

The Impact of Robots on Select Military Operations

An Interactive Qualifying Project Report

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by

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Abstract

The project focused on the current and predicted impact of robots on surveillance, reconnaissance, automated defense, and bomb disposal operations. It investigated existing products and technologies to create a representation of society's present opinions. The project considered technological, legal, and ethical concerns affecting the advancement of military robotics. It anticipates future developments by analyzing opinions from interviews and data from a survey. The project concluded that society endorses the evolution of robotics not involving lethal force that benefits the military.

Executive Summary

This project, entitled *The Impact of Robots on Select Military Operations*, studies the current and predicted impact of robots on surveillance, reconnaissance, automated defense, and bomb disposal operations. The project group, Daniel Duffy and Audra Sosny, investigated what robotic technologies are available, how the military presently uses robots, what society thinks about military robots, and what the future of military robots may hold.

The use of robotics throughout all facets of society is rapidly increasing. As an emerging field with few developmental restrictions, society's reaction to and support of robotics varies greatly. The problem is that society supports the military using robots for some purposes, but not all. Another problem is that society supports robots with certain capabilities, but not all. Thus, it is not only critical but also necessary for the government and those companies designing military robots to understand the current and potential future acceptance of robotics.

The main goal of this project is to learn about society's attitude toward military robots. The results demonstrate how robots do and may affect military operations as well as support speculation about the future development of such robots. This project aims to capture society's initial stance toward military robots in the hope that the government and robotics companies will consider such information useful.

The group started the project by investigating existing products and technologies currently available to the robotics industry. There are presently several companies developing military robots under United States government contract. The group investigated the capabilities and limitations of the robots presently used by the military. These findings are discussed in Chapter 2 and Chapter 3 of the paper. After collecting sufficient background information, the group used the findings to develop survey questions.

The goal of the survey was collect society's opinions about the use of robots for select military operations. The survey questions asked the participant how he or she would define a robot, how much a robot might be trusted to perform a task successfully, and how much a robot might be trusted to perform a task automatically. The questions asked about general military tasks with a focus on the four select military operations: surveillance, reconnaissance, automated defense, and bomb disposal. The group utilized survey development theory by researching how to write survey questions. In addition, Professor Jeanine Skorinko, a Professor from the WPI Social Science & Policy Studies Department, provided advice about the development of the survey questions. She provided ample information and guidance regarding how to eliminate leading questions, order the survey questions, and get the information that we desired out of the survey. The efforts resulted in approval to conduct this study by the WPI Institutional Review Board.

The largest source of data for this project is from the survey results. The group used the results to help form opinions about the future development of robots, as well as impact of robots. In addition, the group conducted interviews with professors at WPI who teach courses in mechanical engineering, electrical engineering, computer science, and robotics. The group also interviewed military cadre of the Army and Air Force ROTC programs at WPI. While the interviews were not mainly used as a reference in the paper, the responses proved very helpful in forming the group's opinions. The survey results are discussed in Chapter 7 and the interviews informed Chapters 8 and 9. Furthermore, the group remained up-to-date with news related to robotics while forming conclusions.

The main outcome of the project is that our research shows that society is generally supportive of robotic development. Overall, society is not supportive of robots using lethal force

with or without the permission of a human soldier. Society believes that the use of robots by the military is beneficial and there are no major ethical conflicts. Presently, there are no major restrictions hindering the development of military robots. It is likely that in the near future more ethical and legal restrictions will develop. The group concluded that the establishment of such laws is necessary to regulate the future development of robots, specifically those used by the military.

As technology advances, the use of robotics by consumers and the military will increase. This emphasizes the importance of understanding the opinions of society, especially as it relates to military robots. The development of robots with capabilities that society does not support may result in major protest. The group recommends that the government seriously consider performing more studies related to society's opinion of military robots. That type of preventive measure will eliminate most future disagreement and increase support. The development of robotics is serious and should be studied in detail.

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Chapter 1: Introduction

As society advances with new technological developments, specifically robotics, more innovations are intended for military purposes. This Interactive Qualifying Project investigates the current and predicted impact of robots on select military operations. The project focuses on four categories of military operations: surveillance, reconnaissance, automated defense, and bomb disposal. The goals of this project are to demonstrate how robots do and may affect military operations as well as to speculate about the future development of such robots. The project achieves the goals first by investigating existing products and technologies then by collecting data from interviews and a survey. The project analyzes the data to determine the short-term and long-term impact of robots on the military.

The purpose of this project is to learn about society's attitude toward military robots. As present citizens and future professionals of the United States, the opinions of the general public related to this topic are important. The field of robotics is emerging and product development regulations are not yet established. Thus, understanding the present outlook on military robots is critical to society's future acceptance. This project aims to capture society's initial stance toward military robots in hopes that the government and robotics companies will consider such information useful.

The project provides a public source of information related to robots. The website contains this paper with all related material and data to disperse and readily utilize. This project is a suitable WPI Interactive Qualifying Project as it educates those involved with the project, and in turn society, about an important topic that may affect the future of warfare. The project audience is all members of society; however, those involved with the military or robotics may benefit most from the project results. The data may also serve as a guideline for the future

development of robot technologies. The project results are in the form of tables, graphs, and basic statistical analysis so that the entire audience can comprehend the project's findings.

First, the project provides a brief history of robots. Second, describes technologies available for the select military operations and their current limitations. Next, the project explains the methodologies for conducting the survey and interviews. The project then addresses restrictions of robotic developments by centering on key topics such as technology, law, and ethics. Afterward, it explains the development of survey and interview questions. Subsequently, the data and conclusions from the survey as well as the interviews are presented. Next, the project describes the short-term and long-term impacts of the use of robots by the military. Finally, the project hypothesizes some future developments of military robots. The Appendices contain all referenced data, interview transcriptions, survey questions, interview questions, and Institutional Review Board documents.

Chapter 2: A Brief History of Robots

Robots are an important part of today's society in general. Our definition of the term "robot" is the following:

Robot: any automatically operated machine that replaces human effort or simulates a living being, though it may not resemble human beings in appearance or perform functions in a human like manner. (Moravec, 2008)

Under this definition, many machines may be identified as robots. Although this definition includes humanoid robots that can do things like walk or communicate, it also includes less traditional robots. One example of a 'less traditional' robot would be the automated machinery in an assembly line, which clearly replaces the effort of the factory workers that would have been working the line. Another example would be a vending machine, which simulates the behavior of a cashier at a snack bar, by requesting payment and following its programming to return the snack item of choice.

Robots are a key area of development in the military in particular. The types of robots currently used in the military are of the 'less traditional' sense. They are not humanoid, nor even animal-like. The current favorites used by the military are four-wheeled intelligent machines and auto-piloted aircraft. Although these are not humanoid in any way or even try to simulate a human being, they do replace human effort in the following ways. The robots can be sent on dangerous or long missions in the place of a human, allowing for greater safety of the soldiers themselves. Robots can also be deployed to deal with explosives, which are much more dangerous if they explode and kill a human. Although to decide exactly how much a human life is worth is ethically questionable, it is undoubtedly worth more than a small machine.

Using our definition of robot also allows us to look into the past to view previous incarnations of robots that would likely not be considered under many other definitions, but are

nonetheless crucial to the development of robots in the modern sense. Although they did not exist exactly in their current form and diversity, robots have been created and used for thousands of years.

In the classical era of ancient Greece and Rome, there existed mechanisms that would be considered a robot. They were by no means as complicated as today's devices, but they would be considered robots nonetheless. For example, Heron of Alexandria, who lived from 10 AD to 70 AD created simple gadgets for novelty purposes, including moving statues and a primitive vending machine, which were robots by definition. These robots were often employed in temples to provide a mystical experience to worshippers (Lahanas).

Until very recently, robots remained a novelty. For example, we know that Leonardo da Vinci, who lived 1452-1519, built a mechanical knight that could at least move, or possibly even swing a weapon (Moran, 2006). In the 18th century, Jacques de Vaucanson built automatons in France which varied in complexity from an instrument-playing shepherd to a very realistic duck (Wood, 2002). Around that same period, small robots in Japan started appearing that could move, and many of them were used to serve tea (Boyle). Again, most of these robots had no true impact on their society beyond sheer wonder, but it is their legacy that spurred the ideas that drive today's robots.

These ancient robots would not have been called 'robots,' as the word did not exist with that definition until 1921, when Karel Capek's play "Rossum's Universal Robots," (RUR) first premiered in theatres across Europe (Capek, 2001). In this play, a man created biological 'robots' which would serve humans, much as future robots might. It was this play that gave the word robot the meaning it has in English today.

Later fiction writings delved deeper into the results of a society that created and employed robots. In some, robots were as useful as a servant, and had no hostile intentions. In others, robots were dangerous and at war with humanity. The writings of science fiction writer Isaac Asimov produced fundamental “Three Laws of Robotics.”

1. “These laws were: 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 such protection does not conflict with the First or Second Law.” (Asimov, 1950)

These laws only exist in the science fiction world in Asimov’s story, but are likely to be consciously thought of whenever a programmer is creating an intelligent machine. The problem comes when the military uses robots because their primary function, if they were robot soldiers, would be to attack humans, directly violating the first law. Alternatively, robots could be used by the military as a sort of humanitarian project, so that they are not so much fighting as cleaning up afterwards.

The military’s use of robots has existed for over a hundred years. The first potential use of a robot in the military was Tesla’s remote controlled torpedo, which was designed and tested in 1898, but never actually used (Glenn, 2008). In World War II, there were two ‘traditional’ robots in service: the German Goliath, and the Soviet Teletank. The Goliath was similar to Tesla’s torpedo in that it was a remote control robot that contained moderate explosives. The Teletank was a functional remote-controlled tank, used starting in 1939 and through the war (Lychagin, 2004). Both of these robots, while not enough to turn the tide of war, were examples of the potential of robots to be used in the military.

Immediately after World War 2, robots were not really used in war. All sorts of leaps in technology were made in robotics at home, but none of them made it to war in Korea or

Vietnam. This could most likely be attributed to two factors: terrain and weather. As most early electronics were large and unwieldy, it would be impossible make one that would be small enough to work in the jungles of Vietnam and mobile enough to climb through mud and underbrush. Also, the rainy season of Indochina would likely have been too much for early electronics to handle, shorting them out and destroying them.

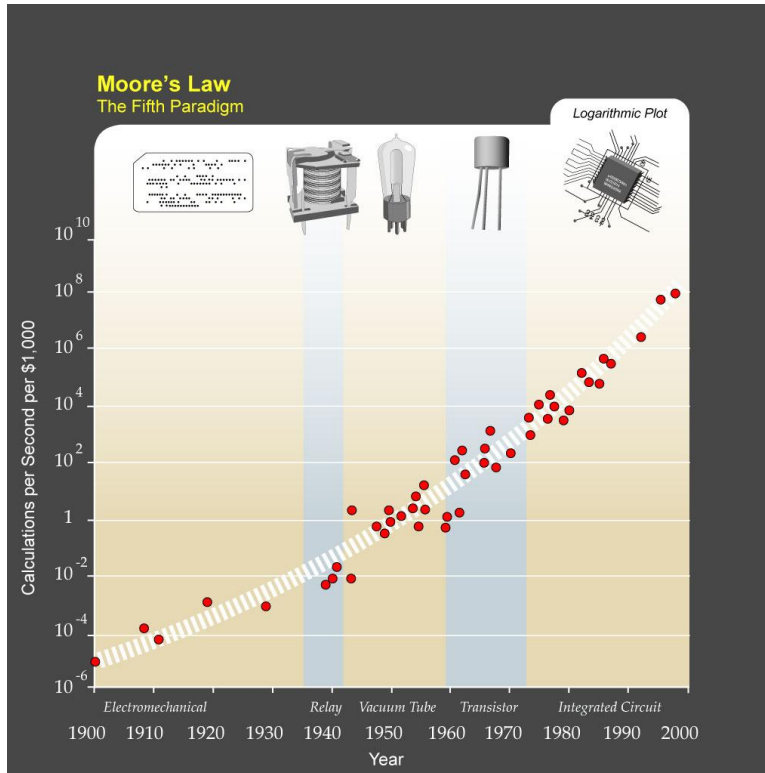


Figure 1: This graph shows the increase in calculations per second per price on a logarithmic graph. As predicted by Moore in 1965, the increase has been approximately exponential since 1965. [Image Courtesy of Ray Kurzweil and Kurzweil Technologies, Inc. (Kurzweil, 2008)]

By the time the war in Afghanistan and Iraq had started, sufficient advances in technology had been made that allowed robots back onto the battlefield. This trend can be explained using the data shown in Figure 1, which illustrates the computing power for a given price (in calculations per second per dollar). The higher a computer's speed and the lower its cost, the more feasible it is for any type of technology, but especially a high-risk environment like a war zone. Although the humanoid soldiers predicted in science fiction were and are still

beyond our current technology, deadly machines have still been made. Most of the current robots on the market still resemble miniature tanks or planes, rather than actual soldiers. Many of them are still remote controlled, which begs the question, what have we truly accomplished in robot technology since World War II?

This question can be answered simply, the tasks able to be accomplished by the machine are greatly increased in complexity and technology. For example, a Goliath tank could be remote controlled to position itself in a specific point, and then explode. Modern robots, after being positioned by humans to be where they are wanted, can do anything from searching for road-side bombs to scanning the terrain for hostile targets, and responding with the appropriate amount of force. There are also many robots that are completely automated, although they are usually designated to the tasks of reconnaissance and cleanup, and guiding ballistic and other missiles after they have been launched (Purdy, 2008).

The memory per unit area and computing power, which are two of the primary factors that constrain how intelligent a computer can be, have increased exponentially over the past 30 years (Twist, 2005). This means that computers have gone from being slightly more than adding machines that took up entire rooms to a more powerful computer being able to fit in a wristwatch. The drastic increase in transistors per chip, which limits how 'smart' a computer can be, was predicted by Gordon Moore, who predicted in 1965 that the value would double every 24 months (Twist, 2005). Given that increase in computing power, it is no surprise that recently have robots started to become truly intelligent. There are robots that can interact with people via speech, robots that can walk without falling over, and robots that can identify friend from foe and react accordingly. As their intelligence increases, robots can be relied on to do longer and more complex tasks.

Another major feature of the evolving technology is its robustness. In the past, a small jolt could break a vacuum tube, which would cause the entire machine to shut down. Now, robots can be dropped from great heights and still function, as well as stand up to water to a limited degree. This is largely due to the use of smaller, less fragile transistors: a change from vacuum tubes to a microscopic electrical component.

The producers of robots have manufactured robots for a variety of purposes, from home care to automated weapons. In this report, we will be analyzing the military's use of robots to fulfill four distinct objectives: *reconnaissance*, *surveillance*, *security*, and *explosive ordinance disposal* (bomb disposal). Different manufacturers have different strategies to solve each of these tasks, and many companies' robots are currently in use by the military. In addition, the government frequently sponsors events that spur further development of systems that they believe will be significant in the years to come.

Chapter 3: Military Operations

The military currently uses robots for a variety of missions; in our paper we are primarily focusing on surveillance, reconnaissance, automated defense systems, and bomb disposal.

Current technology primarily uses remote controlled robotics systems to perform a small number of duties, but the manpower required to run a robotic system is often greater than the manpower required to simply do the task (Michaelson, 2008). The primary benefit of robots is that they can often do a soldier's job faster, and do it with less risk to the soldiers themselves.

3.1: Surveillance

Surveillance is the operation in which a location is monitored for a specific event or signal. This could be waiting for an individual to make himself known or monitoring radio frequencies in an area. This job, if left to a human soldier, requires two things. The first is that the human needs to sustain him- or herself with food and sleep, which limits the amount of time he (or she) could stay at a location. The other problem is that of boredom, where the human can only focus for so long; not even the most well disciplined mind stay on task indefinitely.

Using a robot for this task alleviates these problems. First, a robot can be powered by a battery, or even a solar cell; where a battery will last only a few hours, a solar cell provides means for long-term power generation. Secondly, a robot is not going to be susceptible to boredom, and will follow whatever its programming instructs it to do single-mindedly. Robots also have the advantage that whatever they see can be electronically stored and reviewed at a later date.

3.2: Reconnaissance

Reconnaissance, unlike surveillance, refers to *moving* in order to get tactical information about a location. The oldest method of reconnaissance made use of spies, who would infiltrate and explore an area, and then report information back to their base camp. This was aided by the use of aircraft that flew undetected over an area, often at night, and reported back information in the form of aerial photographs of outdoor areas.

Use of night flights and similar forms of reconnaissance gradually declined with the widespread use of satellite systems, which can view everything a high flying aircraft can, but don't violate airspace rights. This does not solve the problem of not being able to view indoors or underground: This is a problem for urban warfare, where the fighting is building to building, with much of the danger lurking indoors.

Modern robots have approached the problem of reconnaissance from two directions. The first method is to use Unmanned Aerial Vehicles (UAVs) and satellites to survey enemy territory. Initially, this involved remote controlling a UAV over the route you wanted it to take, using video feedback to help steer and make route alterations. More recently, UAVs are able to have coordinates programmed into them, and will automatically follow these coordinates. Some of these aircraft have been armed with weapons, but these weapons have always required human control to fire (SPG Media, 2009).

Currently, the most often used machine for robotic reconnaissance is a satellite, which do classify as robots under our definition. Satellites often view the Earth's surface and get video information about a location, often for long periods of time. This video can be in not only visual frequencies, that the human eye can see, but also in infrared or ultraviolet frequencies, which can reveal information that is not apparent in the visual spectrum.

The alternative way to use robot reconnaissance is to have a robot travel with a unit of soldiers. Robots such as the iRobot Packbot have been frequently used to scout around corners and inside buildings ahead of soldiers, so that they can identify threats before actually putting themselves at risk. Such a robot is also remote controlled; a camera on the robot transmits video to the soldiers, who then use that as their intelligence on the situation.

Current technology has started to break into automated robot navigation. There have recently been government endorsed competitions, such as the DARPA Grand Challenge or Urban Challenge (DARPA, 2007), that have encouraged teams to program vehicles to navigate themselves across both urban and rural environments, with notable successes in recent years. Although this technology is currently only being explored by civilian organizations, it is sponsored by the military, and will likely find its way into military robots in the near future. This type of technology will be crucial for developing intelligent, automated group robots, which will be required to travel around obstacles and on streets, but will not always be able to be programmed with every detail of the route on the way.

3.3: Automated Defense

Automated defense refers to a weapons system, usually stationary, which is used to identify and eliminate incoming threats. Historically, this would be equivalent to soldiers with weapons standing guard at a location. As offensive weapons become longer ranged and more powerful, not only is it more dangerous to have live people standing guard, it is also less practical.

At the time of the First and Second World Wars, the primary defensive technology against ground targets would be machine gun nests; before the gunners could be eliminated, entire units of attackers could be neutralized. Similarly, anti-aircraft guns would be the choice

defensive technology against aircraft, one of the few existing technologies that could attack planes from the ground.

Modern defensive systems are almost required to be robotic due to the weapons they must defend against. With weapons such as long range missiles and artillery, fully human controlled weapons are unreliable for eliminating that threat. One device that is currently being used to combat this type of weapon is the Phalanx Close-In Weapons System. The Phalanx has a radar system for identifying targets, and has an automated firing system. This system is designed to shoot down anti-ship missiles, and is placed on large ships for their defense (Eagles, 2009).

Another modern robot that is used for this mission is the Intelligent Surveillance and Guard Robot, which has voice recognition technology combined with artificial intelligence able to execute a range of actions, from sounding an alarm to firing its machine gun (Christensen, 2006). This is designed to deal with human intruders, and it does so without always requiring lethal force, which is a goal sought after by much of modern security technology.

3.4: Bomb Disposal

One of the persistent, major missions of the military when dealing with terrorism is that of explosive ordinance disposal (EOD). In addition to pressure activated landmines, there are improvised devices and road bombs that can be much more dangerous if they go undetected. Traditionally, a human deminer with a metal detector was required to sweep the area suspected of having mines, putting himself at great risk should he not spot one. More recently, animals such as dogs and rats have been used to smell out the locations of mines (Tabak, 2000).

After the deminer found a mine, he would have three options. The first would be to manually disarm it. The second is to intensely burn the mine, which does not detonate the mine,

but would destroy it. The final method would be to do a smaller detonation of the mine, but avoid the large detonation the mine would be capable of.

An alternative to locating and dealing with one mine is to simply use a very sturdy vehicle and run over their suspected locations, which detonates the mines without causing damage to the vehicle. One of the modern robotic detonation systems is the MineWolf, more specifically the Mini MineWolf, which uses the strategy of simply running over the mines in order to destroy them. It is remote controlled, and its controller is very simple and usable, no more complicated than a children's toy (Schmidt, 2008). It is able to withstand multiple explosions without sustaining damage, which justifies its cost.

Another system used to identify and dispose of bombs is the iRobot Packbot, which has an EOD kit option. This is also a remote controlled device, but is not designed to detonate the bombs or to survive the explosion; instead it is designed to safely handle explosives and let human deminers defuse it (iRobot Corporation, 2009). Humans can control it from a safe distance, only moving in close to the suspected bomb after it has been examined and determined to be non-threatening. If it is identified as threatening, deminers may be employed to dispose of the bomb using one of the traditional methods available to them.

Chapter 4: Methodology

In this section, we will discuss the way in which we performed the research for this project. The section is meant to outline the reasons behind what decisions we made, as well as the particular methods used. We first conducted background research, and then moved on to interviews and surveys. Next, we made projections about the potential future of robots in the military given evidence from the surveys and the insights of our interview subjects. Next, the data was analyzed and summarized, primarily by comparing relative means of data. Finally, we predicted the impact of that future development given the ways robots are being used now and the impacts associated with that technology.

4.1: Background Research

Our first step in our research was to delve into what technology already existed for robots in the military. The most prominent name we found was that of iRobot (<http://www.irobot.com/>), whose Packbot and similar models are being used in the Iraq War for a variety of purposes. More research yielded other robotics companies, primarily American, which had robots that could perform one or more of the tasks we focused on: Reconnaissance, Weapons Platforms, Surveillance, or Explosive Ordinance Disposal (EOD). Many of these robots were similar to the iRobot constructs: they were low to the ground, had 4 wheels and a platform for additional modules to be installed on to for added versatility. The types of upgrades that could be included were summarized in a spreadsheet that has the missions to be accomplished crossed with the packs, which was used to search for gaps in how missions could be accomplished that were not currently in use, of accessories that are designed to accomplish

them. Other models of robots were Unmanned Aerial Vehicles, which were usually shaped like small airplanes.

Further research into current robot technology also yielded foreign robotics distributors, particularly ones based in East Asia. Their robots did not tend to be of four-wheeled model, and varied much more in their general shape. This ranged from something the size of a traffic cone that had extendable arms to an immobile platform with threat recognition technology and a mounted machine gun.

The next important research that was needed was to investigate current laws and ethics governing the operation and use of robots, both civil and in the military. We were initially able to find only limited information on this subject, so it became one of our primary interview questions. One of the sets of laws we were able to find information on were the internationally accepted laws governing warfare, including the Geneva Convention and other similar treaties. Though these laws do not govern robots specifically, laws governing robots can be derived from the laws that do exist.

4.2: Interviews

The next major step of our project was conducting interviews with experts on robotics, the military, and ethics, with an “expert” being loosely defined as having well above average knowledge of one or more of these fields. These experts involved a variety of professors at Worcester Polytechnic Institute; robotic engineering and computer science faculty were our primary subjects for robot experts; ethics professors were also interviewed for their objective perspective on the situation. We also interviewed people from the ROTC program for some insight into the minds of the soldiers and officers in the military and for some first-hand experience of the use of robots in the military. Another important subject was Mrs. Ellen Purdy,

the Joint Enterprise Director of Ground Robotics for the Department of Defense, who was kind enough to let us interview her.

The interview questions were designed to not only find their predictions for the future of robotics in the military, but also to see how robots are being used now, and possibly why they are being used the way that they are. This was useful to fill in our limited knowledge of laws and regulations that govern robots' use in the military. Interviews tended to be approximately 30 minutes long, and were recorded as completely as possible so we could refer to them later. In general, the same questions were asked to everyone, but each subject usually took their own perspective with which to answer each question, making each interview unique. Still, common patterns of answers were analyzed and incorporated into the analysis.

4.3: Survey

Our third step was to design a survey that would help to gauge the general populace's attitudes and knowledge of robots. This survey was designed with the help of Professor Skorinko (Department of Social Science and Policy Studies), who worked closely with us on the format and wording of the survey. The survey was crafted in order to understand three things: What level of autonomy would people tolerate from robots, how well armed do people think robots should be, and what jobs are there that should be for humans only? We also tried to discern between possible differences in opinions of our three target groups. First, we wanted the robotics and computer science people's opinions, as they are the most likely 'experts' on robots; second, we wanted the ROTC students, as they are most likely to deal directly with robots in the military. Finally, we wanted people with no particular knowledge of robots or the military, who are much more representative of the general populace and policy makers in the country.

Questions in the survey were designed in a couple of ways. First, we tried to find out each person's approximate definition of a robot by asking if a variety of machines were robots: Some would be and some would not be under our definition. The next questions were designed to test people's trust in robotics and their programming by asking if the subjects approved of robots doing certain missions, and having various levels of autonomy and power. The final section was a demographic section designed to find out how educated people were in terms of the military, robotics, and ethical matters. The section also asked for a variety of other topics in order to see if there were any other large, cohesive groups that we did not anticipate initially.

The survey first had to be approved by the WPI Institutional Review Board (IRB). We were guided through the approval process by Professor Rissmiller. The IRB required that we add such things as a consent form and other such formalities before it would be approved. After modifying the survey to conform to their regulations, we started to advertise and distribute the survey.

The survey was distributed using a variety of methods. For maximum accessibility, we decided to host our survey online at [surveymonkey.com](https://www.surveymonkey.com). The advertisement process for this was in 3 steps. First, we advertised the survey to the Robotic Engineering, Computer Science, and Electronic and Computer Engineering Departments. Second, we designed a flier to help publicize the survey (see Appendix B). This flyer was emailed to the general faculty and student mailing lists, the recipients of which would provide the bulk of our control group on the survey. Finally, it was also included in weekly events digest to further promote the survey.

