer have anything important enough to die for, we'll no longer have anything left to live for. (Comment 107)

8. I am a UAS operator and I do not like where this is headed. If we have to do test like this one, we have issues as a whole. I think we need to focus more on what the Soldiers are seeing more with the equipment than how we treat the equipment. I've seen guys see a lot of stuff through the lenses of the UAV and not get any help other than be treated and branded as a bad Soldier. (Comment 125)

9. The Shadow 200 is many things, but it is not intelligent. It is not a person either. (Comment 141)

10. Unreliable, the robot was constantly malfunctioning. If I had a choice of sending a soldier downrange or a robot, the robot would always go. The loss of equipment can always be replaced, a soldier can't. (Comment 154)

11. I am an EOD Tech, so robots are a key tool in my profession. In my 11 years of EOD robots have come a long way, but there are still downfalls that I would like to see resolved. (Comment 156)

12. Robots are tools. Replacing the efforts of men at war with them would be a grave error. War is the business of killing and destroying things. When we as a nation cease to be mindful of the awful cost of war, then we are falling in a moral trap. Wars must be waged knowing there is a wretched cost involved on both our side and theirs and therefore must be prosecuted with great care and deliberation. We must never enter into a war on spurious grounds feeling that it isn't an issue because none of our boys will ever get hurt. Furthermore, robots may be named and accessorized like humans or pets, but will never take a place in the camaraderie and cohesiveness of a unit. A soldier who nicknames his weapon or his car does so out of sentimental reasons, or to individualize what is otherwise an assembly line item. It isn't out of a psychological notion that it is another person with whom he identifies. The same goes with military robots. (Comment 173)

13. Robots should be more intuitive...able to tell us when they are sick, broken, or inop. (Comment 202)

14. Robots cannot replace soldiers. If is not acceptable for soldiers to be placed in harm’s way then perhaps it is not acceptable to place American taxpayer money in harm’s way. Building robots to pretend to be soldiers tricks the American people into supporting continuing unjustified operations. Make UVG more capable not "smarter" and friendly. And do not waste time asking how we can improve human-robot relations.

More battery life, strong lighter arms. Clearer pictures and more able cameras. This is how UVG need to be developed. (Comment 204)

15. Over dependence on robots can lead to over confidence in the safety or security of a scene. Also, the habit is to build a cheap robot with basic capability like the bombot in 2006 for several hundred dollars, but then add so much stuff to it to make it too expensive to blow up if needed, like what became the BombBot in 2007 (they ended up costing over $35,000 each, for a claw we didn't use and a camera which we ripped off and put on our truck instead.) (Comment 262)

16. The use of robots is an attempt at bloodless combat, which in of itself an oxymoron. (Comment 265)

17. The concept of de-humanizing warfare is of grave concern for the future generations of Americans. This is due to the physiological concept of separation in which the war fighter is no longer in touch with the reality of their action and the war itself is reduced to a video game in which consequences of actions are not fully understood. The idea of placing names and ranks on an inanimate object furthers this rationalization for the normalizations of ambivalence. We must never forget the price of the soldier in the field and the generations which preceded us. I believe the questions about the naming of boats is somewhat out of context. This viewpoint is due to the fact that the naming of boats is a superstitious act dating back several thousand years. As a result, it has now become tradition. This same tradition held true to the naming of combat aircraft and adorning them with nose art. We use the phrase “this car has its own personality” etc. to describe the mechanical idiosyncrasies of the system itself. Al through this the mechanical system remains just that, a mechanical system and not a

living, loving, being. This de-humanization must be balanced with the need to save American and coalition lives through the advent of technology. It is in this balance that we strive to remain. (Comment 269)

18. I worked as route clearance and we never used robots due to terrain in Afghanistan but we attempted to on numerous occasions and it was too time consuming and difficult to deploy the robots in our area of operation. We also were issued the T hawk robot and it proved to be too noisy and cameras were too low quality to improve our mission, as for the talon robot it was good when the terrain allowed and was very simple to control. While I was deployed I saw robots as a tool to use so one of us does not get hurt, we never had any attachments with them like a pet and actually used and abused them when we trained and or needed them in combat. They were a "its better than me going up there" option, which was an option we never really took because of the terrain and time constraints. (Comment 290)