The survey itself was composed mostly of questions with a five point Likert Scale for answers. The questions were meant to judge what the survey-taker would tolerate from a robot and where they felt uncomfortable. At the end of the scaled section was a section for an open

response, where the taker could write freely about the topics we provided. The final part of the survey was a small demographic section, where peoples' responses would be used to group them by their level of expertise in the robots and the military.

Once we had the survey results, we needed to group the answers by the demographic, and analyze any trends in the locations of different shifts in approval of what subjects thought was appropriate. After the data was analyzed, an appropriate set of representative graphs and charts were chosen to include in the final report. The important concepts that needed to be portrayed were the differences between testing groups, and the overall opinions of the survey subjects towards a variety of robot technologies.

4.4: *Future Predictions*

The last major step to our project was to make predictions about the future of robots in the military, and especially their impact on the military and society in general. Using the predictions of our robot experts, the current technology and restriction we found, and the historical trends concerning robots, we made our best projections about the future of robot technology, and its use in the military. We also used the input of our military experts to help us analyze the impact that technology would have on our selected military operations, namely Surveillance, Reconnaissance, Weapons Platforms, and Explosive Ordinance Disposal.

The survey also impacted our predictions, as it helped determine what people would tolerate from a robot. The interviews gave us a bit more in-depth glance into the likely future of robotics. Finally, a variety of newspaper, magazine, web, and journal articles showing progress in the realm of robotics was used to help predict likely evolutions in robotic systems for the military.

For the Impact section, the ideas of our interview subjects were used to help guide us towards the primary impacts of robots. In addition, we brainstormed additional impacts of robots in the military to supplement the ideas of our “experts.” The impacts we thought were most important for both near and distant future were included in the final report.

Chapter 5: Restrictions

Restrictions hinder, control or guide the development of any technology. The restrictions may be in the form of technology available, laws, or ethics. While restrictions such as technology and laws are clearly defined, ethical restrictions are not. However, any restriction is important to consider when developing a new technology or product. This section explores the three most relevant restrictions that may affect the future development of military robots.

5.1: Technological

The technology available for design and manufacturing greatly affects the design of a product. The tools available for design, specifically computer aided drafting products, may affect the final design of a product. Next, a company must consider the practicality of designing new equipment to manufacture a product. Factors to consider are cost, feasibility, and time. To be competitive, companies need to develop new products at the same or faster rate than other companies in the industry. Thus, in most cases it is not realistic to design new manufacturing equipment to create a new product. Therefore, technological restrictions are important to consider during product development.

Today technological challenges are to create better, smaller, and cheaper products. However, there are trade-offs between each of the above mainly regarding the cost. For consumer products there is more flexibility in determining the trade-offs, as it is common to manufacture a range of quality, size, and cost of products. For military products that flexibility does exist but is more limited. The budget available for military projects is stricter than consumer projects as the prospect of future profit isn't applicable. The size is influenced by the objective of the military robot, but also by the technology available. The size of components is

greatly restricted by the equipment available for manufacturing as well as the existing technology. The quality of the project is greatly dependent upon both the technology and budget available. There are several technological factors that affect product development.

The product development cycle today is fast-paced. Companies are challenged to continuously release “better” products quickly. The technology available greatly influences the design of new products. The development of new military robots will be restricted by technology. As technology advances, robotics will progress as well. The relationship between technology and robotics is symbiotic and that connection will not change over time.

5.2: Legal

Major restrictions that apply to product development are laws and other legal policies. Violation of any legal regulation may result in severe consequences, specifically monetary fines or criminal charges. It is crucial that companies comply with any applicable regulation throughout the design of a product. While the company is not a product’s end-user, if there is a conflict the company may be liable if any legal regulation was violated. Consequently, legal restrictions are vital to consider during product development.

Today’s society holds everyone accountable for their actions. In an age of whistle blowing, it is only a matter of time before a person or company is caught for wrongdoing. The news is full of lawsuit stories related to an injury or death that resulted from the malfunction of a product. It is critical that companies developing new technologies comply with safety regulations, especially if the likelihood of injury or death is high. With regard to military robots, currently there are no regulations, apart from ones that apply to manufacturing in general, restricting any part of the development process or safety features. The use of robots by the military is recent; thus, not enough time has elapsed for society to form a general consensus of

opinion. In turn, Congress has not developed any guidelines related to the development of robot technologies. Similarly, there are no known policies related to the use of robots within any military branch. Typically any item used by the military has a standard operating procedure. However, generally speaking there are no such procedures in place for robots. As of right now, there are no legal restrictions hindering the product development of military robots.

The approval of legal regulations is a slow process. It takes time for society to form opinions and for Congress to pass new policies. The legal process is not fast. Thus, in the mean time without any legal regulations, the development of military robots is unrestricted and open-ended. While this is beneficial for the development of new ideas, it may be detrimental in the near future. It is crucial that regulations guide the product development and use of military robots.

5.3: Ethical

Ethics, morals, and comfort levels are rarely clearly defined. Any situation is open to the individual's interpretation. Typically a social norm exists, but that is also loosely defined. While the opinions of society cannot directly restrict product development, they are significant and should be considered.

Today's society frequently exercises Constitutional rights such as freedom of speech and assembly. Protests and public gatherings, mostly non-violent, are a common means of communicating opinions. The news, both written and televised, is a popular way to publicize opinions or events. While sources may be biased, society continues to believe the news and form opinions. Therefore, it is an influential tool to gain or loss support for a new idea or product. The use of robots by the military is a controversial topic that isn't highly publicized yet. How the military uses robots and with what capabilities are easily debatable topics. Such topics are

not seriously considered now, but when publicized will be a hot topic in the news. Companies should seriously consider the opinions of society with regard to military robots. If society does not agree with the use or capabilities of a product, there will be consequences for that company. Though not a consumer product, the stock and reputation of the company is at stake.

Companies should invest in discovering the opinions of society with regard to military robots. That investment now will spare a lot of potential hassles in the future. It is possible that engineers may refuse to work on products that are controversial. Thus, it is important to maintain a positive company reputation and good employee relations. Ethical restrictions do not directly affect product development but are an integral part of the process.

Chapter 6: Tool Development

This chapter discusses the development of the survey and interview questions used to collect data for our project. As mentioned in Chapter 4, this chapter will elaborate on how the questions were formed, why they were chosen in lieu of other ones, and what the overall purpose of the interview and survey questions were.

The purpose of our survey was to analyze what people's attitudes were towards robots. The rationale behind the survey was that while most of the subjects we planned to test were college age, by the time of the future robotic development, these subjects and those like them would be the shapers of future laws and the developers of future robotic systems. It may be true that the people in one college are not a representative subsection of society; most people who will have the most impact on society are most likely to come from colleges. In particular, the engineers and scientists who will be impacting robot design will likely come from technical school, such as Worcester Polytechnic Institute.

The purpose of the interviews was not only to discern the attitudes of people towards robots, but also to have the interview subjects provide their thoughts about the future of robot development. Some of our subjects were experts in the military, others in robotics and computers, and others in law or philosophy. The experts in the military and robots were an obvious choice, but an outside look from philosophers and social scientists would help to gauge the evolution of laws, as not everyone making laws is going to have knowledge of robotics or the military.

6.1: Survey Question Design

The point of the survey was to discover people's views about robots in the military. To do this, it was important to get as many subjects as possible to help remove the influence of any outliers from the results by having more results to average them out. Another reason to help give specific attributes of the subjects ample numbers where, for analysis purposes, the subjects could be grouped by their specific expertise (robotic, military, or both), and have each group be populated enough to have meaning. As important as this was to get a base set to see what the "average" person thought on the questions, so we could see what effect knowledge would have on a person's opinions. For example, if we had the mean approval rating on an question, we could compare the results of those who said they had significant robotics knowledge with those who had no robotics knowledge, and see the effect, if any, that robotics knowledge had on their answer.

We decided that to maximize the accuracy of our survey, we needed whoever we could get to take the survey should be able to take it, as they would likely compose most of our "average" group. We did want to focus on the few specific groups, corresponding to the experts in each particular field. We used WPI's mailing lists to contact all the Computer Science, Electrical Engineering, Mechanical Engineering, and Robotic Engineering majors by email requesting that they take the survey. We also contacted various groups that we belonged to, including the fraternity and sororities at the school, some sports teams, and the social committee. We also advertised using a general student body email and various other methods to attract the average student, including a flyer posted in various locations on campus displaying where our survey could be found.

When designing the test, it was very important to make the questions as unbiased as possible. To accomplish this, the questions needed to not lead the subject towards any specific mode of thought. Since our group did not have the expertise to design the test unbiased, we consulted someone in the Social Science department to help audit our survey. Professor Skorinko helped us word our questions to not bias our results in any way. She also suggested that we place the demographic section at the end of the test to further remove bias from the test.

To give subjects a measurable way to express their opinions, we decided to use a Five-Point Likert scale to measure responses to our questions. With the exceptions of the open response and demographic questions, all the answers to our test's questions were scaled from "strongly disagree" to "strongly agree." This allowed the test to be scored numerically from one to five, which made computing and comparing means scientifically possible. This would not be possible if they were open response questions, as those are nearly impossible to group. In addition, just because someone does not say something does not mean that they disagreed with the idea, they could simply not have thought of it. Also, it is difficult to judge the magnitude of how someone agrees or disagrees simply because of their choice of words.

The final major aspect of our test we needed to monitor was the order of the questions. For ease of judgment, we decided to group the questions by topic, and order each topic from least likely to most likely to be opposed. This would hopefully provide an obviously detectable point where a specific group's average answer shifted from being in favor to not in favor.

6.2: Interview Question Design

Unlike the survey, the interviews were used primarily to get further ideas about the future of robots and technology. Unlike the survey, we wanted to interview experts only in particular

fields, as the experts were more likely to have a special insight into their field. An average test-taker would likely be more typical for the majority of society, and as such would compose our control group. We thought the interview would be a supplement to the survey data, helping to explain why particular groups of people felt the way they did. Once the test taking was underway, we saw that the survey provided ample data for analysis purposes, and decided that the interviews would be more useful to give us ideas on the future evolution of robots and their impact on society.

Our interview subjects fell into three categories: Military Experts, Robotics Experts, and Law or Ethics Experts. Our first subject was a combination of these three-Ms. Ellen Purdy – the current director of the Joint Group Robotics Enterprise. The Joint Ground Robotics Enterprise is a federal program in charge of military technological research and development. This puts Ms. Purdy in a unique position of authority on robotic development, which made her a key person to interview for our project. Her opinions, although not cited explicitly, were one of the most influential in the formulation of our predictions. Her statements, while not necessarily reflecting the official policy of the military, were important in directing us towards the modes of certain thinking in the modern military.

Other interview subjects that were included were various members of the faculty at WPI. Electrical Engineering, Computer Science, and Mechanical Engineering faculty were interviewed for robotics knowledge. The ROTC command cadre was interviewed for their military knowledge. Finally, we interviewed Philosophy and Social Science faculty for their insight into ethical matters.

The questions on the survey were designed to be open ended, and to guide the subjects thoughts to project into the future, but were not designed to restrict the answer to a question specifically to that topic, since sound ideas can come out of wandering thoughts as well as specific questions. The questions were designed to at least start the same for every interview, but they could be interpreted by the subject however they pleased. In general, the interview questions were designed to address the same topics on the survey, but were not limited in the same way because of their open-ended nature.

Chapter 7: Data Analysis

7.1: Survey Demographics

An online survey was conducted from October 21, 2008 through December 31, 2008. Of the 663 people who opened the survey link, 639 people consented to participate in the study (Table A.1.1). All data analysis excludes the 24 persons who did not consent to participate in the study per the Worcester Polytechnic Institute Institutional Review Board guidelines. A high volume of people began the survey; however, not all 639 persons who consented to participate in the study answered each question. The two bottom rows of Tables A.1.1 – A.1.12 display how many participants answered or skipped each question out of the 639 persons who consented to participate in the study. The Tables display a steady trend, with fewer people completing each question as the survey progressed. The decrease in participation as the survey progressed may be due to disinterest or lack of time to complete the remaining questions. We hypothesize that more participants would have completed the demographic questions if that section had been located at the beginning of the survey. Professor Jeanine Skorinko, of the Social Science & Policies Studies Department at WPI, advised that placing demographic questions at the start of a survey might cause biased responses. Thus, following the advice of Professor Skorinko, those questions were placed at the end of the survey. The subsequent sections present and analyze the data collected from the survey.

7.1.1: All Survey Participants

This section summarizes the data from all persons who participated in the survey without applying a demographic filter. Of the 339 persons who completed the demographic section, 203 (59.9%) participants were male and 131 (38.6%) were female (Table A.2.1). The target age

group was college students, thus 279 of 339 (82.3%) participants were between the ages of 18 and 24 (Table A.2.2), and 271 of 339 (79.9%) participants had a high school or some college education (Table A.2.3). The participants' area of study ranged across all fields of engineering, life science, and business. The majority of participants were students at Worcester Polytechnic Institute (WPI). In addition, WPI faculty and ROTC Cadre as well as professionals working in robotics related fields completed the survey. As the target population was WPI students, 51.1% of participants are unemployed (Table A.2.4). The employed participants work in the public (10.7%), private (17.2%), not-for-profit (5.3%), and other (5.6%) sectors (Table A.2.4). The participants reported political affiliations as Democrat (32.9%), Republican (16.2%), Independent (37.2%), and Other (13.7%) (Table A.2.5). A majority of participants (82.6%) do not have any experience with the military (Table A.2.6). The 17.4% of participants with military experience are active duty, retired, reserve, are part of the ROTC program, or other have other military experience (Table A.2.6). Nearly half of the participants (48.9%) have no experience with robotics (Table A.2.8). The participants with robotics experience have a robotics related major (18.2%), participate in FIRST (22.5%), have a job related to robotics (8.5%), teach robotics courses (2.7%), or other experience with robotics (30.4%) (Table A.2.8). Roughly 50% of participants rated themselves at least "Somewhat familiar and knowledgeable" with both military (48.80%) and robotics (50.46%) (Table A.2.7). The following sections summarize the demographic information of the persons for each filter applied.

7.1.2: Classification of Company Participant Filter

This is a summary of data from all persons who participated in the study that are employed by the private, public, not-for-profit, and other sectors. Of the 136 persons who

reported employment and completed the demographic section, 94 (69.6%) participants were male and 39 (28.9%) were female (Table B.2.1). The target age group for the survey was college students, thus 88 of 136 (64.7%) participants were between the ages of 18 and 24 (Table B.2.2), and 78 of 136 (57.8%) participants had high school or some college education (Table B.2.3). The 136 participants work in the public (25%), private (40.4%), not-for-profit (12.5%), and other (13.2%) sectors (Table B.2.4). The participants reported political affiliations as Democrat (27.1%), Republican (17.3%), Independent (44.4%), and Other (11.3%) (Table B.2.5). A majority of participants (75.9%) do not have any experience with the military (Table B.2.6). Less than 42% of the participants (41.5%) have no experience with robotics (Table B.2.8). The majority of participants rated themselves at least “Somewhat familiar and knowledgeable” with the military and with robotics (Table B.2.7).

7.1.3: Gender Participant Filter

This is a summary of data from all persons who participated in the study that reported his or her gender. Of the 334 persons who reported his or her gender and completed the demographic section, 203 (59.9%) participants were male and 131 (38.6%) were female (Table C.2.1). The target age group for the survey was college students, thus 278 of 334 (82.2%) participants were between the ages of 18 and 24 (Table C.2.2), and 271 of 334 (80.2%) participants had high school or some college education (Table C.2.3). As the target population was WPI students, 51.3% of participants in this category are unemployed (Table C.2.4). The employed participants who reported his or her gender work in the public (10.4%), private (17.3%), not-for-profit (5.3%), and other (5.7%) sectors (Table C.2.4). The participants reported political affiliations as Democrat (33.0%), Republican (15.9%), Independent (37.3%), and Other

(13.8%) (Table C.2.5). A majority of participants (82.5%) do not have any experience with the military (Table C.2.6). Less than half of the participants (49.1%) have no experience with robotics (Table C.2.8). The majority of participants rated themselves at least “Somewhat familiar and knowledgeable” with the military and with robotics (Table C.2.7).

7.1.4: Military Experience Participant Filter

This is a summary of data from all persons who participated in the study that reported military experience as active duty, retired, ROTC, or other. Of the 333 persons in this category who completed the demographic section, 200 (60.2%) participants were male and 128 (38.6%) were female (Table D.2.1). The target age group for the survey was college students, thus 283 of 333 (85.0%) participants were between the ages of 18 and 24 (Table D.2.2), and 267 of 333 (80.5%) participants had high school or some college education (Table D.2.3). As the target population was WPI students, 51.6% of participants in this category are unemployed (Table D.2.4). The employed participants who reported military experience work in the public (10.8%), private (17.2%), not-for-profit (5.4%), and other (5.7%) sectors (Table D.2.4). The participants reported political affiliations as Democrat (33.0%), Republican (16.4%), Independent (37.3%), and Other (13.3%) (Table D.2.5). Less than half of the participants (48.9%) have no experience with robotics (Table D.2.8). The majority of participants rated themselves at least “Somewhat familiar and knowledgeable” with the military and with robotics (Table D.2.7). The demographic information refers to the applied filter of military experience. However, for purposes of data analysis, all participants with any military experience are compared to all participants without any military experience.

7.1.5: Political Party Participant Filter

This is a summary of data from all persons who participated in the study that reported political affiliation as Democrat, Republican, Independent, or Other. Of the 328 persons who completed the demographic section, 198 (60.6%) participants were male and 124 (37.9%) were female (Table E.2.1). The target age group for the survey was college students, thus 269 of 328 (82.0%) participants were between the ages of 18 and 24 (Table E.2.2), and 261 of 328 (79.8%) participants had high school or some college education (Table E.2.3). As the target population was WPI students, 50.8% of participants in this category are unemployed (Table E.2.4). The employed participants who reported political affiliation work in the public (10.7%), private (17.9%), not-for-profit (5.9%), and other (5.5%) sectors (Table E.2.4). Of those participants who reported their political party, 32.9% identify as Democrat, 16.2% as Republican, 37.2% as Independent, and 13.7% as Other (Table E.2.5). A majority of participants (83.0%) do not have any experience with the military (Table E.2.6). Less than 50% of the participants (48.9%) have no experience with robotics (Table E.2.8). The majority of participants rated themselves at least “Somewhat familiar and knowledgeable” with the military and with robotics (Table E.2.7).

7.2: Analysis of Responses

This section analyzes the data obtained from the survey by all participants, classification of company, gender, military experience, and political party demographic filters. All subsections will first discuss the topic and explain the corresponding survey question(s) then analyze the data. The data analysis for each section only includes analysis of data where participants reported the appropriate information as iterated above.

7.2.1: Definition of a Robot

The definition of a robot varies greatly depending upon the source. This project defines a robot as “any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner” (Moravec 2008). As many robots perform tasks automatically, the group defines automated as “the automatic operation or control of equipment, a process, or a system” (The American Heritage Dictionary 2008). In addition, we define remote controlled as “the control of an activity, process, or machine from a distance, as by radioed instructions or coded signals” (The American Heritage Dictionary 2008). Questions 2 through 5 of the survey address the definition of a robot by asking participants to rate different descriptions.

Question 2 asks participants to rate statements concerning the automation of a robot. Question 3 asks participants to rate statements concerning the ability of a robot to be remote controlled. Question 4 asks participants to rate statements concerning the capability of a robot to act as a defense mechanism. Question 5 asks participants to rate statements concerning robots responding to voice commands.

7.2.1.1: All Participants

From Question 2 concerning the automation of a robot, per the project’s definition, 82.2% of participants agree that a robot may be defined as an automated ground vehicle that navigates around obstacles to a given location. More than 61% of participants agree that a robot may be defined as a ground vehicle (e.g., Tank, car) or aircraft (e.g., Jet, helicopter) that can fire a weapon on command with 65.2% and 61.2% respectively. While a majority of participants agree that a robot may have an automated weapon that can be fired on command, less than 49%

of the participants (48.8%) agree that a robot is a defense mechanism such as a missile or a torpedo (Table A.1.2).

From Question 3 concerning the ability of a robot to be remote controlled, roughly 70% of participants agree that a robot may be defined as a remote controlled ground vehicle (e.g., tank, car) or aircraft (e.g., jet, helicopter) with 72.2% and 68.7% respectively. In addition, 79.3% of participants agree that a robot may be defined as a device that can pick up or close around objects (Table A.1.3).

From Question 4 concerning the capability of a robot to act as a defense mechanism, interestingly, 59.6% of participants agree that a robot may be defined as a defense mechanism that will ask permission before firing. However, 52.0% of participants neither agree nor disagree that a robot may be defined as a defense mechanism that will fire automatically at threatening stationary or moving targets (Table A.1.4).

From Question 5 concerning robots responding to voice commands, participants agree that a robot may be defined as a ground vehicle (e.g., tank, car) or aircraft (e.g., jet, helicopter) that responds to voice commands with 70.9% and 66.1% respectively (Table A.1.5).

7.2.1.2: Classification of Company

From Question 2 concerning the automation of a robot, per the project's definition, over 70% of participants from the public (75.8%), not-for profit (70.6%) and other (76.5%) sectors agree that a robot may be defined as an automated ground vehicle that navigates around obstacles to a given location. Over 90% of participants from the private sector (90.9%) agree with the previous definition. Less than 48% of participants from the not-for-profit sector (47.1%) but more 63% of participants from the public (69.7%), private (63.6%), and other (64.7%) sectors agree that a robot may be defined as a ground vehicle (e.g., Tank, car) that can

fire a weapon on command. More than 60% of participants from the public (63.6%), private (60.0%), and other (64.7%) sectors but only 41.2% of participants from the not-for-profit sector agree that a robot may be defined as a aircraft (e.g., Jet, helicopter) that can fire a weapon on command. While roughly 50% of participants agree a robot may have an automated weapon that can be fired on command, less than 48% from the participants from the public (39.4%), private (47.3%), not-for-profit (35.3%), and other (29.4%) sectors agree that a robot is a defense mechanism such as a missile or a torpedo (Table B.1.2).

From Question 3 concerning the ability of a robot to be remote controlled, per the project's definition, over 70% of participants from the public (79.4%), private (74.1%), and other (70.6%) sectors agree that a robot may be defined as a remote controlled ground vehicle (e.g., tank, car). Less than 59% of participants from the not-for profit sector (58.8%) agree with the previous definition. Roughly 70% of participants from the public (70.6%), private (72.7%), and other (70.6%) sectors agree that a robot may be defined as a remote controlled aircraft (e.g., jet, helicopter). Nearly 53% of participants from the not-for profit sector (52.9%) agree with the previous definition. A majority of the participants from the public (85.3%), private (81.8%), and other (82.3%) sectors but less than 59% of the participants the not-for-profit sector (58.8%) agree that a robot may be defined as a device that can pick up or close around objects (Table B.1.3).

From Question 4 concerning the capability of a robot to act as a defense mechanism, a majority of participants from the public (70.6%) and other (64.7%) sectors agree that a robot may be defined as a defense mechanism that will ask permission before firing. However, only half of the participants from the private (54.7%) and not-for-profit (52.9%) sectors agree that a robot may be defined as a defense mechanism that will ask permission before firing. Roughly

half of participants from public (52.9%), private (45.3%), not-for profit (58.8%) and other (52.9%) sectors agree that a robot may be defined as a defense mechanism that will fire automatically at threatening stationary or moving targets (Table B.1.4).

From Question 5 concerning robots responding to voice commands, approximately 70% of participants from the public (70.6%), private (68.5%), and other (70.6%) sectors, but less than 48% of participants from the not-for profit sector (47.1%), agree that a robot may be defined as a ground vehicle (e.g., tank, car) that responds to voice commands. More than 60% of the participants from the public (61.8%) and private (66.7%) sectors but less than half of participants from the not-for profit (35.3%) and other (47.1%) sectors agree that a robot may be defined as an aircraft (e.g., jet, helicopter) that responds to voice commands (Table B.1.5).

Results of Questions 2 through 5 show consistent differences between the opinions of participants who work in the not-for-profit sector compared to other sectors. For every statement in all questions, the not-for-profit sector averaged the lowest rating and consequently lowest percentage. The public sector, private sector, and other sector consistently averaged similar results.

7.2.1.3: Gender

From Question 2 concerning the automation of a robot, per the project's definition, both the male (82.59%) and the female (82.17%) participants agree that a robot may be defined as an automated ground vehicle that navigates around obstacles to a given location. A majority of the male (62.69%) and female (70.54%) participants agree that a robot may be defined as a ground vehicle (e.g., Tank, car) that can fire a weapon on command. Roughly 60% of the male (59.70%) and female (64.34%) participants agree that a robot may be defined as an aircraft (e.g., Jet, helicopter) that can fire a weapon on command. Although a majority of participants agree a

robot may have an automated weapon that can be fired on command, less than 45% of the male (44.50%) and female (44.19%) participants agree that a robot is a defense mechanism such as a missile or a torpedo (Table C.1.2).

From Question 3 concerning the ability of a robot to be remote controlled, per the project's definition, the male (72.00%) and female (73.85%) participants agree that a robot may be defined as a remote controlled ground vehicle (e.g., tank, car). More than 63% of the male (72.00%) and female (63.85%) participants agree that a robot may be defined as a remote controlled aircraft (e.g., jet, helicopter). Over 76% of the male (76.50%) and female (86.92%) participants agree that a robot may be defined as a device that can pick up or close around objects (Table C.1.3).

From Question 4 concerning the capability of a robot to act as a defense mechanism, more than 60% of the male (60.30%) and female (61.24%) participants agree that a robot may be defined as a defense mechanism that will ask permission before firing. However, only about half of the male (54.77%) and female (48.84%) participants agree that a robot may be defined as a defense mechanism that will fire automatically at threatening stationary or moving targets (Table C.1.4).

From Question 5 concerning robots responding to voice commands, more than 65% of the male (65.50%) and female (79.23%) participants agree that a robot may be defined as a ground vehicle (e.g., tank, car) that responds to voice commands. More than 72% of the male (79.23%) and female (72.31%) participants agree that a robot may be defined as an aircraft (e.g., jet, helicopter) that responds to voice commands (Table C.1.5).

Results of Questions 2 through 5 show consistent differences between the opinions of male and female participants. For most statements both genders closely agree, but differ more with regard to voice commands.

7.2.1.4: Military Experience

From Question 2 concerning the automation of a robot, per the project's definition, roughly 80% of participants with military experience (79.31%) and without military experience (83.82%) agree that a robot may be defined as an automated ground vehicle that navigates around obstacles to a given location. More than 62% of participants with military experience (62.06%) and without military experience (66.54%) agree that a robot may be defined as a ground vehicle (e.g., Tank, car) that can fire a weapon on command. Over 56% of participants with military experience (56.89%) and without military experience (62.88%) agree that a robot may be defined as an aircraft (e.g., Jet, helicopter) that can fire a weapon on command. Although a majority of participants agrees a robot may have an automated weapon that can be fired on command, less than 46% of participants with military experience (39.66%) and without military experience (45.39%) agree that a robot is a defense mechanism such as a missile or a torpedo (Table D.1.2).

From Question 3 concerning the ability of a robot to be remote controlled, per the project's definition, roughly 70% of participants with military experience (68.97%) and without military experience (73.89%) agree that a robot may be defined as a remote controlled ground vehicle (e.g., tank, car). More than 63% of participants with military experience (63.79%) and without military experience (70.22%) agree that a robot may be defined as a remote controlled aircraft (e.g., jet, helicopter). A majority of participants with military experience (70.69%) and

without military experience (83.09%) agree that a robot may be defined as a device that can pick up or close around objects (Table D.1.3).

From Question 4 concerning the capability of a robot to act as a defense mechanism, more than 60% of participants with military experience (60.34%) and without military experience (61.10%) agree that a robot may be defined as a defense mechanism that will ask permission before firing. However, only half of participants with military experience (50.00%) and without military experience (52.96%) agree that a robot may be defined as a defense mechanism that will fire automatically at threatening stationary or moving targets (Table D.1.4).

From Question 5 concerning robots responding to voice commands, approximately 70% of participants with military experience (70.69%) and without military experience (70.96%) agree that a robot may be defined as a ground vehicle (e.g., tank, car) that responds to voice commands. Slightly over 65% of participants with military experience (65.52%) and without military experience (65.44%) agree that a robot may be defined as an aircraft (e.g., jet, helicopter) that responds to voice commands (Table D.1.5).

Results of Questions 2 through 5 consistently show that the participants with military experience agree less with the statements compared to the participants with military experience. The participants with and without military experience closely agree with Question 4 and 5.

7.2.1.5: Political Party

From Question 2 concerning the automation of a robot, per the project's definition, the participants from the Democratic (83.18%), Republican (86.53%), Independent (82.79%), and Other (79.07%) political parties agree that a robot may be defined as an automated ground vehicle that navigates around obstacles to a given location. More than half of participants from the Democratic (68.22%), Republican (76.92%), Independent (60.66%), and Other (55.81%)

political parties agree that a robot may be defined as a ground vehicle (e.g., Tank, car) that can fire a weapon on command. Over half of participants from the Democratic (59.81%), Republican (78.85%), Independent (59.02%), and Other (53.49%) political parties agree that a robot may be defined as an aircraft (e.g., Jet, helicopter) that can fire a weapon on command. Although a majority of participants agrees a robot may have an automated weapon that can be fired on command, less than 50% of the participants from the Democratic (48.59%), Republican (43.13%), Independent (43.44%) and Other (44.19%) political parties disagree that a robot is a defense mechanism such as a missile or a torpedo (Table E.1.2).

From Question 3 concerning the ability of a robot to be remote controlled, per the project's definition, participants from the Democratic (71.69%), Republican (67.92%), Independent (72.95%) and Other (74.41%) political parties agree that a robot may be defined as a remote controlled ground vehicle (e.g., tank, car). More than 60% of participants from the Democratic (63.20%), Republican (66.04%), Independent (73.77%), and Other (67.44%) political parties agree that a robot may be defined as a remote controlled aircraft (e.g., jet, helicopter). Over 75% of participants from the Democratic (76.41%), Republican (77.36%), Independent (83.61%), and Other (83.72%) political parties agree that a robot may be defined as a device that can pick up or close around objects (Table E.1.3).

From Question 4 concerning the capability of a robot to act as a defense mechanism, more than half of participants from the Democratic (62.86%), Republican (65.38%), Independent (59.02%), and Other (53.49%) political parties agree that a robot may be defined as a defense mechanism that will ask permission before firing. Approximately half of participants from Democratic (49.52%), Republican (59.62%), Independent (50.82%) and Other (53.49%) political

parties neither agree nor disagree that a robot may be defined as a defense mechanism that will fire automatically at threatening stationary or moving targets (Table E.1.4).

From Question 5 concerning robots responding to voice commands, more than half of participants from the Democratic (77.36%), Republican (69.81%), Independent (69.67%) and Other (60.47%) political parties agree that a robot may be defined as a ground vehicle (e.g., tank, car) that responds to voice commands. More than half of participants from the Democratic (70.75%), Republican (66.04%), Independent (64.75%), and Other (53.49%) political parties agree that a robot may be defined as an aircraft (e.g., jet, helicopter) that responds to voice commands (Table E.1.5).

The difference between the percentage of Democrats versus Republicans who agree with Questions 4 and 5 is notable. A significantly lower percentage of Democrats agree with Question 4 compared to the percentage of Republicans. Conversely, a significantly higher percentage of Democrats agree with Question 5 compared to the percentage of Republicans. There is a consistent difference of opinion between the Democrat and Republican political parties.

7. 2.2: Successful Robot Operations

The group defines “successful” as “having a favorable outcome. Having obtained something desired or intended” (The American Heritage Dictionary 2008). Given the technologies currently available for the development of robotics, it is important to know if society actually trusts robots. The United States military currently uses robots for several of the operations already mentioned in the survey. Question 6 asks participants to rate how much he or she would trust a robot to perform military operations and tasks successfully.

7.2.2.1: All Participants

From Question 6 asking participants to rate how much he or she would trust a robot to perform military operations successfully, the majority of participants would trust a robot to perform surveillance (85.5%), reconnaissance (78.1%), bomb disposal (82.2%), and defense military operations (63.9%). There is a considerable difference of society's support for non-defense military operations compared to defense military operations. All military personnel interviewed trust and support the future use of robots for surveillance, reconnaissance, and bomb disposal military operations (Appendix H). By using robots, soldiers are exposed to less risk and dangerous situations. However, 59.5% of participants would not trust a robot to successfully recognize friend from foe. A major concern is that robots do not have the capability to make decisions other than the programmed actions. Society is concerned that the robot will incorrectly identify a foe and innocents will be injured or killed. On the other hand, participants would trust a robot to carry a defense mechanism properly (e.g., weapon without misuse or misfire) and only use lethal force with the permission of a human with 63.3% and 62.6% respectively.

7.2.2.2: Classification of Company

From Question 6 asking participants to rate how much he or she would trust a robot to perform military operations successfully, participants from the public (97.06%), private (92.73%), not-for-profit (82.35%), and other (94.44%) sectors would trust a robot to perform surveillance military operations. The participants from the public (77.78%), private (82.35%), not-for-profit (88.89%), and other (72.73%) sectors would trust a robot to perform reconnaissance military operations. The participants from the public (82.35%), private (83.64%), not-for-profit (100%), and other (88.89%) sectors would trust a robot to perform bomb disposal military operations. Similarly, the participants from the public (82.35%), private

(83.64%), not-for-profit (100%), and other (88.89%) sectors would trust a robot to perform defense military operations. However, less than 30% of participants from the public (29.41%) and private (23.64%) sectors and less than 20% of participants from the not-for-profit (17.65%) and other (11.76%) sectors would trust a robot to recognize friend from foe successfully. On the other hand, participants from the public (70.59%), private (67.27%), not-for-profit (64.71%), and other (55.56%) sectors would trust a robot to carry a defense mechanism properly (e.g., weapon without misuse or misfire). In addition, participants from the public (64.71%), private (69.09%), not-for-profit (52.94%), and other (77.78%) sectors would trust a robot to use lethal force with the permission of a human (Table B.1.6.1 – 2).

7.2.2.3: Gender

From Question 6 asking participants to rate how much he or she would trust a robot to perform military operations successfully, the male (88.56%) and female (83.08%) participants would trust a robot to perform surveillance military operations. Over 85% of the male (86.00%) but less than 70% of the female (68.99%) participants would trust a robot to perform reconnaissance military operations. Similarly, nearly 90% of the male (89.50%) and less than 75% of the female (73.64%) participants would trust a robot to perform bomb disposal military operations. Over 60% of the male (67.50%) and female (60.00%) participants would trust a robot to perform defense military operations. However, less than 30% of the male (27.00%) and only 10.01% of the female participants would trust a robot to successfully recognize friend from foe. Close to 60% of the male (66.67%) and female (62.31%), participants would trust a robot to carry a defense mechanism properly (e.g., weapon without misuse or misfire). Likewise, over 60% of the male (64.18%) and female (63.08%) participants would trust a robot to use lethal force *with* the permission of a human (Table C.1.6.1 – 2).

Both male and female participants trust robots to perform military operations successfully but would not trust a robot to recognize friend from foe. While this is true, there is approximately a difference of 10% between the male and female participants for all statements in Question 6.

7.2.2.4: Military Experience

From Question 6 asking participants to rate how much he or she would trust a robot to perform military operations successfully, the participants with military experience (84.21%) and without military experience (87.23%) would trust a robot to perform surveillance military operations. The participants with military experience (78.95%) and without military experience (79.41%) would trust a robot to perform reconnaissance military operations. Similarly, the participants with military experience (78.95%) and without military experience (84.19%) would trust a robot to perform bomb disposal military operations. Only 50% of participants with military experience but more than 65% of participants without military experience (67.52%) would trust a robot to perform defense military operations. However, approximately 20% of participants with military experience (19.64%) and without military experience (20.15%) would trust a robot to successfully recognize friend from foe. On the other hand, slightly over 70% of participants with military experience (71.93%) and 60% of participants without military experience (63.60%) would trust a robot to carry a defense mechanism properly (e.g., weapon without misuse or misfire). Likewise, 70% of participants with military experience (70.18%) and only slightly over 60% of participants without military experience (62.04%) would trust a robot to use lethal force with the permission of a human (Table D.1.6.1 – 2).

While the overall opinions to trust or not to trust robots to perform military operations successfully are similar, the difference between the participants with and without military

experience is significant. A major difference is meaningfully fewer participants with military experience would trust a robot to perform defense military operations successfully. Interestingly, significantly more participants with military experience would trust a robot to use lethal force with the permission of a human.

7.2.2.5: Political Party

From Question 6 asking participants to rate how much he or she would trust a robot to perform military operations successfully, the participants from the Democratic (89.72%), Republican (84.91%), Independent (85.12%), Other (79.55%) political parties would trust a robot to perform surveillance military operations. Over 75% of participants from the Democratic (83.02%), Republican (75.47%), Independent (79.17%) political parties, but only 70% of participants from the Other political party (70.45%) would trust a robot to perform reconnaissance military operations. The participants from the Republican (73.58%), Independent (83.19%), and Other (77.27%) political parties would trust a robot to perform bomb disposal military operations. Over 90% of participants from the Democratic (90.65%) political parties would agree with the previous statement. The participants from the Democratic (66.36%), Republican (63.46%), Independent (66.94%), Other (54.55%) political parties would trust a robot to perform defense military operations. However, only approximately 20% of participants from the Democratic (18.87%), Republican (24.53%), Independent (20.00%), Other (20.45%) political parties would trust a robot to successfully recognize friend from foe. On the other hand, the participants from the Democratic (69.16%), Republican (69.81%), Independent (61.98%), Other (54.55%) political parties would trust a robot to carry a defense mechanism properly (e.g., weapon without misuse or misfire). In addition, approximately 60% of the participants from the Democratic (63.55%), Independent (61.98%), Other (54.55%) political

parties would trust a robot to use lethal force with the permission of a human. Over 70% of participants from the Republican (73.58%) political party would agree with the previous statement (Table E.1.6.1 – 2).

While the overall opinions to trust or not to trust robots to perform military operations successfully are similar, the difference between each political party is significant. A major difference is considerably more participants who identify as Democratic would trust a robot to perform bomb disposal military operations. In addition, more participants who identify as Republican would trust a robot to use lethal force with the permission of a human.

7.2.3: Automation of Robot Operations

The group defines automated as “the automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary 2008). Question 2 addressed how to define a robot as it relates to autonomous functions. Given ability of robots to be autonomous, it is important to know if society actually trusts robots to execute commands without human control. The United States military currently uses robots for several of the operations mentioned but with human control. Question 7 asks participants to rate how much he or she would trust a robot to perform military operations or tasks autonomously.

7.2.3.1: All Participants

From Question 7 asking participants to rate how much he or she would trust a robot to perform military operations autonomously, the majority of participants would trust a robot to perform autonomous surveillance (81.6%), reconnaissance (69.2%), and bomb disposal (65.1%). On the other hand, 52.2% participants would not trust a robot to perform defense military operations autonomously. Nearly 60% of the participants (59.07%) would trust a robot to fly an

aircraft (e.g., jet or airplane). Half of the participants (51.4%) are not confident that a robot could guard a facility, assuming it could recognize friend from foe. Slightly over 60% of participants (60.2%) would not trust a robot to defend itself autonomously without using lethal force. However, over 75% of participants (77.47%) would trust a robot to autonomously detect and dispose of explosives. A robot with the capability to use lethal force is an important concern. A majority of participants (70.6%) agree that robots should *not* be allowed to use lethal force *with or without* human control (Table A.1.7).

7.2.3.2: Classification of Company

From Question 7 asking participants to rate how much he or she would trust a robot to perform military operations autonomously, the participants from the public (91.18%), private (83.33%), not-for-profit (82.35%), and other (94.44%) sectors would trust a robot to perform surveillance military operations. Over 70% of participants from the public (73.53%), private (72.22%), not-for-profit (76.47%), and other (83.33%) sectors would trust a robot to perform reconnaissance military operations. Nearly 70% of participants from the public (70.59%) and other (70.59%) sectors but less than 65% of participants from the private (64.81%) and not-for-profit (52.94%) sectors would trust a robot to perform bomb disposal military operations autonomously. Over 55% of participants from the public (55.88%) and private (55.56%) sectors but less than 42% of participants from the not-for-profit (41.18%) and other (38.89%) sectors would trust a robot to perform defense military operations. Approximately 60% of the participants from the public (64.71%), private (66.67%), and not-for-profit (58.82%) sectors but less than 40% of participants from the other sector (38.89%) would trust a robot to fly an aircraft (e.g., jet or airplane) autonomously. Half of the participants from the public (55.88%), private (62.96%), not-for-profit (52.94%), and other (61.11%) sectors would trust a robot to guard a

facility, assuming it could recognize friend from foe. Over 60% of participants from the public (61.76%), private (67.92%), and other (61.11%) sectors would trust a robot to defend itself autonomously without using lethal force. Conversely, approximately 40% of participants from the not-for-profit sector (41.18%) would agree with the previous statement. However, over 70% of participants from the public (88.24%), private (77.36%), not-for-profit (70.59%), and other (76.47%) sectors would trust a robot to autonomously detect and dispose of explosives. Less than 40% of the participants from the public (38.24%), private (38.89%), not-for-profit (23.53%), and other (5.56%) sectors agree that robots should *not* be allowed to use lethal force *with or without* human control (Table B.1.7.1 – 2).

7.2.3.3: Gender

From Question 7 asking participants to rate how much he or she would trust a robot to perform military operations autonomously, over 75% of the male (85.50%) and female (77.52%) participants would trust a robot to perform surveillance military operations. More than 75% of male participants (79.50%) but less than 57% of female participants (56.25%) would trust a robot to perform reconnaissance military operations. Similarly slightly over 70% of male participants (70.85%) but less than 57% of female participants (56.69%) would trust a robot to perform bomb disposal military operations. Half of the male (55.50%) and female (50.00%) participants would trust a robot to perform defense military operations. Over 65% of male participants (65.83%) but less than 49% of female participants (48.44%) would trust a robot to fly an aircraft (e.g., jet or airplane) autonomously. Nearly 59% of male participants (58.79%) but less than 45% of female participants (44.19%) would trust a robot to guard a facility autonomously, assuming it could recognize friend from foe. Approximately 60% of male (61.31%) and female (58.14%) participants would trust a robot to defend itself autonomously without using lethal force.

However, over 80% of male (81.31%) and 72% of female (72.66%) participants would trust a robot to autonomously detect and dispose of explosives. Less than 32% male participants (31.16%) and less than 26% of female participants (25.58%) agree that robots should *not* be allowed to use lethal force *with or without* human control (Table C.1.7.1 – 2).

The difference between the percentages of male versus female participants who would trust a robot to perform military operations autonomously is drastic. More than 10% of male participants compared to female participants would trust a robot to perform surveillance military operations. Similarly, an additional 10% of male participants compared to female participants would trust a robot to fly an aircraft or recognize friend from foe autonomously. Greater than 15% more male participants compared to female participants would trust a robot to perform reconnaissance, bomb disposal, and defense military operations autonomously.

7.2.3.4: Military Experience

From Question 7 asking participants to rate how much he or she would trust a robot to perform military operations autonomously, participants with military experience (78.95%) and without military experience (83.15%) would trust a robot to perform surveillance military operations. Over 65% of participants with military experience (66.67%) and without military experience (70.59%) would trust a robot to perform reconnaissance military operations. The participants with military experience (60.71%) and without military experience (66.42%) would trust a robot to perform bomb disposal military operations. Only 35% of participants with military experience (35.09%) but nearly 57% of participants without military experience (56.99%) would trust a robot to perform defense military operations. Over 56% of participants with military experience (56.14%) and without military experience (60.15%) would trust a robot to fly an aircraft (e.g., jet or airplane) autonomously. Only 45% of participants with military

experience (44.64%) and nearly 55% of participants without military experience (54.58%) would trust a robot to guard a facility autonomously, assuming it could recognize friend from foe. Half of the participants with military experience (49.12%) and more than 62% of participants without military experience (62.13%) would trust a robot to defend itself autonomously without using lethal force. However, more than 73% of participants with military experience (73.21%) and without military experience (78.97%) would trust a robot to autonomously detect and dispose of explosives. Less than 30% of participants with military experience (26.32%) and without military experience (29.04%) agree that robots should *not* be allowed to use lethal force *with or without* human control (Table D.1.7.1 – 2).

The difference between the percentages of participants with military experience versus participants without military experience who would trust a robot to perform autonomous military operations is drastic. An additional 20% of participants with military experience compared to participants without military experience would trust a robot to perform defense military operations autonomously. Similarly, an additional 10% of participants with military experience compared to participants without military experience would trust a robot to guard a facility or defend itself autonomously using lethal force.

7.2.3.5: Political Party

From Question 7 asking participants to rate how much he or she would trust a robot to perform military operations autonomously, over 72% of participants from the Democratic (85.85%), Republican (79.25%), Independent (82.64%), Other (72.73%) political parties would trust a robot to perform surveillance military operations. Roughly 70% of participants Democratic (72.64%), and Independent (71.67%) political parties but fewer participants from the Republican (66.04%) and Other (59.09%) political parties would trust a robot to perform

reconnaissance military operations. The Democratic (67.62%), Republican (60.38%), Independent (65.83%), Other (62.79%) political parties would trust a robot to perform bomb disposal military operations. A majority of participants from the Democratic (60.00%), Republican (47.17%), Independent (56.20%) political parties but less than 40% of participants from the Other political party (38.64%) would trust a robot to perform defense military operations. Over half of participants from the Democratic (65.09%), Republican (55.77%), Independent (58.33%), Other (52.27%) political parties would trust a robot to autonomously fly an aircraft (e.g., jet or airplane). Interestingly, an additional 10% of participants who identify as Democrat compared to Republican would trust a robot to perform defense military operations and fly an aircraft. Approximately half of the participants from the Democratic (45.28%), Republican (58.49%), Independent (55.37%), Other (60.47%) political parties would trust a robot to guard a facility, assuming it could recognize friend from foe. A majority of participants from the Democratic (60.38%), Republican (65.38%), Independent (60.33%), Other (56.82%) political parties would trust a robot to autonomously defend itself without using lethal force. However, the participants from the Democratic (77.36%), Republican (78.85%), Independent (82.35%), Other (68.18%) political parties would trust a robot to autonomously detect and dispose of explosives. Less than 35% of participants from the Democratic (27.36%), Republican (33.96%), Independent (28.10%), Other (29.55%) political parties agree that robots should *not* be allowed to use lethal force *with or without* human control (Table E.1.7.1 – 2).

7.2.4: Execution of Operations

As technology advances, the abilities of robots to perform military operations expand. Although the robot may be capable, society may not support the use of robots for certain military

operations. United States military personnel are highly trained and specialized. While certain skills are programmable, some expertise and judgment cannot be programmed for the use of a robot. Question 8 asks participants to rate how much he or she agrees with the use of robots for the given military operations and whether robots should have a human-like appearance.

7.2.4.1: All Participants

From Question 8 asking participants to rate how much he or she agrees with the use of robots for the given military operations, a majority of participants disagree that only humans should perform surveillance (76.9%), reconnaissance (68.4%), and bomb disposal (77.6%). Over 50% of participants disagree that only humans should perform defense military operations (53.7%). The results of Question 8 correspond with the results of Questions 6 and 7. Society believes that not just soldiers should perform such operations and trusts robots, with human control or autonomously, to act as a supplemental tool. Similarly, there is less support overall for robots to be involved with defense military operations.

From, the last component of Question 8 concerning the appearance of military robots, 63.8% of participants do not support the design of robots that look like humans. Robots currently do not resemble humans and society does not want that to change (Table A.1.8).

7.2.4.2: Classification of Company

From Question 8 asking participants to rate how much he or she agrees with the use of robots for the given military operations, over 75% participants from the public (78.13%), private (83.33%), not-for-profit (82.35%), and other (77.78%) sectors disagree that only humans should perform surveillance military operations. More than 75% of participants from the public (75.00%), private (74.07%), not-for-profit (82.35%), and other (77.78%) sectors disagree that

only humans should perform reconnaissance military operations. Approximately 80% of participants from the public (78.13%), private (85.19%), and not-for-profit (82.35%) sectors but only 67% of participants from the other sector (66.67%) disagree that only humans should perform bomb disposal military operations. A majority of the participants from the public (62.35%), private (55.56%), not-for-profit (58.82%) sectors, but less than 39% of participants from the other sector (38.89%) disagree that only humans should perform defense military operations.

From, the last component of Question 8 concerning the appearance of military robots, more than 62% of participants from the public (62.50%) and private (62.96%) sectors as well as more than 75% of participants from the not-for-profit (76.47%) and other (77.78%) sectors do not support the design of robots that look like humans. Robots currently do not resemble humans and society does not want that to change (Table B.1.8).

7.2.4.3: Gender

From Question 8 asking participants to rate how much he or she agrees with the use of robots for the given military operations, nearly 80% of male participants (80.71%) and 72% of female participants (72.31%) disagree that only humans should perform surveillance military operations. Over 75% of male participants (76.14%) but only 60% of female participants (60.16%) disagree that only humans should perform reconnaissance military operations. Similarly, over 80% of male participants (80.20%) but only 74% of female participants (73.85%) disagree that only humans should perform bomb disposal military operations. The majority of male (57.87%) and female (49.23%) participants disagree that only humans should perform defense military operations. Overall, there is a significant difference between the percentages of male participants versus female participants for these statements.

From, the last component of Question 8 concerning the appearance of military robots, over 61% of male (64.97%), and female (61.54%) participants do not support the design of robots that look like humans. Robots currently do not resemble humans and society does not want that to change (Table C.1.8).

7.2.4.4: Military Experience

From Question 8 asking participants to rate how much he or she agrees with the use of robots for the given military operations, over 71% of participants with military experience (71.93%) and without military experience (78.15%) disagree that only humans should perform surveillance military operations. Likewise, approximately 70% of participants with military experience (71.68%) and without military experience (69.40%) disagree that only humans should perform reconnaissance military operations. Over 73% of participants with military experience (73.68%) and without military experience (78.52%) disagree that only humans should perform bomb disposal military operations. Roughly 50% of participants with military experience (47.37%) and without military experience (55.56%) disagree that only humans should perform defense military operations.

From, the last component of Question 8 concerning the appearance of military robots, a majority of participants with military experience (57.89%) and without military experience (64.44%) do not support the design of robots to appear like humans. Robots currently do not resemble humans and society does not want that to change (Table D.1.8).

7.2.4.5: Political Party

From Question 8 asking participants to rate how much he or she agrees with the use of robots for the given military operations, over 75% of participants from the Democratic (77.36%),

Republican (75.47%), Independent (76.47%), and Other (79.07%) political parties disagree that only humans should perform surveillance military operations. Approximately 70% of participants from the Democratic (70.75%), Republican (67.92%), Independent (69.49%), and Other (69.05%) political parties disagree that only humans should perform reconnaissance military operations. The participants from the Democratic (85.85%), Republican (69.81%), Independent (76.47%), and Other (72.09%) political parties disagree that only humans should perform bomb disposal military operations. The higher percentage of participants who identify as Democratic compared to Other political parties is notable. The participants from the Democratic (60.38%), Republican (54.72%), Independent (52.10%), and Other (44.19%) political parties disagree that only humans should perform defense military operations.

From, the last component of Question 8 concerning the appearance of military robots, participants from the Democratic (69.81%), Republican (56.60%), Independent (60.50%), and Other (58.14%) political parties do not support the design of robots that look like humans. Robots currently do not resemble humans and society does not want that to change (Table E.1.8).

7.2.5: Purpose of Robots

The use of robots by the military is a new trend that is expected to continue. Previous questions addressed how much society trusts robots and for what military operations. There are currently no regulations for the use of robots by the military. As the use of robotics increases, it is likely that restrictions will develop over time. Thus, it is important to know how society views the purpose of robots. Question 9 asks participants about the purpose of robots for use by the military.

7.2.5.1: All Participants

From Question 9 asking participants about the purpose of robots for use by the military, 73.0% of participants agree that robots should be a supplement for the military, not a replacement for soldiers. In conjunction with that opinion, 57.8% of participants do not support the military to conduct operations without the direct command of a human soldier. Nearly 60% of participants support the use of robots instead of human drivers for ground vehicles where a common application is transportation of soldiers and supplies (59.2%). Similarly, 50% of participants also support the use of robots instead of human pilots (50.4%). Only 46.3% of participants support use of robots instead of soldiers whenever possible but not completely to replace soldiers on the battlefield (Table A.1.9).

7.2.5.2: Classification of Company

From Question 9 asking participants about the purpose of robots for use by the military, participants from the public (81.25%), private (74.07%), not-for-profit (76.47%), and other (66.67%) sectors agree that robots should be a supplement for the military, not a replacement for soldiers. In conjunction with that opinion, participants from the public (50.00%), private (66.67%), not-for-profit (58.82%), and other (64.71%) sectors do not support the military to conduct operations without the direct command of a human soldier. Roughly half of participants from the public (53.13%), private (58.49%), not-for-profit (58.82%), and other (55.56%) sectors support the use of robots instead of human drivers for ground vehicles where a common application is transportation of soldiers and supplies. However, approximately 50% of participants from the public (50.00%), private (52.83%), and not-for-profit (47.06%) sectors and but only 33% of participants from the other sector (33.33%) support the use of robots instead of human pilots. Less than half of participants from the public (37.50%), private (44.44%), not-for-

profit (35.29%), and other (38.89%) sectors support of use of robots instead of soldiers whenever possible but not completely to replace soldiers on the battlefield (Table B.1.9).

7.2.5.3: Gender

From Question 9 asking participants about the purpose of robots for use by the military, just over 66% of male participants (66.16%) and 85% of female participants (85.50%) agree that robots should be a supplement for the military, not a replacement for soldiers. In conjunction with that opinion, 51% of male participants (51.78%) and 66% of female participants (66.41%) do not support the military to conduct operations without the direct command of a human soldier. Nearly 62% of male participants (61.93%) and 55% of female participants (54.96%) support the use of robots instead of human drivers for ground vehicles where a common application is transportation of soldiers and supplies. Similarly, close to 56% of male participants (55.56%) and 42% of female participants (42.31%) support the use of robots instead of human pilots. Less than half of male (46.97%) and female (42.75%) participants support of use of robots instead of soldiers whenever possible but not completely replace soldiers on the battlefield (Table C.1.9).

The difference between the opinions of male participants versus female participants is interesting. Almost 20% more female participants support the use of robots as a supplement for the military but 15% more female participants do not support the use of robots without the direct command of a human soldier. Interestingly, nearly 10% more male participants support the use of robots instead of human pilots. Based upon the results, it appears that the female participants' opinions conflict likely depending upon the situation.

7.2.5.4: Military Experience

From Question 9 asking participants about the purpose of robots for use by the military, participants with military experience (77.19%) and without military experience (73.53%) agree that robots should be a supplement for the military, not a replacement for soldiers. In conjunction with that opinion, participants with military experience (52.63%) and without military experience (59.04%) do not support the military to conduct operations without the direct command of a human soldier. Participants with military experience (52.63%) and without military experience (59.78%) support the use of robots instead of human drivers for ground vehicles where a common application is transportation of soldiers and supplies. However, less than 39% of participants with military experience (38.60%) and 52% of participants without military experience (52.03%) support the use of robots instead of human pilots. The difference of percentages between those with and without military experience is over 20%. Approximately 44% of participants with military experience (43.86%) and without military experience (44.49%) support use of robots instead of soldiers whenever possible but not completely replace soldiers on the battlefield (Table D.1.9).

7.2.5.5: Political Party

From Question 9 asking participants about the purpose of robots for use by the military, participants from the Democratic (71.74%), Republican (88.68%), Independent (70.00%), and Other (65.91%) political parties agree that robots should be a supplement for the military, not a replacement for soldiers. In conjunction with that opinion, participants from the Democratic (55.66%), Republican (54.72%), Independent (63.03%), and Other (54.55%) political parties do not support the military to conduct operations without the direct command of a human soldier. Participants of the Democratic (61.32%) and Independent (65.55%) political parties but less than

half of participants from the Republican (47.17%) and Other (45.45%) political parties support the use of robots instead of human drivers for ground vehicles where a common application is transportation of soldiers and supplies. However, participants from the Republican (39.62%), Independent (55.00%), and Other (34.88%) political parties but only 16% of participants from the Democratic political parties (16.04%) support the use of robots instead of human pilots. Approximately half of participants from the Democratic (46.23%), Republican (37.74%), Independent (46.67%), and Other (47.73%) political parties support of use of robots instead of soldiers whenever possible but not completely replace soldiers on the battlefield (Table E.1.9).

The difference in opinions between political parties for this question is noteworthy. While fewer participants who identify as Republican support the use of robots instead of human drivers for ground vehicle, more of those participants support the use of robots instead of human pilots. Conversely, more participants who identify as Democratic support the use of robots instead of human drivers for ground vehicle, and less of those participants support the use of robots instead of human pilots.

7.2.6: Robots and Ethics

With the development of any new technology, there may be controversies, most often centered on ethics. Ethics is important as it relates to the advancement of robots for warfare purposes. Professionals involved with the design of new robots may refuse to work on a project if it conflicts with his or her morals, beliefs, religion, or ethics. Therefore, it is imperative to know if society believes the use of robots by the military is ethical. Question 10 asks participants to answer questions related to the use of robots in warfare.

7.2.6.1: All Participants

From Question 10 asking participants to answer questions related to the use of robots in warfare, 43.9% of participants neither agree nor disagree that the safety provided to the soldiers by the use of robots is worth the potential loss of the soldier's expertise. Society agrees that the benefit of using robots is it removes soldiers from various dangerous situations. However, society also agrees that in certain situations the expertise and experience of a soldier is necessary. Consequently, participants believe that robots designed for use during combat is not against the rules of warfare and is ethical, with 61.6% and 63.6% respectively (Table A.1.10).

7.2.6.2: Classification of Company

From Question 10 asking participants to answer questions related to the use of robots in warfare, roughly 50% of participants from the public (51.52%), private (48.15%), not-for-profit (47.06%), and other (44.44%) sectors agree that the safety provided to the soldiers by the use of robots is worth the potential loss of the soldier's expertise. On the other hand, participants from the public (57.58%), private (62.96%), not-for-profit (70.59%), and other (66.67%) sectors believe that robots designed for use during combat is not against the rules. Similarly, participants from the public (66.67%), private (64.81%), not-for-profit (70.59%), and other (55.56%) sectors believe that robots designed for the use during combat is ethical (Table B.1.10).

7.2.6.3: Gender

From Question 10 asking participants to answer questions related to the use of robots in warfare, nearly 48% of male participants (47.72%) but only 38% of female participants (37.69%) agree that the safety provided to the soldiers by the use of robots is worth the potential loss of the soldier's expertise. On the other hand, male (66.33%) and female (56.59%) participants believe that robots designed for use during combat is not against the rules. Similarly, male (66.83%) and

female (60.77%) participants believe that robots designed for the use during combat is ethical (Table C.1.10). Both male and female participants support the use of robots during combat and do not see any ethical conflict. However, male participants see the use of robots during warfare as less of a conflict.

7.2.6.4: Military Experience

From Question 10 asking participants to answer questions related to the use of robots in warfare, participants with military experience (45.61%) and without military experience (42.59%) agree that the safety provided to the soldiers by the use of robots is worth the potential loss of the soldier's expertise. Nearly 72% of participants with military experience (71.93%) but only 60% of participants without military experience (59.78%) believe that robots designed for use during combat is not against the rules. Similarly, slightly over 70% of participants with military experience (70.18%) and only 62% of participants without military experience (62.13%) believe that robots designed for the use during combat is ethical (Table D.1.10). It is important to note that participants with military experience are significantly more supportive of the use of robots for warfare.

7.2.6.5: Political Party

From Question 10 asking participants to answer questions related to the use of robots in warfare, participants from the Democratic (47.62%), Republican (44.23%), Independent (42.50%), and Other (40.91%) political parties agree that the safety provided to the soldiers by the use of robots is worth the potential loss of the soldier's expertise. On the other hand, participants from the Democratic (64.76%), Republican (77.36%), Independent (55.37%), and Other (53.49%) political parties believe that robots designed for use during combat is not against

the rules. Similarly, participants from the Democratic (68.57%), Republican (73.58%), Independent (57.85%), and Other (56.82%) political parties believe that robots designed for the use during combat is ethical (Table E.1.10). The results show that the participants from the Republican political party see less of a conflict using robots for military purposes.

7.2.7: Robot and Defense

Society believes that the use of robots for offensive military operations is dependent upon the circumstance and use. However, society is more comfortable with the use of robots for defensive military operations. It is crucial to understand that warfare involves both offensive and defensive objectives. Question 11 asks participants to answer questions related to the ability of a robot security guard.

7.2.7.1: All Participants

From Question 11 asking participants to answer questions related to the ability of a robot security guard, 61.2% of participants agree that robot security guards should replace a human security guard if it is successfully able to recognize friend from foe, spot an intrusion, alert proper authorities, but do nothing else. Similarly, 61.2% of participants also agree that robot security guards should accompany human security guards and be able to operate without human control but supervised. Consequently, 68.5% of participants agree that robot security guards should be able to defend themselves without using lethal force. A majority of participants (63.8%) agree that robot security guards should be able to hold a stationary guard position with the use of lethal force if a human soldier grants permission. Similarly, 69.4% of participants do not support the use of robot security guards to hold a stationary position and use lethal force without the permission of a human soldier (Table A.1.11).

7.2.7.2: Classification of Company

From Question 11 asking participants to answer questions related to the ability of a robot security guard, over 60% of participants from the public (60.61%), private (66.67%), and not-for-profit (64.71%) sectors agree that robot security guards should replace a human security guard if it is successfully able to recognize friend from foe, spot an intrusion, alert proper authorities, but do nothing else. Over 72% of participants from the other sector (72.22%) agree with the previous statement. However, approximately half of participants from the private (48.15%) and not-for-profit (52.94%) sectors but over 72% of participants from the public (75.76%) and other (72.22%) sectors agree that robot security guards should accompany human security guards. Roughly 50% of participants from the private (55.56%), not-for-profit (52.94%), and other (55.56%) sectors but over 72% of participants from the public sector (72.73%) agree robots should be able to operate without human control but supervised. Interestingly, over 74% of participants from the public (78.13%) and private (74.07%) sectors, but significantly less participants from the not-for-profit (35.29%) and other (55.56%) sectors agree that robot security guards should be able to defend themselves without using lethal force. Roughly 70% of participants from the public (72.73%), not-for-profit (76.47%), and other (72.22%) sectors but only 65% of participants from the private sector (64.81%) do not agree that robot security guards should be able to hold a stationary guard position with the use of lethal force if a human soldier grants permission. Therefore, participants from the public (54.55%), private (62.26%), not-for-profit (58.82%), and other (61.11%) sectors do not support the use of robot security guards to hold a stationary position and use lethal force without the permission of a human soldier (Table B.1.11).

The participants from the public sector are remarkably more supportive of robot security guards operating without human control under supervision compared to other sectors. Another striking difference is that 20% fewer participants from the not-for-profit sector agree that robot security guards should be able to defend themselves, even without using lethal force.

7.2.7.3: Gender

From Question 11 asking participants to answer questions related to the ability of a robot security guard, slightly over 60% of male participants (66.16%) and but only 53% of female participants (52.67%) agree that robot security guards should replace a human security guard if it is successfully able to recognize friend from foe, spot an intrusion, alert proper authorities, but do nothing else. Similarly, slightly over 57% of male participants (57.07%) and nearly 67% of female participants (66.92%) agree that robot security guards should accompany human security guards. Male (58.59%) and female (48.85%) participants agree robots should be able to operate without human control but supervised. Consequently, roughly 70% of male (70.56%) and female (67.94%) participants agree that robot security guards should be able to defend themselves without using lethal force. Over half of male (62.76%) and female (67.69%) participants agree that robot security guards should be able to hold a stationary guard position with the use of lethal force if a human soldier grants permission. However, just over 64% of male participants (64.14%) and nearly 78% of female participants (77.69%) do not support the use of robot security guards to hold a stationary position and use lethal force without the permission of a human soldier (Table C.1.11).

There are major differences in opinion between male participants and female participants. For every part of this question, the percentage of male participants and female participants that are is separated by approximately 10%.

7.2.7.4: Military Experience

From Question 11 asking participants to answer questions related to the ability of a robot security guard, nearly 58% of participants with military experience (57.89%) and just over 61% of participants without military experience (61.40%) agree that robot security guards should replace a human security guard if it is successfully able to recognize friend from foe, spot an intrusion, alert proper authorities, but do nothing else. Roughly 60% of participants with military experience (59.65%) and without military experience (61.25%) also agree that robot security guards should accompany human security guards. Similarly, participants with military experience (54.39%) and without military experience (54.78%) agree robots should be able to operate without human control but supervised. Consequently, participants with military experience (64.91%) and without military experience (70.11%) agree that robot security guards should be able to defend themselves without using lethal force. Participants with military experience (61.40%) and without military experience (64.44%) agree that robot security guards should be able to hold a stationary guard position with the use of lethal force if a human soldier grants permission. However, nearly 67% of participants with military experience (66.67%) but just over 71% of participants without military experience (71.32%) do not support the use of robot security guards to hold a stationary position and use lethal force without the permission of a human soldier (Table D.1.11).

7.2.7.5: Political Party

From Question 11 asking participants to answer questions related to the ability of a robot security guard, participants from the Democratic (60.38%), Republican (55.77%), Independent (65.29%), and Other (52.27%) political parties agree that robot security guards should replace a human security guard if it is successfully able to recognize friend from foe, spot an intrusion,

alert proper authorities, but do nothing else. Similarly, participants from the Democratic (61.32%), Republican (71.15%), Independent (58.68%), and Other (46.51%) political parties also agree that robot security guards should accompany human security guards. Participants from the Democratic (60.38%), Republican (53.85%), Independent (51.24%), and Other (45.45%) political parties agree robots should be able to operate without human control but supervised. Consequently, participants from the Democratic (70.75%), Republican (84.31%), Independent (63.64%), and Other (65.91%) political parties agree that robot security guards should be able to defend themselves without using lethal force. The participants who identify as Republican significantly support the ability of robot security guards to defend themselves without using lethal force compared to Other political parties. Participants from the Democratic (67.31%), Republican (65.38%), Independent (61.67%), and Other (59.09%) political parties agree that robot security guards should be able to hold a stationary guard position with the use of lethal force if a human soldier grants permission. However, participants from the Democratic (75.24%), Republican (71.15%), Independent (75.21%), and Other (43.18%) political parties do not support the use of robot security guards to hold a stationary position and use lethal force without the permission of a human soldier (Table D.1.11).

7.2.8: Robots and Reconnaissance

Reconnaissance operations are crucial for situations where the military needs to discover information about the enemy. These operations may be dangerous as it risks the capture of a soldier by an enemy. The use of robots for reconnaissance operations is beneficial to the military as it reduces the number of soldiers at risk of capture. Reconnaissance is a military operation

that society trusts robots to perform autonomously. Question 12 asks participants about the function of robots for reconnaissance operations.

7.2.8.1: All Participants

From Question 12 asking participants about the function of robots for reconnaissance operations, 69.0% of participants support the use of robots to explore territory without human control. While it is possible to send a robot to explore territory autonomously, 86.7% of participants agree that robots should accompany a platoon as they explore territory to act as a supplemental tool. If a robot is sent to explore a territory autonomously, with or without human control, 66.9% of participants agree a robot should be able to defend itself without using lethal force if necessary (Table A.1.12).

7.2.8.2: Classification of Company

From Question 12 asking participants about the function of robots for reconnaissance operations, roughly 80% of participants from the public (79.41%), and not-for-profit (82.35%) sectors but over 92% of participants from the private (92.45%), and other (94.44%) sectors support the use of robots to explore territory without human control. While it is possible to send a robot to explore territory autonomously, over 75% of participants from the public (76.47%), private (77.36%), not-for-profit (76.47%), and other (83.33%) sectors agree that robots should accompany a platoon as they explore territory to act as a supplemental tool. If a robot is sent to explore a territory autonomously, with or without human control, participants from the public (79.41%), private (65.38%), not-for-profit (58.82%), and other (55.56%) sectors agree a robot should be able to defend itself without using lethal force if necessary (Table B.1.12). It is

notable that participants from the public sector are nearly 15% more supportive of robots for this purpose.

7.2.8.3: Gender

From Question 12 asking participants about the function of robots for reconnaissance operations, over 85% of male (85.86%) and female (88.46%) participants support the use of robots to explore territory without human control. While it is possible to send a robot to explore territory autonomously, just over 79% of male participants (79.29%) but only 53% of female participants (53.08%) agree that robots should accompany a platoon as they explore territory to act as a supplemental tool. If a robot is sent to explore a territory autonomously, with or without human control, slightly over 70% of male participants (70.56%) but only 64% of female participants (64.34%) agree a robot should be able to defend itself without using lethal force if necessary (Table C.1.12). The difference between the male participants and female participants who support the use of robots for that purpose is important.

7.2.8.4: Military Experience

From Question 12 asking participants about the function of robots for reconnaissance operations, nearly 79% of participants with military experience (78.95%) and just over 88% of participants without military experience (88.24%) support the use of robots to explore territory without human control. While it is possible to send a robot to explore territory autonomously, only 65% of participants with military experience (64.91%) and slightly over 70% of participants without military experience (70.22%) agree that robots should accompany a platoon as they explore territory to act as a supplemental tool. If a robot is sent to explore a territory autonomously, with or without human control, nearly 60% of participants with military

experience (59.95%) and almost 69% of participants without military experience (68.89%) agree a robot should be able to defend itself without using lethal force if necessary (Table D.1.12). It is important to note that overall participants with military experience are less supportive of topics discussed in Question 12 compared to participants without military experience.

7.2.8.5: Political Party

From Question 12 asking participants about the function of robots for reconnaissance operations, participants from the Democratic (88.57 %), Republican (88.46 %), Independent (85.95%), and Other (77.27%) political parties support the use of robots to explore territory without human control. While it is possible to send a robot to explore territory autonomously, participants from the Democratic (73.33%), Republican (63.46%), Independent (67.77%), and Other (68.18%) political parties agree that robots should accompany a platoon as they explore territory to act as a supplemental tool. If a robot is sent to explore a territory autonomously, with or without human control, participants from the Democratic (66.67 %), Republican (74.51 %), Independent (64.17%), and Other (70.45%) political parties agree a robot should be able to defend itself without using lethal force if necessary (Table E.1.12).

7.2.9: Robot and Bombs

Explosive Ordinance Disposal (EOD) operations are crucial for situations where the military needs to discover if an object is a threat and, if so, dispose of that threat. These operations may be dangerous as it risks the life of a soldier. The use of robots for EOD operations is beneficial to the military as it reduces the number of soldiers at risk of unnecessary death. Explosive Ordinance Disposal is a military operation that society trusts robots to perform

successfully and autonomously. Question 13 asks participants about the function of robots for EOD operations.

7.2.9.1: All Participants

From Question 13 asking participants about the function of robots for EOD operations, 55.6% of participants agree that robots should be under the constant surveillance of a human soldier. Furthermore, 68.6% of participants agree that robots should be able to find bombs, but not proceed to disengage the bomb unless given permission by a human soldier. Interestingly, 75.8% of participants support the use of robots to find and disengage of explosives autonomously (Table A.1.13).

7.2.9.2: Classification of Company

From Question 13 asking participants about the function of robots for EOD operations, roughly half of participants from the public (54.55%), private (50.94%), not-for profit (58.82%) and other (55.56%) sectors agree that robots should be under the constant surveillance of a human soldier. Furthermore, participants from the public (69.70%), private (56.60%), not-for profit (88.24%), and other (66.67%) sectors agree that robots should be able to find bombs, but not proceed to disengage the bomb unless given permission by a human soldier. There is a great difference in support for the previous statement. Less than 40% of participants from the public (39.39%), private (38.46%), not-for profit (23.53%) and other (38.89%) sectors support the use of robots to find and disengage of explosives autonomously (Table B.1.13). The biggest difference in support for this question is the not-for-profit sector with the highest or lowest percentage for all statements.

7.2.9.3: Gender

From Question 13 asking participants about the function of robots for EOD operations, just over 49% of male participants (49.24%) but over 66% of female participants (66.15%) agree that robots should be under the constant surveillance of a human soldier. The difference in support for this statement between male and female participants is noteworthy. Furthermore, male (67.01%) and female (70.00%) participants agree that robots should be able to find bombs, but not proceed to disengage the bomb unless given permission by a human soldier. Interestingly, male (41.33%) and female (33.08%) participants support the use of robots to find and disengage of explosives autonomously (Table C.1.13).

7.2.9.4: Military Experience

From Question 13 asking participants about the function of robots for EOD operations, only 39% of participants with military experience (39.29%) and almost 59% of participants without military experience (58.46%) agree that robots should be under the constant surveillance of a human soldier. Furthermore, just over 57% of participants with military experience (57.14%) but almost 71% of participants without military experience (70.96%) agree that robots should be able to find bombs, but not proceed to disengage the bomb unless given permission by a human soldier. Interestingly, participants with military experience (30.36%) and without military experience (39.85%) support the use of robots to find and disengage of explosives autonomously (Table D.1.13). Overall, participants without military experience are more supportive of the use of robots for EOD operations compared to participants with military experience.

7.2.9.5: Political Party

From Question 13 asking participants about the function of robots for EOD operations, roughly half of participants from the Democratic (59.05%), Republican (49.02%), Independent (54.55%), and Other (54.55%) political parties agree that robots should be under the constant surveillance of a human soldier. Furthermore, nearly 60% of participants from the Democratic (73.33%) and Other (59.09%) political parties but roughly 70% of participants from the Democratic (73.33%) and Independent (70.25%) political parties agree that robots should be able to find bombs, but not proceed to disengage the bomb unless given permission by a human soldier. Interestingly, participants from the Democratic (33.33%), Republican (36.00%), Independent (40.50%), and Other (45.45%) political parties support the use of robots to find and disengage of explosives autonomously (Table E.1.13). The biggest difference in support for this question is the participants who identify with the Democratic political party with the highest or lowest percentage for all statements.

Chapter 8: Future Development of Robots in the Military

The possible future development of robots in the military can be divided into two by considering the near future and the distant future. In the near future, the technology used will be roughly on par with current laboratory and research & development robots. The distant future would likely be the full evolution of all modern robot technology, as well as a considerable advance in robotic theory, but not so advanced that it would be unrecognizable.

The timetable for these two different futures will be the following: The near future will be before approximately ten years from now. The distant future would be approximately from ten to thirty years from now. Both of these eras will have their own defining characteristics and impacts, but they are by no means mutually exclusive.

In light of the planning horizon and the current war outlook, it is likely that most of these robots will not be in active use unless they could have a purpose in present day warfare tactics as the current method of conducting war is not likely to change in the coming years. Modern warfare is generally characterized by long range missiles and bombs for initial assault, and close urban fighting as the war goes on.

The information for our analysis of each of these eras came from different sources. For the near future, it is most likely that the most beneficial and easiest to develop technologies will be improved upon, and the more complex and controversial technologies will remain roughly as they currently are, but continue to be developed. Predictions for this near future view came from three sources, the actual manufacturers, and two groups of our interview subjects, the robot experts and the military experts. The robot manufacturers and the robot experts would know what is actually possible to do quickly and easily. The military experts, however, were the most helpful for their input about the robots of the near future. As is often said, “necessity is the

mother of invention,” and no one knows the necessity for military robots more than the people who are fighting.

For the more distant future, it is likely that the path of the evolution of robots will be governed primarily by the ethical and legal limitations in regards to robots. For the purposes of this investigation, it is assumed that there is enough time for all possible and likely avenues for robot development to be explored and either used or discarded. This means that for the distant future, the predictions came from our survey and interview subjects, primarily our ethics experts. The other information that has great impact on this future is the restrictions section, which explored the modern laws regarding robots. It is likely the goals these laws are not going to change, even though the wording of them may need to, if only to accomplish the same purpose in an ever changing technological realm.

8.1: Evaluation of the Evolution of Robot Technology

As stated before, the predictions our research suggested can be broken into near future and distant future. Near future would be from the present to approximately ten years from now. Distant future would be from approximately ten to fifty years in the future. There is nothing that stops any overlap between these two predictions, but our predictions correspond to where our research would most likely place the evolution of any given technology.

8.1.1: Near Future of Robotics

The near future of robotics is going to be governed by what has the most immediate gain for the military, both economically and strategically. The general consensus of both the military and the robotics experts interviewed was that the most easy to develop field of robotics for

military use would be surveillance and reconnaissance technology, next most useful would be explosive ordinance disposal robots, and least useful would be automated weapons.

8.1.1.1: Air Based Surveillance and Reconnaissance

These technologies can be broken down into aerial technologies and land-based ones. Land based can be broken down into stationary robots and mobile robots. There will be some mobile robots that are fully automated, requiring no human interaction from the start of their mission to its conclusion. There will also be teleoperated robots, which will be operated by a human via a video screen and a controller.

A constant trade-off in all robotics technology is between the convenience of having robots operate autonomously and the safety and control of human operation. In fields such as surveillance and reconnaissance, there is little argument as to what should be done to maximize resources: fully automate these robots to traverse or fly their specified route. This frees up a significant number of people for each mission that can be done this way – current estimates have four soldiers required to support one robot (Michaelson, 2008) – with little added risk despite the loss of direct human control.

The current frontrunner of aerial reconnaissance technology is the Unmanned Aerial Vehicle (UAV). The UAVs used by the military are based on standard airplanes, but are smaller and are remote controlled by a team of soldiers. Some of these are capable of becoming autonomous while navigating flight points, which the UAV would move to via GPS. Alternatively, if the UAV needed to perform particularly complicated maneuvers, a soldier, who could potentially monitor several of these UAVs, could take full control over the robot. These robots are also being armed, for their own defense while they are on missions. To fire these armaments, a soldier always needs to give a direct command.

In the near future, it is likely that the range and durability of these robots will increase substantially, while the cost decreases. It is also likely that they will become fully automated, as there is little risk to humans should something malfunction. That frees up soldiers from a potentially monotonous control task.

However, even though UAVs are meant primarily for reconnaissance and surveillance missions, the fact that they will be armed with weapons systems adds another dimension to the automation vs. control debate, because weapons have the possibility of being misfired and ending a human life. The current vehicles that are armed have the weapons systems under full human control, which means that the UAV is effectively acting no different from a gun. The human is in full control of whether the plane fires and what it fires at, and the only difference is that the human is relying on remote control and video telemetry to accurately make decisions. This amount of control is not likely to diminish in the near future: the military experts especially felt uncomfortable with the idea of a robot firing a weapon on its own, mimicking the general attitude of the survey participants. In general, robot experts felt slightly more comfortable with the idea of a robot in control of the firing, but even then they acknowledged that this would require intensive programming to make sure only what was supposed to be destroyed actually was.

8.1.1.2: Ground Based Surveillance and Reconnaissance

Similar debates and ideas exist for ground-based reconnaissance and surveillance technologies as for the aerial technologies. In general, however, ground-based technologies are going to be used in more crowded spaces, such as urban environments and inside buildings. This is due to the fact that in an open space, an air-based vehicle is usually able to out-pace a ground-

based one; inside a city, however, the maneuverability of the ground robot is going to be a great asset.

For mobile robots, current ground-based technologies are used in conjunction with a team of soldiers to peer around corners and into buildings. The same idea is going to be used in the near future, but with the soldiers perhaps being further and further away from the robot. Eventually, it is conceivable that the robots will simply be air-dropped from a plane, and when they touch down, they will explore a pre-programmed route around a city and transmit imagery to the soldiers' base. Current robot navigating technologies may not even require a pre-programmed route to move as there is existing technology that would allow the robot to explore, mapping as it goes, identify where it is able to move, and to move there.

For stationary robots, the possible upgrades are the following: increase the sensitivity of the sensors, change what is able to be sensed, and decrease the size of the robot. What is able to be sensed is a function of new technologies that are developed and what is desirable to detect, but both sensitivity and size of the robot are limited by the size and capacity of robotic technology. Judging by Moore's Law, the amount of processing power per unit area will continue to exponentially increase for the near future. Research into technologies such as quantum memory will allow robots to decrease in scale many hundreds of times (Kurzweil, 2008). Such technology could allow for things such as nano-scale cameras and audio receivers.

8.1.1.3: Explosive Ordinance Disposal

The next most likely field to develop in the near future is that of explosive ordinance disposal. The use of roadside bombs and other improvised explosives are a simple and easy way to inflict casualties, and have been used by terrorists in recent conflicts such as the Iraq War. Landmines as well are a humanitarian concern in many third-world countries, causing many

unnecessary deaths that could be prevented with better methods of bomb identification, location, and disposal.

Currently, there are robots that do the job of explosive ordinance disposal (EOD), but they require a team of soldiers to operate, and they are unable to locate explosives. Once a team of soldiers does locate an explosive device, there are two methods of dealing with it: Either destroy the bomb with a robot that can be used multiple times, or simply detonate the bomb with the robot. A robot build to destroy the bomb will, in general, be more expensive than a standard robot, because it either must be sturdy enough to survive an explosion or must be able to maneuver and otherwise disable to bomb. Detonating the bomb with the robot requires only a simple robot, so it is cheaper, but it could potentially be dangerous to nearby people, and it requires a new robot every time. Given that many bombs are very cheap to manufacture, their cost will almost always be less than that of a robot required to detonate it. The logical conclusion is that robots need to survive to destroy more than one bomb. Due to the relative danger involved with soldiers being in proximity to explosives, in the near future EOD robots are likely to be teleoperated, and able to either withstand multiple explosions, or to destroy the bomb without it exploding.

8.1.1.4: Automated Weapons Systems

The research supporting these predictions suggest that the least likely field of robotic technology to develop significantly in the near future is that of automated weapons platforms, either for offensive or defensive purposes. This is largely due to fear of the technology killing innocent civilians or surrendered opponents, or possibly even our own troops. Another impact of this is that it is almost inhumane for such robots to exist, as it allows one side to wage war with no risk to their citizens, while the others risk their lives. Far more likely is that guns and

weapons will continue to be ‘intelligent’—having guided projectiles, automated targeting systems, and the like—but will continue to be under the control of human soldiers.

Another possibility for defensive platforms designed to combat infantry would be fully automatic systems with voice activation that only wield non-lethal force. Similar to the Samsung Guard Robot, the robot could make some sort of hail requesting a password or identification (Christensen, 2006). Failure to properly answer this question would mean the trespasser would be incapacitated with some sort of non-lethal force, such as a moderate electric shock or tear gas. This would allow human soldiers to assess the situation and use their own experience and judgment to make proper decisions.

While the technology of the near future is likely to be a great asset to military operations, it is not going to change the face of warfare as we know it. Most of the autonomous technologies will be for either surveillance and reconnaissance missions. Warfare will likely be conducted at a distance, with long range aircraft and missiles damaging the opponent’s infrastructure, with well armed infantry moving in after the opponent has been sufficiently damaged. This infantry will be armed with not just conventional weapons, but also with tactical information provided with robotic reconnaissance. Most of the weapons with conceivably lethal force will likely still require human approval of actions, if not direct control.

8.1.2 Distant Future of Robots

In regards to the distant future of robots in the military, there are some assumptions that must be made to narrow down the potential futures of robotics. The first assumption is that robotics will follow the current path of smaller and more powerful technology. The second assumption is that robots will not violate the current laws and restrictions governing military technology, and that future law will be made in a spirit similar to current ones. Finally, we

assume no major advances will come about that will change the very nature of robotics. To find out the spirit with which these laws will be made, we use the feedback from our interview and survey subjects, as they will be representative of the decision makers of the far future.

8.1.2.1: Air Based Surveillance and Reconnaissance

The distant future of airborne reconnaissance and surveillance lies along two distinct paths. One path is the technology of long duration, self-sufficient crafts, the other is that of very small robots that will act as a swarm to retrieve intelligence. With computer memory and programming ability, it is likely that the robots will become completely autonomous. Their missions will be input before deployment, and then they will either transmit data about their objectives or record it to be uploaded when they finish their mission.

The idea of a long duration craft is similar to a spy plane of the Cold War. In all likelihood, it will be a high altitude UAV. Current UAV technology allows for missions lasting approximately 16 hours from take-off to landing. In the future, the power supply could be from solar cells on the wings, which could potentially allow for an unlimited mission length. This concept was first illustrated with the Sunrise I, a solar powered craft which was unveiled in 1974. This concept was gradually improved upon, the most successful current one would be the SunSailor series of planes, which hold the endurance record for solar radio controlled UAVs (Genuth, 2007). The aircraft itself would be composed of mostly wing, with a small fuselage housing sensors and the CPU. This form of aircraft will be similar to a satellite that will orbit over a small area on Earth's surface. This technology would be ideal for patrolling borders and over enemy territory. The structure of the aircraft would likely be similar to the RQ-3A Darkstar, an Endurance UAV designed by the Air Force; the craft was around 70 feet across the wing, 15 feet long from nose to tail, and 5 feet high (Goebel, 2009). In the future, this model will

likely become slimmer and wider, to allow for less weight and more wingspan, and therefore more area with which to generate solar power.

The second idea for these robots is that they will be very small, possibly on the order of centimeters or even smaller. The robots would probably emulate small birds or insects, which would make the robots seem less of a threat to any radar systems. This sort of robot would be ideal for operating in urban areas, possibly even inside large buildings. It is unlikely that the robots would be resilient to extreme weather conditions, including dust, rain, or high winds. This would make this technology difficult to use in areas exposed to such conditions. The current term for this type of robot is the Miniature UAVs, some of which are already under a meter across (Goebel, 2009).

Similar to an antenna, a formation of these robots could function as a much larger sensor. This technology is already in use such as deep space radio observatories, composed of an array of many smaller dishes to function with the precision and resolution of a larger dish. This could help increase sensitivity to what the robots are detecting, but it could also allow the units to possibly transmit information using much smaller individual transmissions, due to the fact that they could each send a smaller signal, which could combine with the others and produce a much larger signal. Such an idea is already being used in the Very Large Array, a radio observatory in New Mexico, which uses a series of 27 antennas to give the resolution of one antenna 22 miles across (Harrison, 2008). Such robots could be programmed to stay in formation relative to one robot, which could be remote controlled by a person.

8.1.2.2: Ground Based Surveillance and Reconnaissance

The future of ground reconnaissance and surveillance will probably be restricted to indoor and underground areas, where it would be impractical for a flying robot to enter or for it

to remain undetected. Because it would not need to keep itself in flight, ground based robots could probably be even smaller than flying ones need to be. Since they would be indoors, it is unlikely they would be able to draw from solar power, so their size is going to be restricted, in part, by their energy storage requirements.

Another restriction to robot size would be their method of locomotion. For robots that would need to be able to move significant distances, their method of locomotion will be small wheels or treads, possibly even legs. There is technology in development today, similar to the Big Dog program, that makes the possibility of legged, walking robots very real (Blankespoor, 2008). For small robots, it may be possible to walk on walls or ceilings, not just on the floor. Animals like geckos already possess a biological gripping mechanism, and this grip has been replicated in robotic version of this (Santos, 2008).

Such robots would, again, be very useful in buildings for mapping the structure and detecting a myriad of other data. They would not be as useful in the rubble of collapsed buildings. It is more likely that serpentine robots would be good for burrowing through rubble, just as worms and snakes dig through loose earth. These robots could be detected with heat or movement detection, which would allow for search of survivors in a disaster, such as a bombing or earthquake. Modern attempts at this task are attempted in the RoboCup Rescue competition (<http://www.rescuesystem.org/robocuprescue/>).

8.1.2.3: Explosive Ordinance Disposal

The most likely change for EOD robots is that they will become fully automated to locate hazardous materials, identify the best way to dispose of them, and disarm or detonate the material. It is more probable that the robot will be able to disarm the robot, so that even in crowded areas, the bomb can be safely disposed of without damaging nearby buildings or

civilians. The robot is likely to be sturdy enough to withstand one or more explosions, just in case one bomb does go off.

Soldiers themselves would have no need to operate this robot, which would free up a team to do things that only humans can do effectively. Where a robot or a human can disarm a bomb, only a human can greet and comfort the actual people affected should the bomb go off. This would mean that while a group of soldiers would still need to be deployed with the robot, they do not need to operate the robot at all, simply convince the civilian population that the robot is doing good for them.

8.1.2.4: Automated Defense Platforms

Should technology continue to evolve in the way it is, automated weapons will be able to combat almost anything that is attacking them, as their aim and reaction time are far beyond any human's, and even offensive weapons would be hard pressed to overcome fully realized defensive technology, which should be able to shoot down missiles and aircraft well before the robot is in danger.

The greatest way the robots will likely change is that they will probably make it easier for humans to interface with robots. Such technology would mean a controller more complex than a video-game controller, but able to react more closely to a small human adjustment, or even correct for human error without overriding the command.

The major question, however, is whether or not military scientists would want to pursue this technology to its fullest extent. The US military currently has no current public interest in pursuing this technology, and that is not likely to change in the future. Our interview and survey results reflected this fact, which means that it is unlikely that much research is going to go into

this branch. In that respect, automated defense platforms are not likely to change appreciably even in the distant future (Purdy, 2008).

8.2: Summary of Future Development

These predictions are no more than a best estimate of what to expect in the future. Without knowing the breakthroughs in robotics, or even in world politics, it is impossible to know for certain what is to come. The impacts predicted can be no more certain these predictions themselves, so the accuracy of this and the following section are restricted by the confidence level in our survey and in our interviews.

In general, robots will become more “intelligent,” that is, more likely to make decisions and act in their own stead. This could be a decision to act or to not act, how to move to a certain location, or even to interact with people. Robots will also likely be more efficient, so that a given robot can do its job for longer than a modern robot would be able to without stopping. Finally, some robots will probably become more biological looking, which could mean having legs or wings. At least, robots will continue to replicate ideas seen in nature, to increase the effectiveness and efficiency of the systems being designed.

Chapter 9: Impact of Robotics in the Military

The impact of robots on the military is going to depend not only on the robots that are being used, but also the way in which they are used. While intelligent use of robots could greatly reduce casualties on both sides of a conflict, unwise use could cause a slaughter for one side and an easy victory for the other. Such an unwise use would likely violate many ethical and moral boundaries people have set for themselves.

The assumptions made in this chapter are that robots will develop along the lines put forth in the previous chapter. Another assumption is that robots will be used the way a majority of the survey subjects feel. Since our data was on a scale of 1 to 5, an average of 3 or higher supports the specific issue, an average of under 3 disapproves. Between subjects' approval, and the restrictions listed in Chapter 5, we can predict a probable view of how the robots will be used and what the impacts of those uses will be.

9.1: Near Future Impacts

This section is devoted to the near future as defined as the same as in the Future Development section, between five and ten years in the future. In this period, the biggest changes come in the control style of the robots, manual control giving way to longer and longer range teleoperation, or even full automation for some robots.

9.1.1: Delocalization of War

The biggest impact of this change is that the people fighting wars will be farther away from the actual battle than ever before. With advancements in long range UAV and missile technology, it is possible that a war can be conducted without any troops in the combat theatre. Even at the start of the Iraq War, the initial assault consisted entirely of bombings and missile

attacks, conducted by jets which were based either in neighboring countries or on aircraft carriers in the Persian Gulf.

As the amount of automation and teleoperation increases, so will the distance between the controllers and the robots. Given the variety of tasks robots will be able to do, most tasks will be able to be conducted from long range. UAVs will potentially be able to conduct bombing missions with the soldiers controlling them being far away. There is no reason the soldiers would need to even be in the region they are fighting; aircraft could be controlled with a video-game like interface, and the best pilots would not be trained soldiers so much as professional video gamers. Warfare could potentially even be conducted as a job for civilians, with all the actual fighting being done by robots on the other end of a video link.

9.1.2: Offensive Advantage

One of the great axioms of war is that the side with the most intelligence will win. That can possibly mean technological superiority, but also to knowledge of tactical intelligence regarding the enemy. While technology is frequently able to accomplish this intelligence gain, robots will bring that to a new level for the more technologically advanced nations. Robots give the advantage primarily in the realm of surveillance and reconnaissance. Given the fact that robots are replaceable, there is no real loss besides the money to replace it if a robot gets destroyed.

The impact of this is that soldiers can send robots on missions far too risky for humans. This means more intelligence can be obtained to allow better use of force where it will be most effective. It will also prevent soldiers from blindly walking into ambushes. The methods for obtaining information can vary between UAVs and satellites, that can observe enemy

movements and strongholds, and small ground-based robots, which can scout around corners and inside buildings. It is possible that attacking soldiers will only need use the information at hand to avoid any losing battle, and to most greatly exploit their advantages when they have them.

9.1.3: Defensive Advantage

As with offensive technology, the more advanced technologically a nation is, the more able it is to defend itself effectively. Already, robotic weapons systems are being used to defend ships from missile attacks and stationary positions. The robots' reaction times are already much too fast for humans to match, which is why they are used currently. This gap will only widen with advances in robot technology.

With the use of non-lethal force, robots could incapacitate enemies without permanently damaging them. Such non-lethal force would allow the machine to attack without irreversible consequences in case a human is not available to authorize a defense against an attacker. Even with long range missiles and aircraft, robots could mount a defense by shooting down targets which are on a collision course and are moving too fast for the robot to ask for human intervention.

9.1.4: Efficiency

The last main impact of robots on warfare would be that the same number of people could accomplish much more than they currently can. With increased independence of surveillance and reconnaissance robots, all that would be needed is a human monitoring several robots rather than multiple people being required to control one robot.

The fear of having robots autonomously controlling weapons will prevent maximum possible efficiency out of people and robots. Any group of soldiers that needs to actually fight

the enemy offensively may be able to use robots for intelligence purposes, but all the actual fighting will require a person at least be instructing the robot to fire, if not actually firing the gun.

9.2 Distant Future

Again, this section will devote itself to the distant future as defined by Chapter 8, as between 10 and 30 years from now. In the distant future, the same effects as in the near future will be present, as well some added impacts due to increased automation of robots. Again, the distant future will be characterized by fully automated surveillance, reconnaissance, and bomb disposal robots, as well as teleoperated armed robots.

9.2.1: Greater Efficiency

Again, as robots become more and more automated, fewer people will be required to control increasing numbers of robots. In addition to fully automated robots, there could be small squadrons of robots that are programmed to mimic the movements of one lead robot, which could be teleoperated. This could provide multiple robots with a way of moving in formation seemingly automated, but under complete control of a soldier. This great efficiency could lead to one person controlling a potentially unlimited number of robots, all designed to act in a way similar to the controlled one. Eventually, people could leave the battlefield altogether as people grow more comfortable with human control of battle robots.

9.2.2: Dehumanization

As soldiers continue to leave the battlefield in favor of civilian or offshore positions conducting the battles, they will see less of the damage done to the places they are attacking. Some future soldiers will see only what the robots they are controlling are trying to see, which will be military objectives. This may result in highly technological countries being much more

aggressive, partly because of less risk to their citizens and their land, and partly because the aggressors simply do not realize the damage they are doing to the defending nation. Even in modern wars, such as the Iraq War, long distance attacks are being used as a primary method of initial assault, only sending in people when the defenders have been severely crippled. To add to this, only selected video of invasions are generally shown to the public in the homeland, which further reduces the impact of the assault on their minds, making them more detached from reality and less opposed to the war.

Chapter 10: Concluding Remarks

10.1: Challenges

The biggest challenges of this project were the survey topics and questions. The group struggled to narrow the scope of the project and, in turn, the questions for the survey. As an emerging industry, there were numerous areas to investigate related to the use of robotics by the military. The obvious choices were between ground, air, and water robots. The group chose to investigate ground robots as it is currently the most developed area and the most controversial as well. With a multitude of ground military operations, the group also needed to choose what military operations to investigate. Similarly, the group chose the four military operations based upon most common use of robots. After deciding upon the topic, the group spent several hours developing the survey questions.

Surveys appear easy to design at first but are actually difficult to create properly. The group researched how to write survey questions without displaying any bias toward the group's hypothesis. The survey questions were changed frequently based upon the advice of Professor Brown, Professor Skorinko, and other references. Despite the group's opinion that the survey questions were without error, after administering the survey, problems were found. A handful of survey participants had difficulty understanding the wording of the first section related to the definition of a robot. However, as a lot of participants had already completed the survey, the group decided not to change that section and continue administering the survey as it was. This provided a challenge because it is possible that those questions are not as accurate as future sections.

10.2: Achievements

The greatest achievement of the project was the number of participants who completed the actual survey and interviews. The group expected far less participants and was pleased with the higher number of participants as it meant more significant results. Another achievement was the participation of Ms. Ellen Purdy. As a person extremely involved with military robots, it was an honor that she spent time answering our interview questions. Her responses proved very useful and the group is thankful for her participation. Finally, the group is also happy that it is likely our results will be beneficial for future projects.

10.3: Future Recommendations and Suggestions

As previously mentioned, one of the more difficult parts of this project was deciding what topics to explore. While the project topics are specific, the overall project is still very broad. The group's recommendation for future projects is to further investigate each of the topics separately and in great detail. Without doubt an entire project could focus on each of the four military operations selected. This project provides a good foundation for investigating this topic, but future projects should be more specific.

With regard to any future survey, it is best to create fewer questions that are more significant. By narrowing the project topic, it would allow the group to explore the results in more detail. Due to time constraints, the group could not investigate each section of the survey in great detail. It would be beneficial to narrow the focus of the survey and investigate each topic more. Specifically, it would be interesting for future projects to incorporate any psychological differences between the demographic filters, especially gender.

Finally, performing more detailed data analysis, such as significance testing, would increase the credibility of results. Due to time constraints, the group could not complete such testing.

10.4: Conclusions

This project concludes that robots are beneficial to the military. Society is generally supportive of the future development of military robots. There are differences in opinion between the demographic filters applied for data analysis. For example, the difference between opinions of the male and female participants are significant and should be further investigated. There is clearly a future for the robot industry and it is likely that robots will become a more integral part of military operations.

10.5: Project Experience

Overall the group had a positive project experience. We learned a lot about survey development that will definitely be useful for future projects and employment. The group developed interview skills as well. The experience gained by acquiring approval from the Worcester Polytechnic Institute Institutional Review Board is useful for similar situations. While the group faced several challenges, the lessons learned are beneficial for the future. The group further developed critical thinking and writing skills throughout the project experience. Specifically, the group improve organizational and planning skills to coordinate several facets of the project, especially the interviews.

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Appendix A.1

Table A.1.1

All Data - Question 1		
Informed Consent Agreement for Participation in a Research Study		
Answer Options	Response Frequency	Response Count
I do NOT consent to participate in this study	0.0%	0
I do consent to participate in this study	100.0%	639
<i>answered question</i>		639
<i>skipped question</i>		0

Table A.1.2

All Data - Question 2							
Please use the definition posted below to answer the following questions. Robot: any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner (Encyclopedia Britannica). Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). A robot is defined as an automated...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
2.1: Ground vehicle that navigates around obstacles to a given location (e.g. Tank, car)	20 (5.04%)	20 (5.04%)	30 (7.56%)	167 (42.07%)	159 (40.05%)	4.07	396
2.2: Ground vehicle that can fire a weapon on command (e.g. Tank, car)	31 (7.81%)	50 (12.59%)	57 (14.36%)	163 (41.06%)	96 (24.18%)	3.61	397
2.3: Aircraft that can fire a weapon on command (e.g. Jet, helicopter)	30 (7.56%)	68 (17.13%)	56 (14.11%)	152 (38.29%)	91 (22.92%)	3.52	397
2.4: Defense mechanism (e.g. missile, torpedo)	38 (9.57%)	100 (25.19%)	85 (21.41%)	108 (27.20%)	64 (16.12%)	3.15	395
<i>answered question</i>							397
<i>skipped question</i>							242

Table A.1.3

All Data - Question 3							
Please use the definition posted below to answer the following questions. Remote Controlled: The control of an activity, process, or machine from a distance, as by radioed instructions or coded signals (The American Heritage Dictionary) A robot is defined as a remote controlled...							
Answer Options	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Rating Average	Response Count
3.1: Ground vehicle (e.g. tank, car)	23 (5.81%)	41 (10.35%)	46 (11.62%)	181 (45.71%)	105 (26.52%)	3.77	396
3.2: Aircraft (e.g. jet, helicopter)	22 (5.56%)	51 (12.88%)	51 (12.88%)	171 (43.18%)	101 (25.51%)	3.70	396
3.3: Device that can pick up or close around objects (e.g. mechanical claw)	21 (5.30%)	23 (5.81%)	38 (9.60%)	173 (43.69%)	141 (35.61%)	3.98	396
<i>answered question</i>							396
<i>skipped question</i>							243

Appendix A.1

Table A.1.4

All Data - Question 4							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a defense mechanism (e.g. weapon) that...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
4.1: Will ask permission before firing	17 (4.33%)	62 (15.78%)	79 (20.10%)	148 (37.66%)	87 (22.14%)	3.58	393
4.2: Will fire automatically at threatening stationary or moving targets	56 (14.25%)	73 (18.58%)	59 (15.01%)	140 (35.62%)	65 (16.54%)	3.22	393
<i>answered question</i>							394
<i>skipped question</i>							245

Table A.1.5

All Data - Question 5							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
5.1: A ground vehicle that responds to voice commands (e.g. tank, car)	16 (4.05%)	38 (9.62%)	61 (15.44%)	203 (51.39%)	77 (19.49%)	3.73	395
5.2: An aircraft that responds to voice commands (e.g. jet, helicopter)	18 (4.56%)	50 (12.66%)	66 (16.71%)	190 (48.10%)	71 (17.97%)	3.62	395
<i>answered question</i>							395
<i>skipped question</i>							244

Appendix A.1

Table A.1.6

All Data - Question 6							
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
6.1: Perform surveillance military operations	8 (2.19%)	17 (4.64%)	28 (7.65%)	177 (48.36%)	136 (37.16%)	4.14	366
6.2: Perform reconnaissance military operations	7 (1.92%)	29 (7.97%)	42 (11.54%)	164 (45.05%)	122 (33.52%)	4.00	364
6.3: Perform bomb disposal military operations	7 (1.92%)	27 (7.42%)	29 (7.97%)	148 (40.66%)	153 (42.03%)	4.13	364
6.4: Perform defense military operations	11 (3.01%)	46 (12.60%)	74 (20.33%)	173 (47.53%)	61 (17.03%)	3.62	365
6.5: Recognize friend from foe	77 (21.15%)	141 (38.74%)	76 (20.88%)	50 (13.74%)	20 (5.49%)	2.44	364
6.6: Carry a defense mechanism properly (e.g. weapon without misuse or misfire)	14 (3.83%)	49 (13.39%)	71 (19.40%)	166 (45.36%)	66 (18.03%)	3.60	366
6.7: Use lethal force with permission of a human	36 (9.84%)	47 (12.84%)	54 (14.75%)	164 (44.81%)	65 (17.76%)	3.48	366
<i>answered question</i>							366
<i>skipped question</i>							273

Appendix A.1

Table A.1.7

All Data - Question 7							
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
7.1: Perform surveillance military operations	14 (3.85%)	25 (6.87%)	28 (7.69%)	175 (48.08%)	122 (33.53%)	4.01	364
7.2: Perform reconnaissance military operations	15 (4.13%)	43 (11.85%)	53 (14.60%)	147 (40.50%)	105 (28.93%)	3.78	363
7.3: Perform bomb disposal military operations	21 (5.82%)	57 (15.79%)	46 (12.74%)	143 (39.61%)	94 (26.04%)	3.64	361
7.4: Perform defense military operations	26 (7.16%)	74 (20.39%)	73 (20.11%)	136 (37.47%)	54 (14.88%)	3.33	363
7.5: Fly an aircraft (e.g. Jet or airplane)	18 (4.97%)	62 (17.13%)	67 (18.51%)	148 (40.88%)	67 (18.51%)	3.51	362
7.6: Guard a facility assuming it could recognize friend from foe	46 (12.71%)	74 (20.44%)	56 (15.47%)	135 (37.19%)	52 (14.40%)	3.20	363
7.7: Defend itself with weapons without using lethal force	31 (8.56%)	57 (15.75%)	55 (15.19%)	168 (46.41%)	51 (14.09%)	3.42	362
7.8: Detect and dispose of explosives	9 (2.49%)	27 (7.48%)	43 (11.91%)	175 (48.48%)	107 (29.64%)	3.95	361
7.9: Use lethal force	91 (25.07%)	98 (27.00%)	67 (18.46%)	78 (21.49%)	29 (7.99%)	2.60	363
<i>answered question</i>							364
<i>skipped question</i>							275

Appendix A.1

Table A.1.8

All Data - Question 8							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Execution of Operations:							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
8.1: Only humans should perform surveillance military operations	76 (22.42%)	185 (54.57%)	57 (16.81%)	14 (4.13%)	7 (2.05%)	2.09	339
8.2: Only humans should perform reconnaissance military operations	72 (21.36%)	160 (47.48%)	66 (19.58%)	25 (7.42%)	14 (4.15%)	2.26	337
8.3: Only humans should perform bomb disposal military operations	111 (32.74%)	152 (44.84%)	43 (12.68%)	26 (7.67%)	7 (2.06%)	2.01	339
8.4: Only humans should perform defense military operations	41 (12.09%)	141 (41.59%)	79 (23.30%)	58 (17.11%)	20 (5.90%)	2.63	339
8.5: Battlefield robots should look like humans	108 (31.86%)	105 (30.97%)	105 (30.97%)	15 (4.42%)	6 (1.77%)	2.13	339
<i>answered question</i>							339
<i>skipped question</i>							300

Appendix A.1

Table A.1.9

All Data - Question 9							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Purpose of Robots: Robots should...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
9.1: Be a supplement for the military, not a replacement for soldiers	14 (4.11%)	29 (8.50%)	49 (14.37%)	160 (46.92%)	89 (26.10%)	3.82	341
9.2: Conduct military operations without the direct command of human soldiers	73 (21.47%)	124 (36.47%)	74 (21.76%)	55 (16.19%)	14 (4.12%)	2.45	340
9.3: Be used instead of human drivers for ground vehicles (e.g. convoy purposes)	16 (4.71%)	46 (13.53%)	76 (22.35%)	150 (44.12%)	52 (15.29%)	3.52	340
9.4: Be used instead of human pilots for aircraft (e.g. supply drops)	18 (5.29%)	58 (17.06%)	92 (27.06%)	133 (39.12%)	39 (11.47%)	3.34	340
9.5: Be used instead of soldiers on the battlefield whenever possible	25 (7.33%)	55 (16.13%)	103 (30.21%)	100 (29.33%)	58 (17.01%)	3.33	341
<i>answered question</i>							341
<i>skipped question</i>							298

Table A.1.10

All Data - Question 10							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Ethics:							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
10.1: The safety provided to soldiers by the use of robots is worth the potential loss of the soldiers' expertise	22 (6.49%)	71 (20.94%)	96 (28.32%)	116 (34.22%)	34 (10.03%)	3.20	339
10.2: Robots designed for use during combat is against the rules of warfare	89 (26.18%)	121 (35.59%)	93 (27.35%)	25 (7.35%)	12 (3.53%)	2.26	340
10.3: Robots designed for use during combat is unethical	96 (28.15%)	121 (35.48%)	76 (22.29%)	31 (9.09%)	17 (4.99%)	2.27	341
<i>answered question</i>							341
<i>skipped question</i>							298

Appendix A.1

Table A.1.11

All Data - Question 11							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
11.1: Replace human security guards if able to assume friend from foe, spot an intrusion, alert proper authorities, but take no further action	20 (5.88%)	55 (16.18%)	57 (16.76%)	165 (48.53%)	43 (48.53%)	3.46	340
11.2: Accompany human security guards but not have the ability to operate autonomously (i.e. without the permission of a human security guard)	9 (2.65%)	44 (12.98%)	78 (23.01%)	162 (47.79%)	46 (47.79%)	3.57	339
11.3 Operate without human control, but should be supervised by human security guards	19 (5.59%)	58 (17.06%)	78 (22.94%)	155 (45.59%)	30 (45.59%)	3.35	340
11.4: Be able to defend themselves without using lethal force if necessary against intruders assuming it can recognize friend from foe	14 (4.13%)	39 (11.50%)	53 (15.63%)	181 (53.39%)	52 (53.39%)	3.64	339
11.5: Only be used in conjunction with human security guards	8 (2.67%)	44 (13.06%)	100 (29.67%)	149 (44.21%)	36 (44.21%)	3.48	337
11.6: Be allowed to hold stationary guard positions, but only be allowed to use lethal force to defend a territory if granted permission by a human soldier	23 (6.82%)	39 (11.57%)	58 (17.21%)	171 (50.74%)	46 (50.74%)	3.53	337
11.7: Be used to hold stationary guard positions and use lethal force if necessary without the permission of a human soldier	96 (28.40%)	140 (41.42%)	58 (17.16%)	34 (10.06%)	10 (10.06%)	2.18	338
<i>answered question</i>							340
<i>skipped question</i>							299

Appendix A.1

Table A.1.12

All Data - Question 12							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Reconnaissance: Robots should...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
12.1: Accompany a platoon as they explore territory	4 (1.18%)	5 (1.47%)	36 (10.62%)	205 (60.47%)	89 (26.25%)	4.09	339
12.2: Explore territory without human control	10 (2.95%)	43 (12.68%)	52 (15.34%)	162 (47.79%)	72 (21.24%)	3.72	339
12.3: Be able to defend themselves without using lethal force against attackers if necessary	16 (4.75%)	32 (9.50%)	62 (18.40%)	168 (49.85%)	59 (17.51%)	3.66	337
<i>answered question</i>							339
<i>skipped question</i>							300

Table A.1.13

All Data - Question 13							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Bombs: Robots with the ability to handle (i.e. find and disengage) bombs should...							
Answer Options	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)	Rating Average	Response Count
13.1: Be under the constant surveillance of a human soldier	10 (2.96%)	61 (18.05%)	79 (23.37%)	134 (39.64%)	54 (15.98%)	3.48	338
13.2: Be allowed to find bombs, but only be allowed to proceed with disengage the bomb with the permission of a human	9 (2.66%)	38 (11.24%)	59 (17.46%)	177 (52.37%)	55 (16.27%)	3.68	338
13.3: Be allowed to set down, find and disengage explosives without direct human control	24 (7.12%)	103 (30.56%)	81 (24.04%)	89 (26.41%)	40 (11.87%)	3.05	337
<i>answered question</i>							338
<i>skipped question</i>							301

Appendix A.2

Table A.2.1

All Data - Question 18		
Are you?		
Answer Options	Response Frequency	Response Count
Male	59.9%	203
Female	38.6%	131
Would rather not say	1.5%	5
<i>answered question</i>		339
<i>skipped question</i>		300

Table A.2.2

All Data - Question 19		
What is your age?		
Answer Options	Response Frequency	Response Count
Under 18	2.4%	8
18-24	82.3%	279
25-34	8.0%	27
35-44	2.1%	7
45-54	3.5%	12
55-64	0.9%	3
65 or older	0.3%	1
Would rather not say	0.6%	2
<i>answered question</i>		339
<i>skipped question</i>		300

Table A.2.3

All Data - Question 20		
What is the highest level of education you have completed?		
Answer Options	Response Frequency	Response Count
Less than high school	0.3%	1
High School/ Vocational	15.0%	51
Some College	64.9%	220
Associate's Degree	0.6%	2
Bachelor's Degree	11.5%	39
Master's Degree	8.3%	28
Doctoral Degree	3.2%	11
Professional Degree	0.0%	0
Would rather not say	0.3%	1
<i>answered question</i>		339
<i>skipped question</i>		300

Table A.2.4

All Data - Question 23		
What is the classification of the company you are employed by?		
Answer Options	Response Frequency	Response Count
Public Sector	10.7%	34
Private Sector	17.2%	55
Not-for-Profit	5.3%	17
Don't Know	6.3%	20
Other	5.6%	18
Not Employed	51.1%	163
Would rather not say	3.8%	12
<i>answered question</i>		319
<i>skipped question</i>		320

Table A.2.5

All Data - Question 25		
Do you consider yourself?		
Answer Options	Response Frequency	Response Count
Democrat	32.9%	108
Republican	16.2%	53
Independent	37.2%	122
Other	13.7%	45
<i>answered question</i>		328
<i>skipped question</i>		311

Table A.2.6

All Data - Question 26		
What is your experience, if any, with the military?		
Answer Options	Response Frequency	Response Count
Active Duty	1.5%	5
Retired	0.9%	3
Reserve	0.0%	0
ROTC	5.4%	18
Other	9.6%	32
None	82.6%	275
<i>answered question</i>		333
<i>skipped question</i>		306

Appendix A.2

Table A.2.7

All Data - Question 27							
How would you rate your familiarity and knowledge of...?							
Answer Options	Very unfamiliar and knowledgeable	Somewhat unfamiliar and knowledgeable	Neither familiar or unfamiliar	Somewhat familiar and knowledgeable	Very familiar and knowledgeable	Rating Average	Response Count
Military	17 (5.12%)	63 (18.98%)	90 (27.11%)	118 (35.54%)	44 (13.25%)	3.33	332
Robotics	27 (7.96%)	55 (16.22%)	81 (23.89%)	124 (36.58%)	42 (12.77%)	3.30	329
<i>answered question</i>							334
<i>skipped question</i>							305

Table A.2.8

All Data - Question 28		
What is your experience, if any, with robotics?		
Answer Options	Response Frequency	Response Count
Robotics related major	18.2%	60
FIRST	22.5%	74
Job related to robotics	8.5%	28
Teaching position	2.7%	9
Other	30.4%	100
None	48.9%	161
<i>answered question</i>		329
<i>skipped question</i>		310

Appendix A.3

Table A.3.1

Demographic Comparison Summary - Question 2																			
Please use the definition posted below to answer the following questions. Robot: any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner (Encyclopedia Britannica). Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). A robot is defined as an automated...																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
2.1: Ground vehicle that navigates around obstacles to a given location (e.g. Tank, car)																			
	4.06	4.18	3.82	4.24	3.58	4.00	5.00	3.94	3.91	4.12	4.20	4.23	3.96	4.05	4.16	3.98	4.40	4.07	396
2.2: Ground vehicle that can fire a weapon on command (e.g. Tank, car)																			
	3.76	3.56	3.41	3.47	3.00	3.60	3.67	3.67	3.41	3.64	3.69	3.88	3.48	3.44	3.58	3.69	3.60	3.61	397
2.3: Aircraft that can fire a weapon on command (e.g. Jet, helicopter)																			
	3.67	3.47	3.18	3.47	2.92	3.60	3.67	3.72	3.22	3.55	3.50	3.88	3.44	3.40	3.50	3.57	3.60	3.52	397
2.4: Defense mechanism (e.g. missile, torpedo)																			
	3.12	2.93	2.94	3.12	2.58	3.00	3.33	3.50	2.59	3.21	3.37	3.10	3.04	3.16	3.18	3.16	2.60	3.15	395
																		<i>answered question</i>	397
																		<i>skipped question</i>	242

Appendix A.3

Table A.3.2

Demographic Comparison Summary - Question 3																			
Please use the definition posted below to answer the following questions. Remote Controlled: The control of an activity, process, or machine from a distance, as by radioed instructions or coded signals (The American Heritage Dictionary) A robot is defined as a remote controlled...																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
3.1: Ground vehicle (e.g. tank, car)																			
	3.79	3.91	3.29	3.76	3.67	2.80	4.67	3.89	3.69	3.80	3.84	3.77	3.70	3.81	3.77	3.81	3.60	3.77	396
3.2: Aircraft (e.g. jet, helicopter)																			
	3.65	3.87	3.18	3.65	3.67	2.80	4.67	3.72	3.63	3.72	3.69	3.70	3.70	3.72	3.76	3.63	3.80	3.70	396
3.3: Device that can pick up or close around objects (e.g. mechanical claw)																			
	4.09	4.11	3.41	4.12	3.75	4.20	4.67	3.72	3.75	4.06	4.00	3.92	4.02	4.12	3.93	4.13	4.40	3.98	396
																	<i>answered question</i>	396	
																	<i>skipped question</i>	243	

Appendix A.3

Table A.3.3

Demographic Comparison Summary - Question 4																				
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a defense mechanism (e.g. weapon) that...																				
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data		
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count	
4.1: Will ask permission before firing																				
	3.79	3.49	3.24	3.76	3.08	3.40	4.33	3.50	3.44	3.63	3.61	3.58	3.55	3.72	3.63	3.57	3.20	3.58	393	
4.2: Will fire automatically at threatening stationary or moving targets																				
	3.06	2.98	3.29	3.29	3.08	2.80	3.67	3.22	3.16	3.22	3.18	3.46	3.11	3.30	3.31	3.10	3.20	3.22	393	
																		<i>answered question</i>		394
																		<i>skipped question</i>		245

Table A.3.4

Demographic Comparison Summary - Question 5																				
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a...																				
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data		
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count	
5.1: A ground vehicle that responds to voice commands (e.g. tank, car)																				
	3.76	3.57	3.24	3.94	3.58	4.20	4.67	3.72	3.41	3.74	3.83	3.75	3.66	3.56	3.68	3.80	3.80	3.73	395	
5.2: An aircraft that responds to voice commands (e.g. jet, helicopter)																				
	3.56	3.50	3.00	3.41	3.58	3.60	4.67	3.67	3.28	3.63	3.72	3.66	3.55	3.37	3.56	3.68	3.80	3.62	395	
																		<i>answered question</i>		395
																		<i>skipped question</i>		244

Appendix A.3

Table A.3.5

Demographic Comparison Summary - Question 6																			
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
6.1: Perform surveillance military operations																			
	4.35	4.33	4.00	4.44	4.00	4.60	5.00	4.00	4.16	4.17	4.26	4.23	4.10	4.00	4.30	3.95	4.20	4.14	366
6.2: Perform reconnaissance military operations																			
	4.15	4.06	4.00	4.44	3.91	4.60	5.00	4.00	4.10	4.01	4.11	4.08	3.96	3.91	4.26	3.71	3.40	4.00	364
6.3: Perform bomb disposal military operations																			
	4.29	4.20	4.29	4.28	3.73	4.60	4.67	4.06	4.06	4.15	4.30	4.06	4.09	4.05	3.37	3.82	3.80	4.13	364
6.4: Perform defense military operations																			
	3.79	3.62	3.53	3.61	3.36	4.40	4.33	3.17	3.20	3.69	3.68	3.69	3.66	3.45	3.75	3.47	3.00	3.62	365
6.5: Recognize friend from foe																			
	2.65	2.40	2.29	2.35	2.09	3.25	3.67	2.72	2.16	2.45	2.46	2.43	2.43	2.61	2.67	2.16	1.80	2.44	364
6.6: Carry a defense mechanism properly (e.g. weapon without misuse or misfire)																			
	3.79	3.73	3.41	3.78	2.73	4.40	4.00	3.94	3.68	3.60	3.64	3.87	3.58	3.57	3.69	3.59	2.80	3.60	366
6.7: Use lethal force with permission of a human																			
	3.59	3.60	3.18	3.83	2.91	4.60	5.00	3.44	3.58	3.47	3.48	3.81	3.44	3.43	3.52	3.53	2.80	3.48	366
																		<i>answered question</i>	366
																		<i>skipped question</i>	273

Appendix A.3

Table A.3.6

Demographic Comparison Summary - Question 7																				
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?																				
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data		
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count	
7.1: Perform surveillance military operations																				
	4.29	4.09	3.94	4.39	3.73	4.80	5.00	3.78	3.87	4.05	4.07	4.06	4.02	3.89	4.19	3.79	4.20	4.01	364	
7.2: Perform reconnaissance military operations																				
	3.97	3.89	3.88	4.28	3.55	4.80	5.00	3.72	3.58	3.80	3.80	3.85	3.79	3.68	4.06	3.41	3.40	3.78	363	
7.3: Perform bomb disposal military operations																				
	3.85	3.63	3.24	3.59	3.27	4.25	4.00	3.50	3.35	3.68	3.73	3.55	3.58	3.58	3.81	3.36	3.80	3.64	361	
7.4: Perform defense military operations																				
	3.56	3.31	3.00	3.17	3.27	3.80	3.67	3.06	2.94	3.39	3.48	3.23	3.39	3.02	3.44	3.18	3.20	3.33	363	
7.5: Fly an aircraft (e.g. Jet or airplane)																				
	3.62	3.70	3.12	3.22	3.36	3.40	4.33	3.33	3.52	3.52	3.65	3.52	3.48	3.25	3.65	3.29	3.80	3.51	362	
7.6: Guard a facility assuming it could recognize friend from foe																				
	3.53	3.39	2.88	3.33	2.55	4.00	4.33	3.00	3.00	3.27	3.08	3.51	3.22	3.44	3.48	2.88	2.80	3.20	363	
7.7: Defend itself with weapons without using lethal force																				
	3.65	3.66	2.94	3.33	2.82	3.60	4.33	3.11	3.16	3.46	3.37	3.56	3.45	3.39	3.52	3.29	2.80	3.42	362	
7.8: Detect and dispose of explosives																				
	4.29	3.94	3.65	3.88	3.55	4.75	4.00	3.78	4.03	3.96	3.90	4.15	4.03	3.70	4.07	3.79	3.80	3.95	361	
7.9: Use lethal force																				
	2.91	2.80	2.53	1.94	2.36	4.20	3.67	2.33	2.42	2.57	2.52	2.79	2.57	2.55	2.68	2.46	1.80	2.60	363	
																		<i>answered question</i>		364
																		<i>skipped question</i>		275

Appendix A.3

Table A.3.7

Demographic Comparison Summary - Question 8																				
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Execution of Operations:																				
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data		
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count	
8.1: Only humans should perform surveillance military operations																				
	2.16	1.85	2.24	2.06	2.36	1.80	1.33	2.11	2.19	2.08	2.11	2.00	2.12	2.05	1.95	2.26	2.40	2.09	339	
8.2: Only humans should perform reconnaissance military operations																				
	2.25	2.04	2.24	1.89	2.64	1.20	1.33	2.11	2.32	2.26	2.26	2.17	2.23	2.26	2.04	2.53	3.20	2.26	337	
8.3: Only humans should perform bomb disposal military operations																				
	2.00	1.76	1.88	2.17	2.18	1.60	1.67	1.94	2.13	2.00	1.83	2.15	2.08	2.05	1.85	2.24	2.20	2.01	339	
8.4: Only humans should perform defense military operations																				
	2.47	2.48	2.71	2.83	2.64	1.80	2.00	2.83	3.00	2.59	2.57	2.57	2.62	2.81	2.49	2.82	3.20	2.63	339	
8.5: Battlefield robots should look like humans																				
	2.09	2.13	1.94	1.78	2.27	1.60	1.67	2.61	1.94	2.12	2.05	2.30	2.13	2.09	2.02	2.28	2.20	2.13	339	
																		<i>answered question</i>		339
																		<i>skipped question</i>		300

Appendix A.3

Table A.3.8

Demographic Comparison Summary - Question 9																			
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Purpose of Robots: Robots should...																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
9.1: Be a supplement for the military, not a replacement for soldiers																			
	3.94	3.87	3.82	3.44	3.73	4.00	3.67	4.17	3.87	3.82	3.77	4.17	3.75	3.67	3.71	4.04	3.60	3.82	341
9.2: Conduct military operations without the direct command of human soldiers																			
	2.65	2.44	2.35	2.29	2.36	3.00	3.33	2.50	2.23	2.44	2.43	2.47	2.46	2.41	2.60	2.22	2.60	2.45	340
9.3: Be used instead of human drivers for ground vehicles (e.g. convoy purposes)																			
	3.40	3.38	3.47	3.44	3.82	3.60	4.00	3.06	3.35	3.53	3.51	3.25	3.61	3.45	3.56	3.44	3.20	3.52	340
9.4: Be used instead of human pilots for aircraft (e.g. supply drops)																			
	3.31	3.37	3.35	3.11	3.73	3.40	4.00	3.67	3.16	3.37	3.40	3.06	3.48	3.05	3.45	3.15	3.60	3.34	340
9.5: Be used instead of soldiers on the battlefield whenever possible																			
	3.16	3.24	3.24	3.05	3.73	4.20	4.00	2.72	3.23	3.30	3.37	3.11	3.35	3.29	3.40	3.17	3.40	3.33	341
																		<i>answered question</i>	341
																		<i>skipped question</i>	298

Appendix A.3

Table A.3.9

Demographic Comparison Summary - Question 10																			
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Ethics:																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
10.1: The safety provided to soldiers by the use of robots is worth the potential loss of the soldiers' expertise																			
	3.30	3.22	3.29	3.22	3.50	3.60	3.67	2.56	3.06	3.22	3.32	3.12	3.21	3.05	3.27	3.09	2.40	3.20	339
10.2: Robots designed for use during combat is against the rules of warfare																			
	2.18	2.13	2.18	2.33	2.80	2.00	1.67	2.39	2.00	2.30	2.19	1.98	2.40	2.40	2.15	2.39	3.40	2.26	340
10.3: Robots designed for use during combat is unethical																			
	2.09	2.24	2.35	2.56	2.40	2.00	1.67	2.22	2.23	2.29	1.98	1.98	2.45	2.36	2.16	2.38	3.20	2.27	341
																		<i>answered question</i>	341
																		<i>skipped question</i>	298

Appendix A.3

Table A.3.10

Demographic Comparison Summary - Question 11																			
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
11.1: Replace human security guards if able to assume friend from foe, spot an intrusion, alert proper authorities, but take no further action																			
	3.52	3.61	3.47	3.78	3.00	3.20	3.33	3.39	3.35	3.47	3.42	3.40	3.54	3.27	3.59	3.23	3.80	3.46	340
11.2: Accompany human security guards but not have the ability to operate autonomously (i.e. without the permission of a human security guard)																			
	3.76	3.31	3.59	4.00	3.55	3.40	3.00	3.72	3.32	3.58	3.62	3.69	3.49	3.35	3.53	3.60	3.60	3.57	339
11.3: Operate without human control, but should be supervised by human security guards																			
	3.67	3.33	3.00	3.50	3.55	3.20	4.00	3.39	3.29	3.35	3.46	3.29	3.22	3.41	3.47	3.18	3.00	3.35	340
11.4: Be able to defend themselves without using lethal force if necessary against intruders assuming it can recognize friend from foe																			
	3.91	3.83	2.88	3.50	3.18	4.00	4.33	3.33	3.45	3.68	3.67	3.92	3.55	3.61	3.73	3.56	2.60	3.64	339
11.5: Only be used in conjunction with human security guards																			
	3.45	3.33	3.53	3.72	3.55	2.60	2.67	3.89	3.52	3.48	3.53	3.58	3.38	3.39	3.35	3.69	3.00	3.48	337
11.6: Be allowed to hold stationary guard positions, but only be allowed to use lethal force to defend a territory if granted permission by a human soldier																			
	3.33	3.49	3.35	3.72	3.36	3.20	3.33	3.44	3.48	3.53	3.63	3.46	3.48	3.48	3.49	3.60	2.80	3.53	337
11.7: Be used to hold stationary guard positions and use lethal force if necessary without the permission of a human soldier																			
	2.09	2.31	2.18	1.94	2.00	2.80	3.33	2.00	2.06	2.14	2.04	2.15	2.15	2.48	2.31	2.00	1.60	2.18	338
																		<i>answered question</i>	340
																		<i>skipped question</i>	299

Appendix A.3

Table A.3.11

Demographic Comparison Summary - Question 12																			
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Reconnaissance: Robots should...																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
12.1: Accompany a platoon as they explore territory																			
	4.15	4.19	3.94	4.28	3.73	4.20	4.33	3.61	4.10	4.11	4.13	4.08	4.10	3.89	4.12	4.05	3.80	4.09	339
12.2: Explore territory without human control																			
	4.00	3.94	3.65	3.83	3.36	4.20	4.67	3.28	3.74	3.72	3.80	3.60	3.68	3.73	3.94	3.37	3.60	3.72	339
12.3: Be able to defend themselves without using lethal force against attackers if necessary																			
	3.90	3.73	3.41	3.39	3.27	4.00	3.00	3.56	3.39	3.70	3.64	3.76	3.58	3.80	3.74	3.57	2.80	3.66	337
																		<i>answered question</i>	339
																		<i>skipped question</i>	300

Table A.3.12

Demographic Comparison Summary - Question 13																			
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Bombs: Robots with the ability to handle (i.e. find and disengage) bombs should...																			
Answer Options	What is the classification of the company you are employed by?					What is your experience, if any, with the military?					Do you consider yourself?				Are you?			All Data	
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Active Duty	Retired	ROTC	Other	None	Democrat	Republican	Independent	Other	Male	Female	Would rather not say	Rating Average	Response Count
13.1: Be under the constant surveillance of a human soldier																			
	3.42	3.21	3.76	3.39	3.36	3.25	2.33	3.33	3.32	3.52	3.49	3.27	3.50	3.52	3.35	3.67	3.80	3.48	338
13.2: Be allowed to find bombs, but only be allowed to proceed with disengage the bomb with the permission of a human																			
	3.61	3.53	3.88	3.61	3.55	3.00	2.67	3.67	3.55	3.71	3.81	3.45	3.66	3.59	3.68	3.68	3.80	3.68	338
13.3: Be allowed to set down, find and disengage explosives without direct human control																			
	3.15	3.12	2.71	3.06	3.09	3.75	3.33	2.78	2.94	3.09	3.04	2.92	3.09	3.27	3.18	2.87	3.60	3.05	337
																		<i>answered question</i>	338
																		<i>skipped question</i>	301

Chart A.4.1

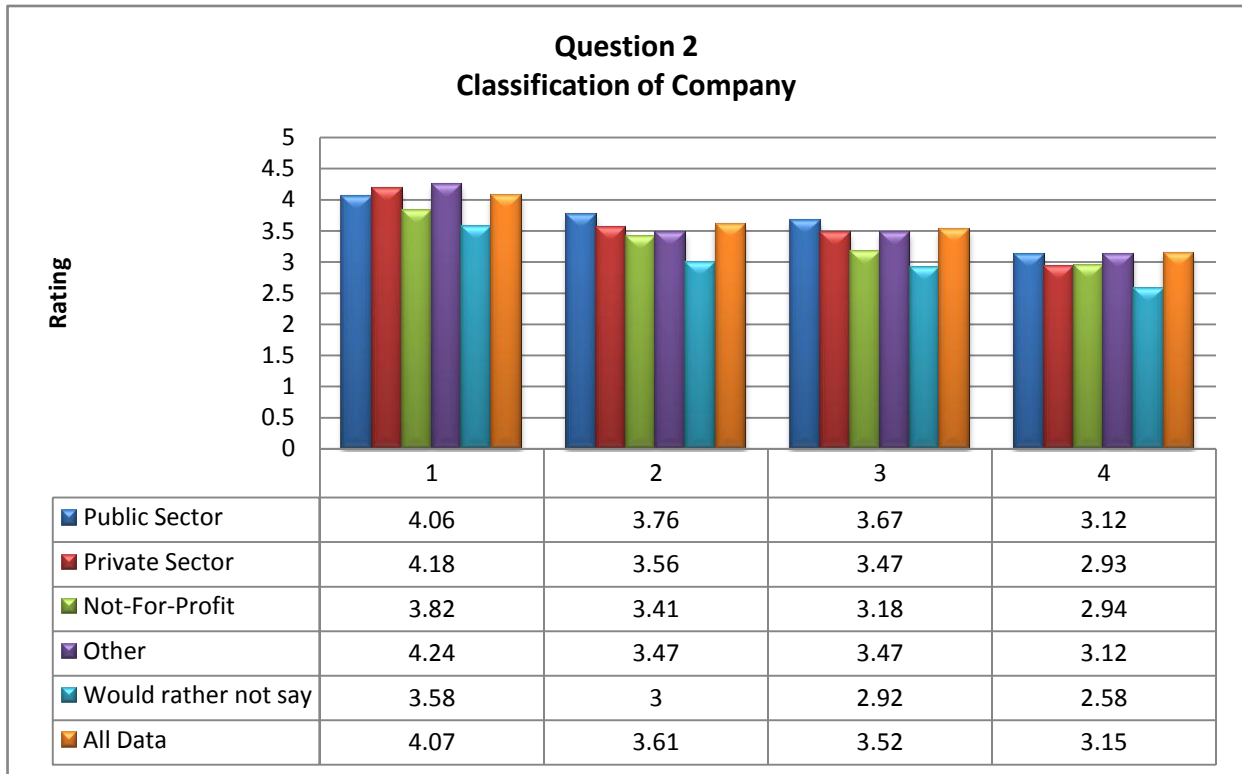


Chart A.4.2

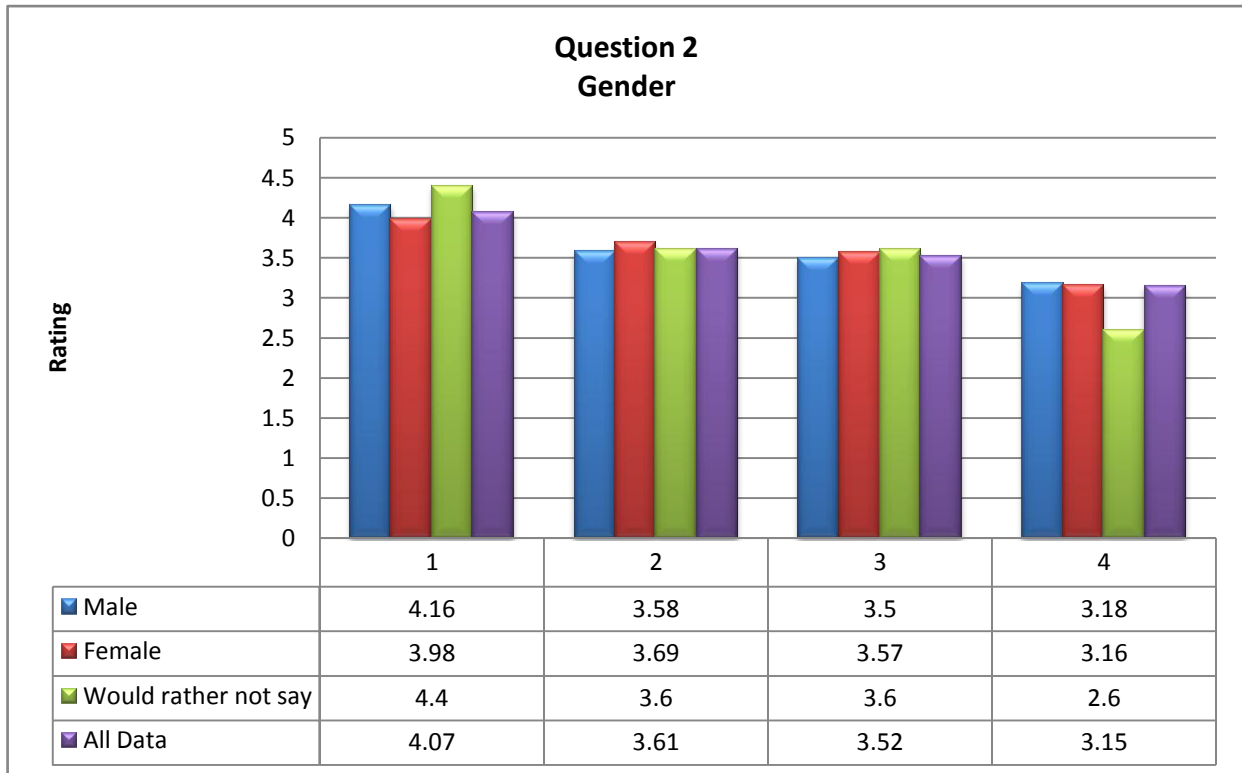


Chart A.4.3

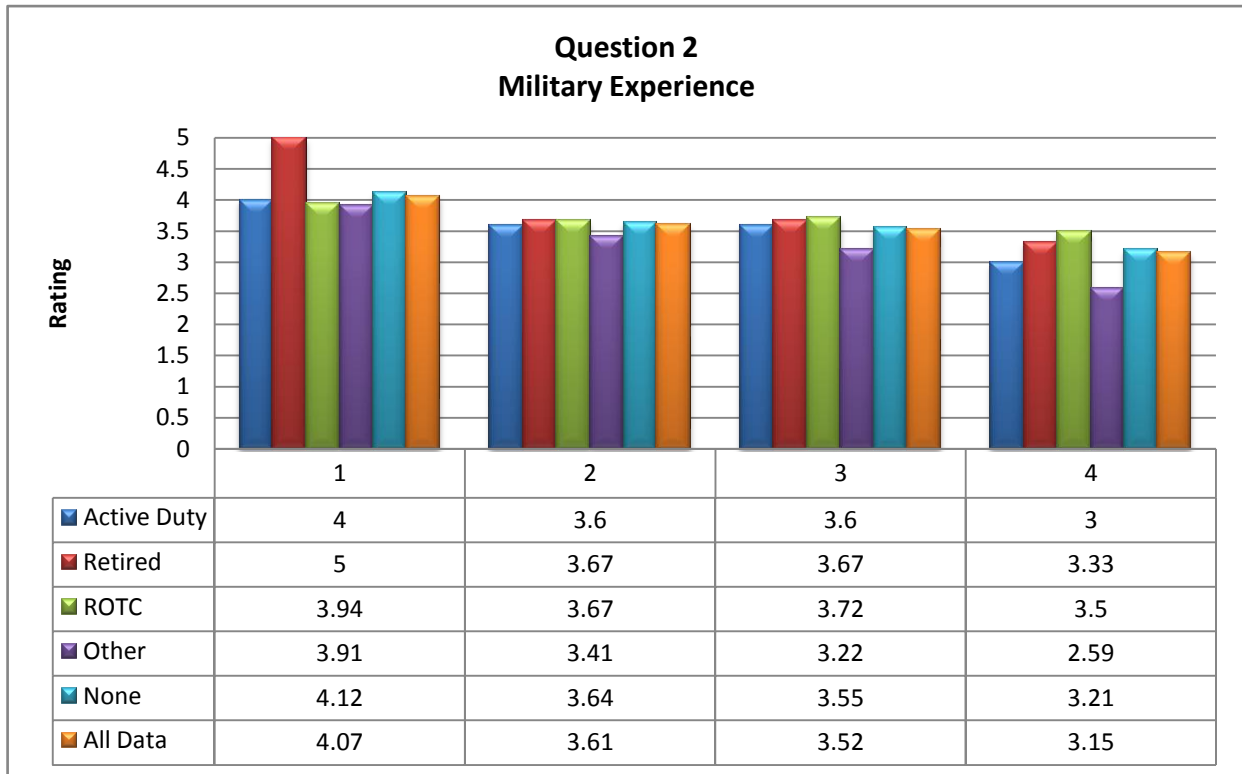


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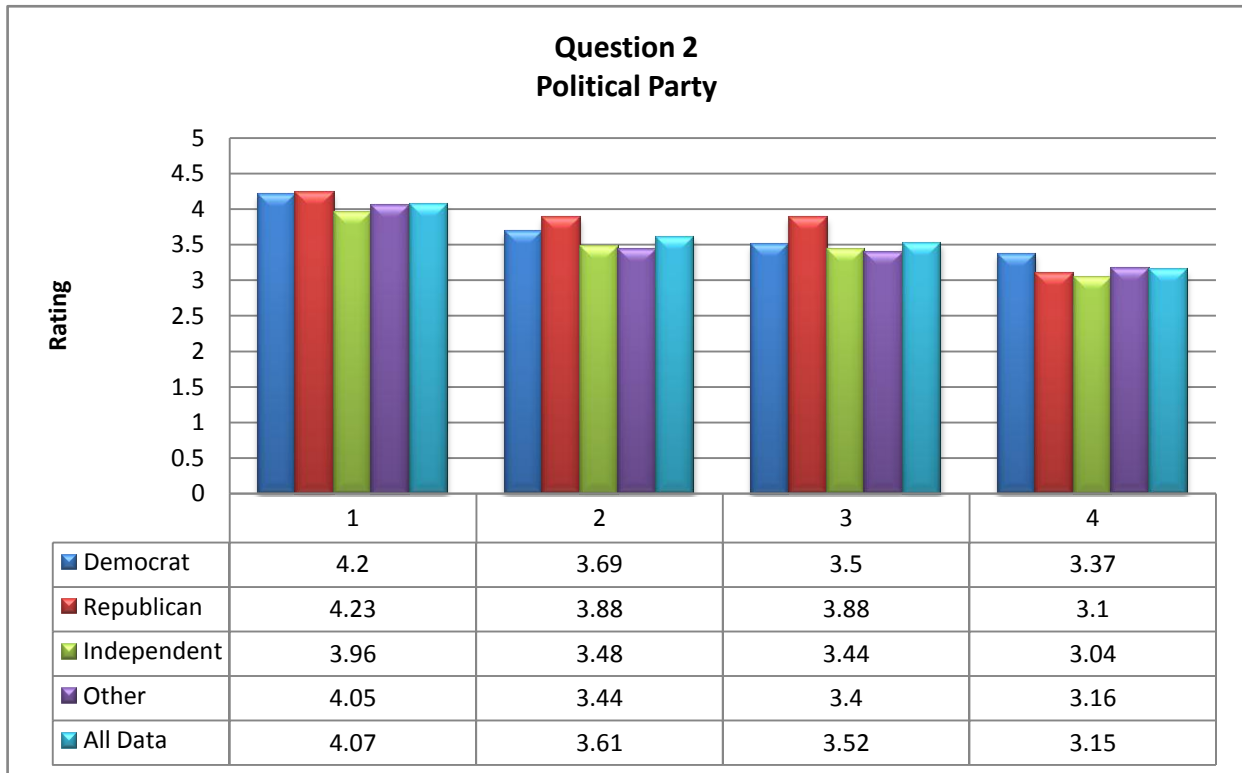


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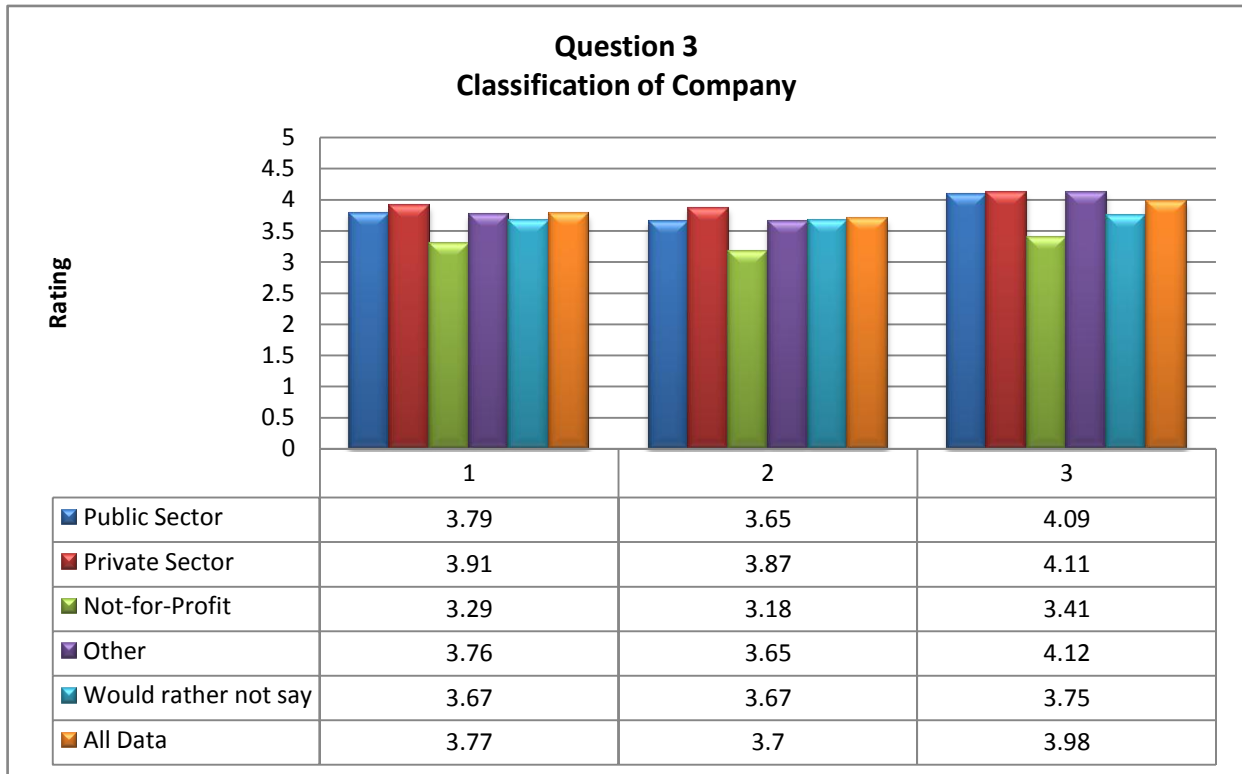


Chart A.4.6

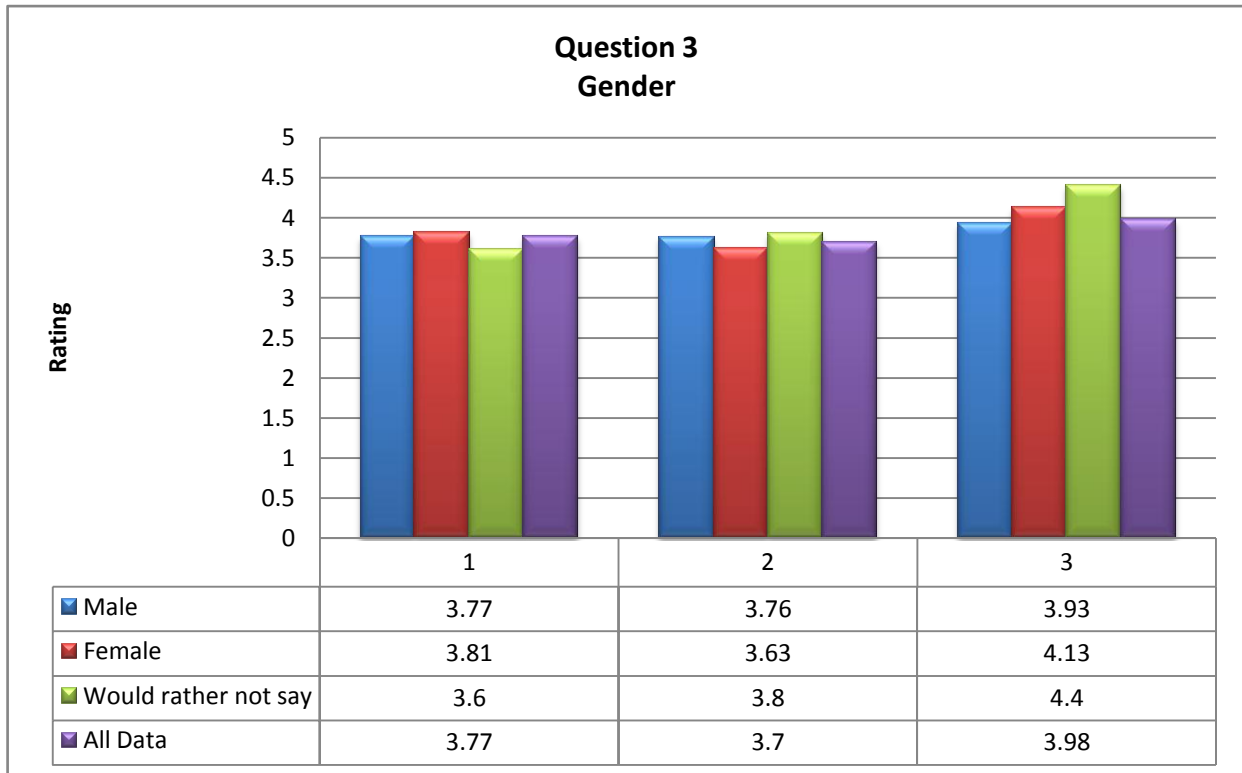


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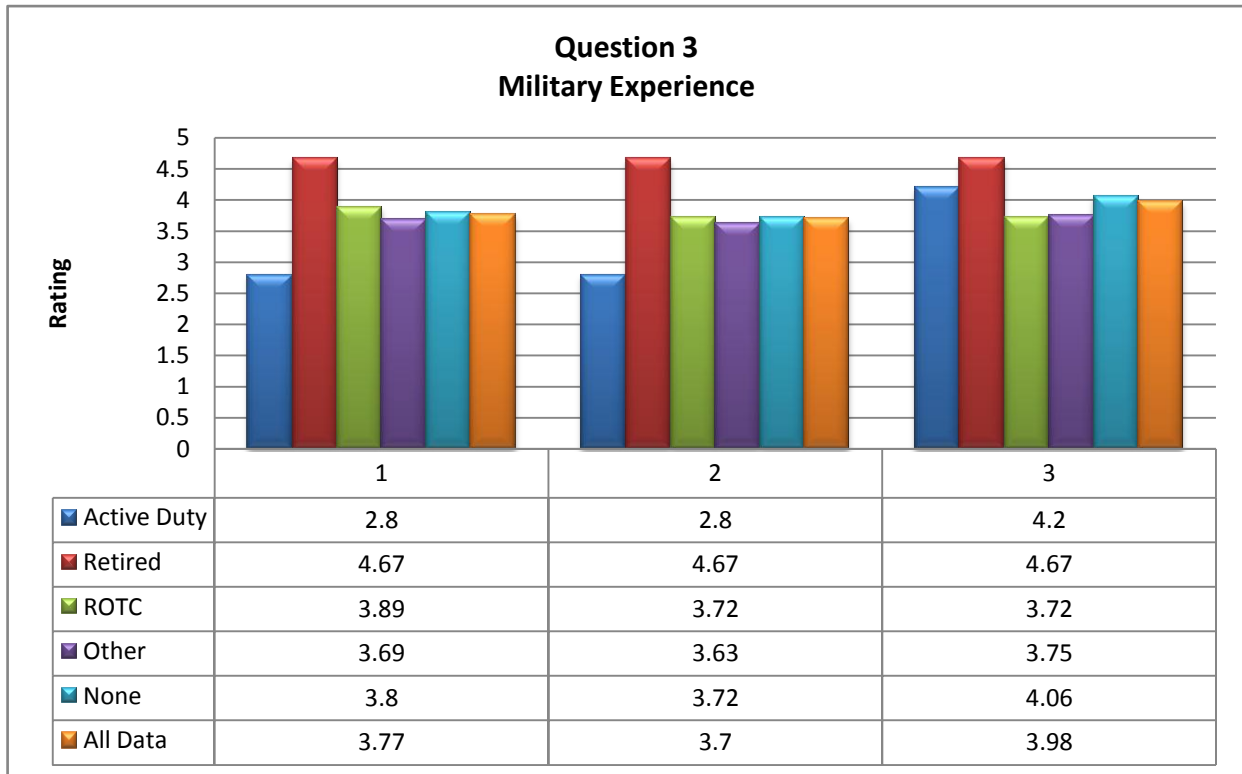


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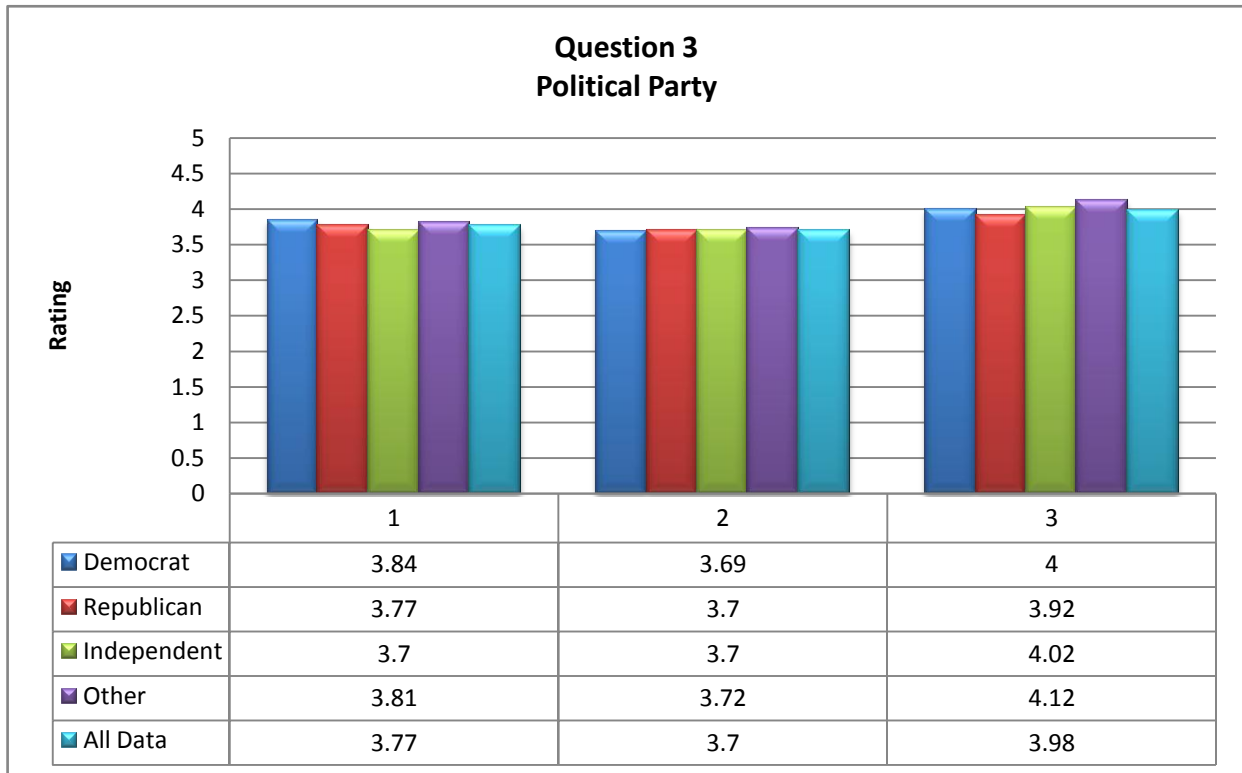


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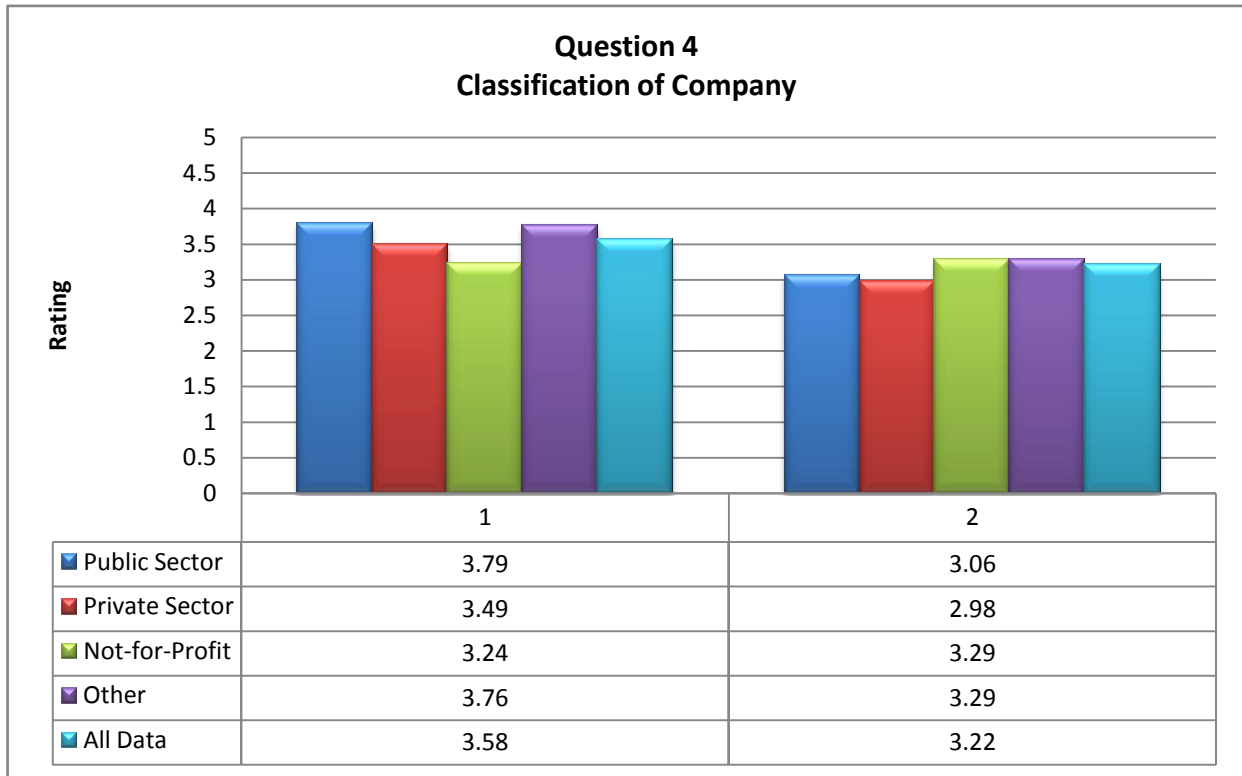


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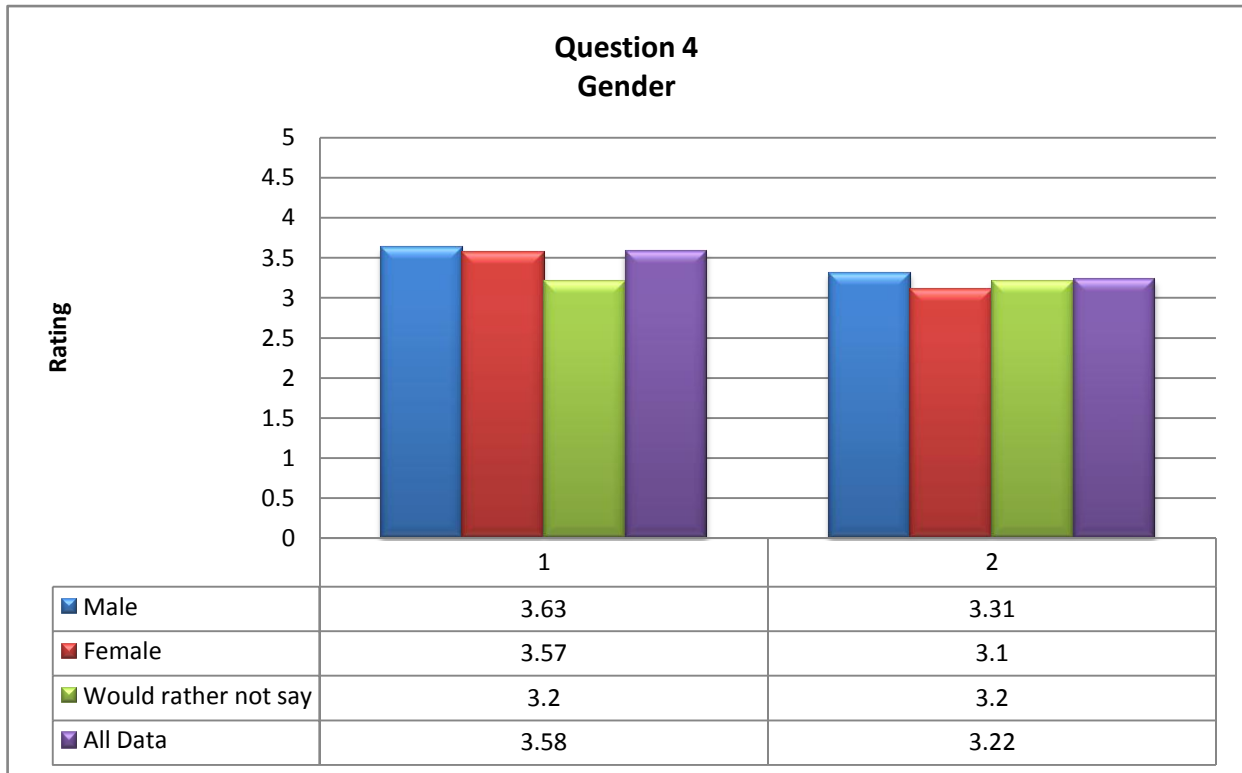


Chart A.4.11

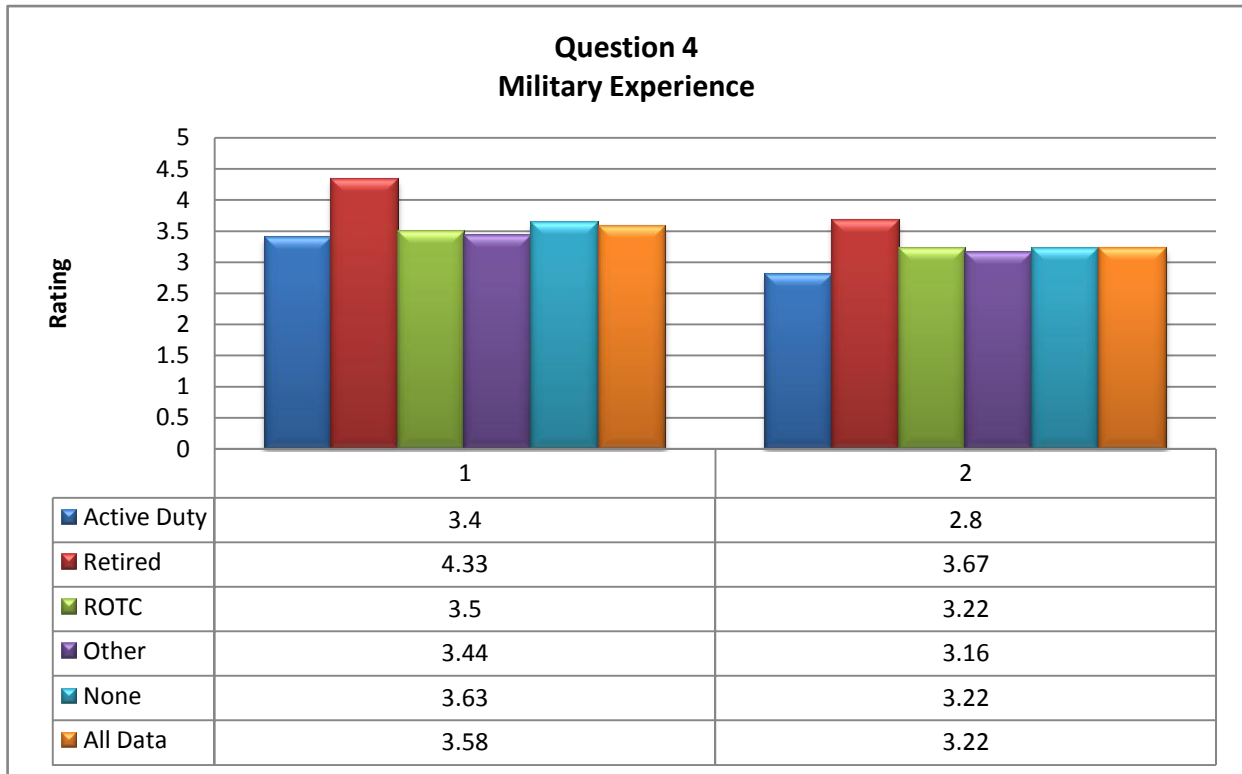


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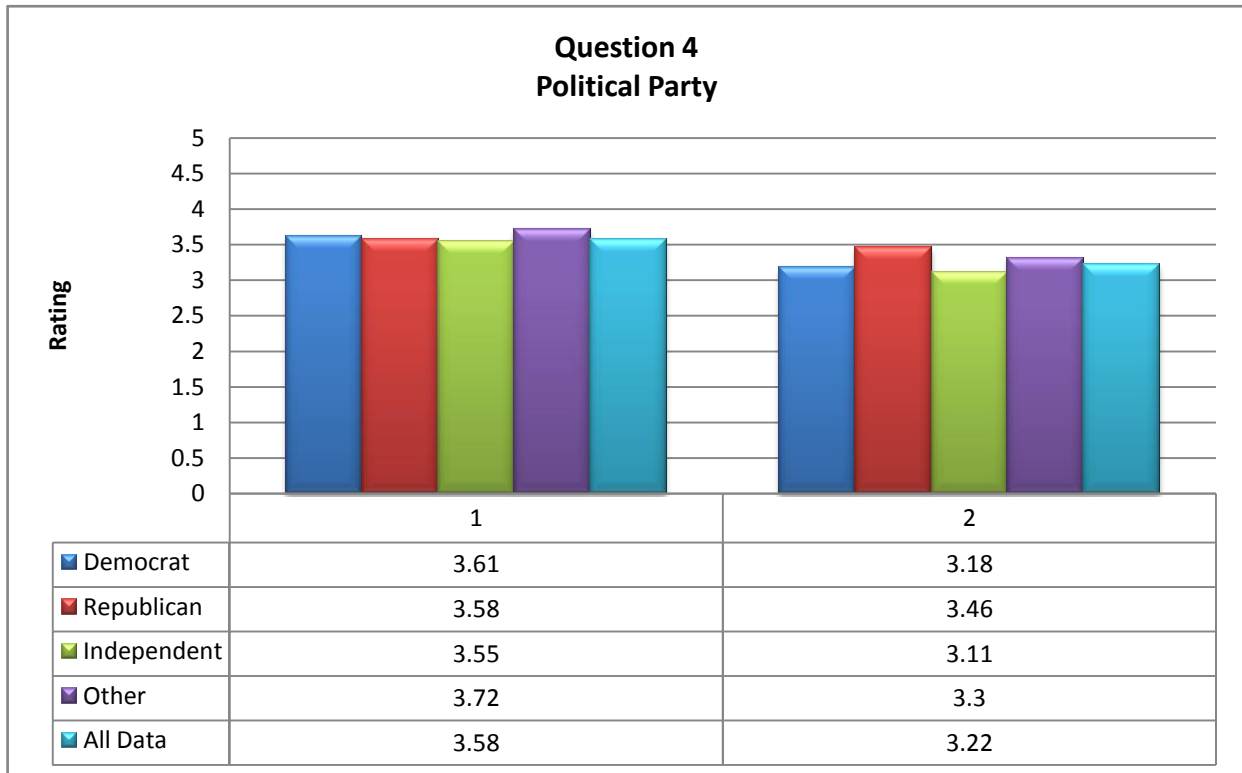


Chart A.4.13

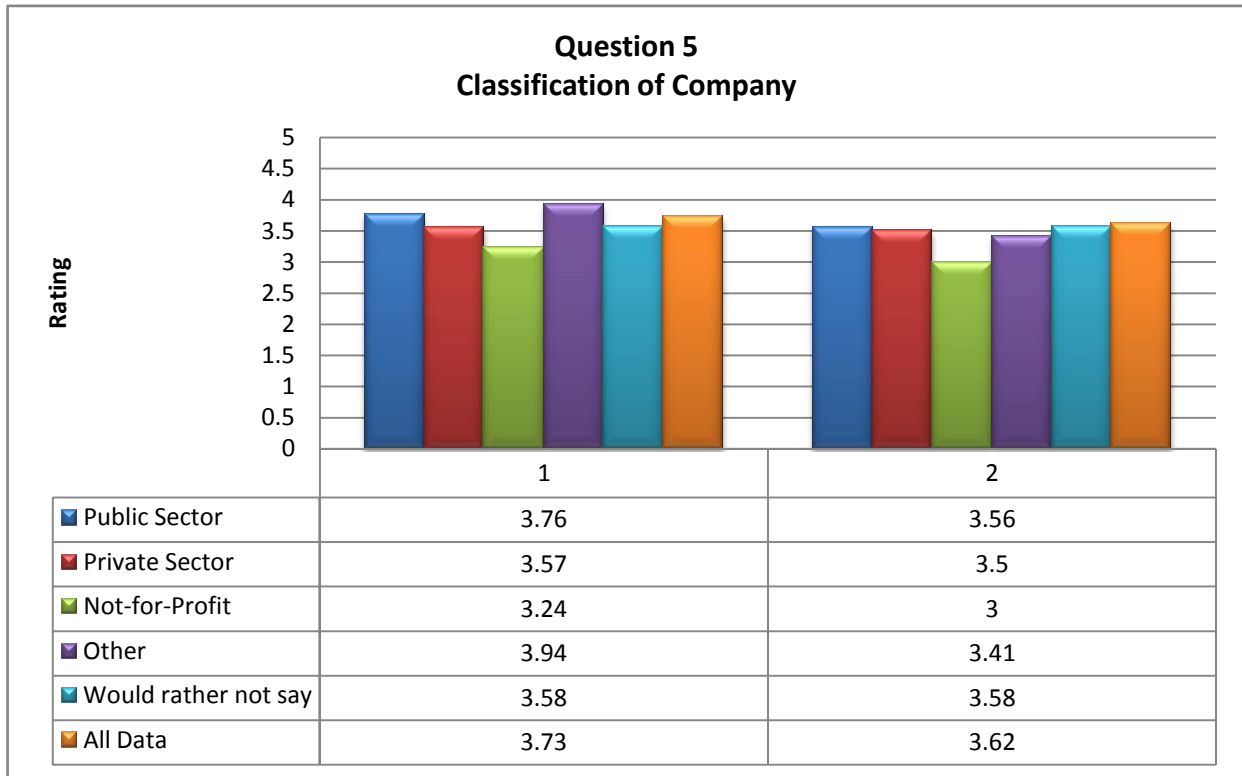


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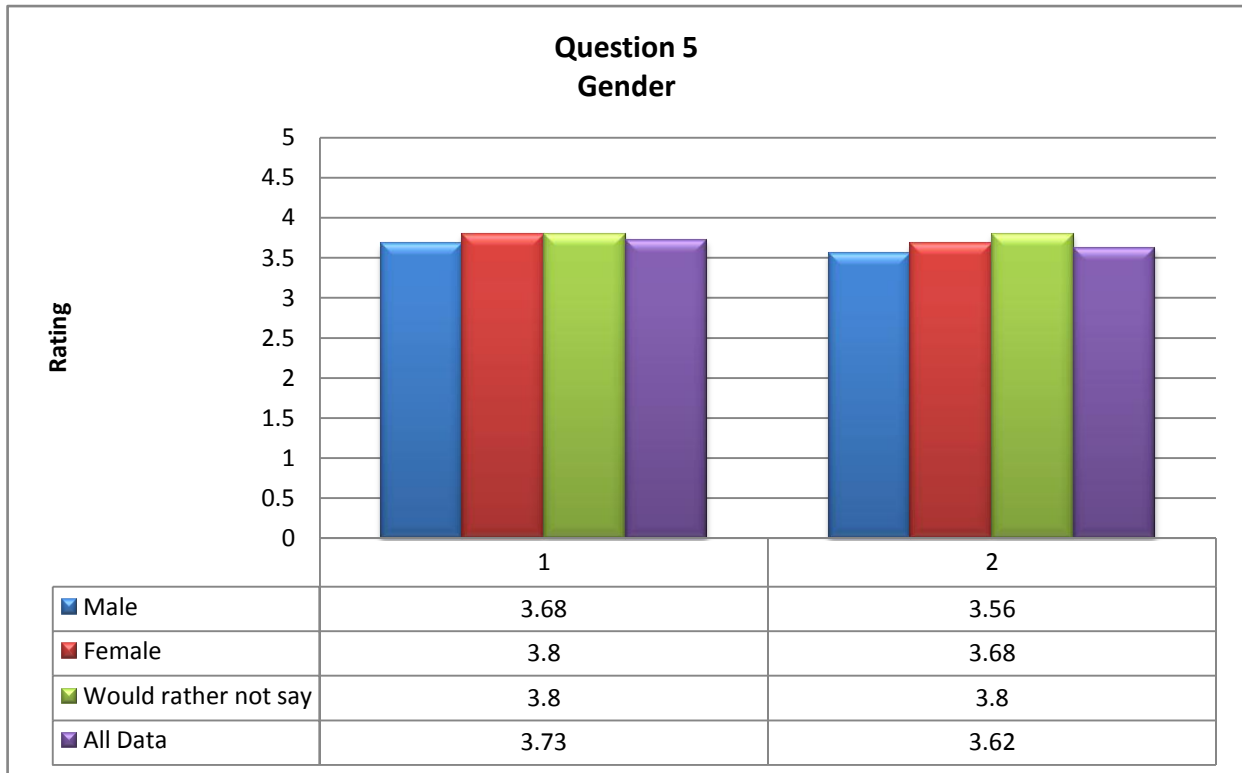


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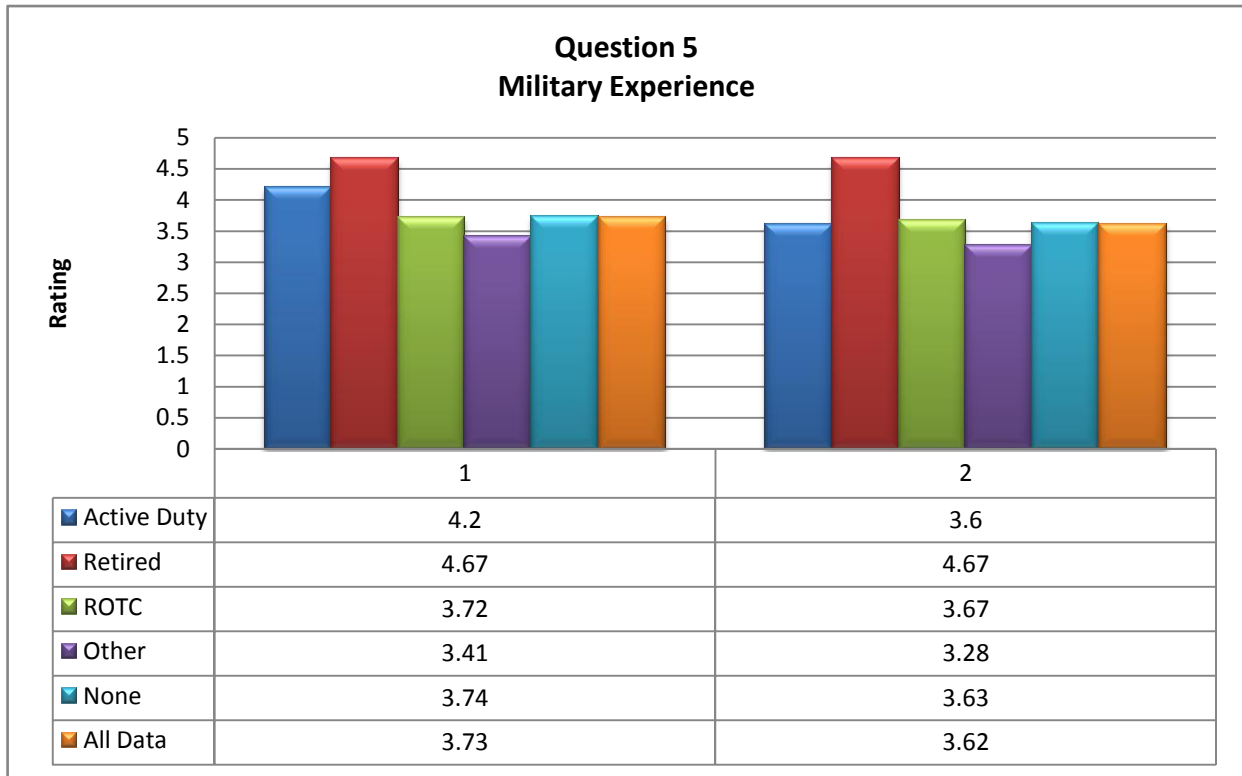


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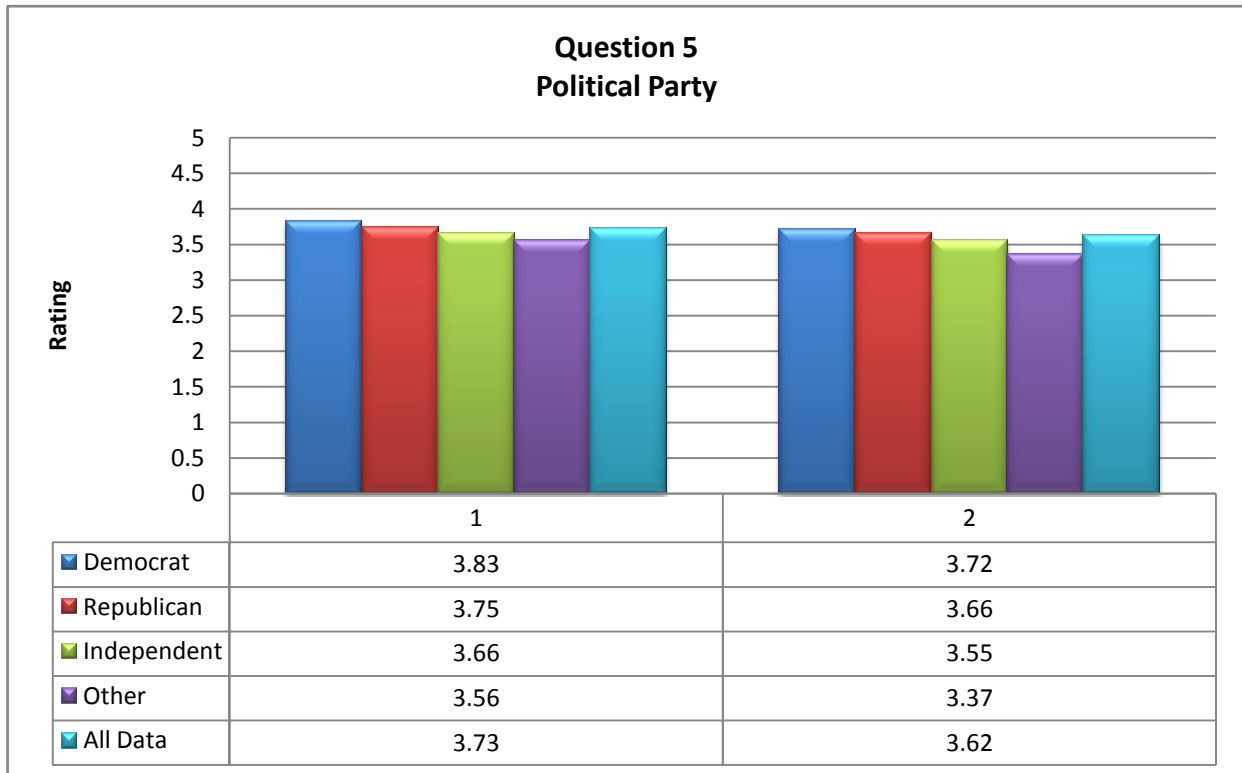


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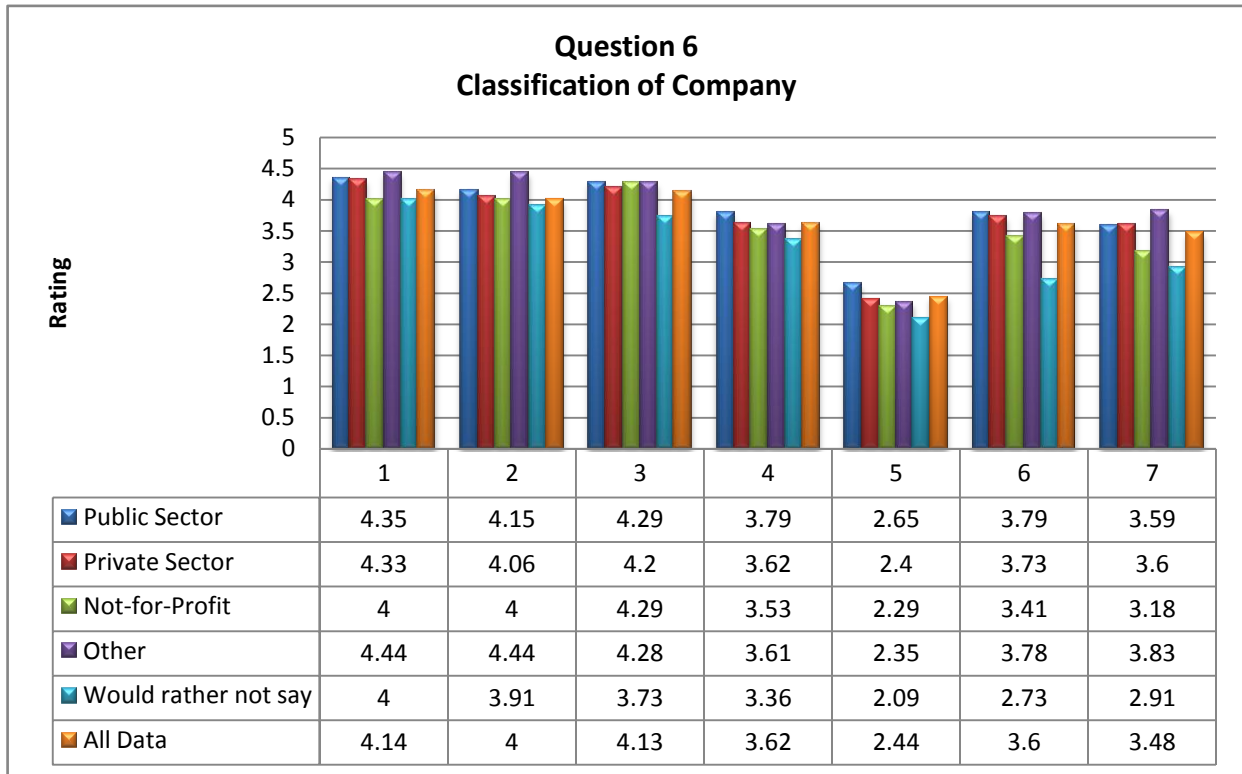


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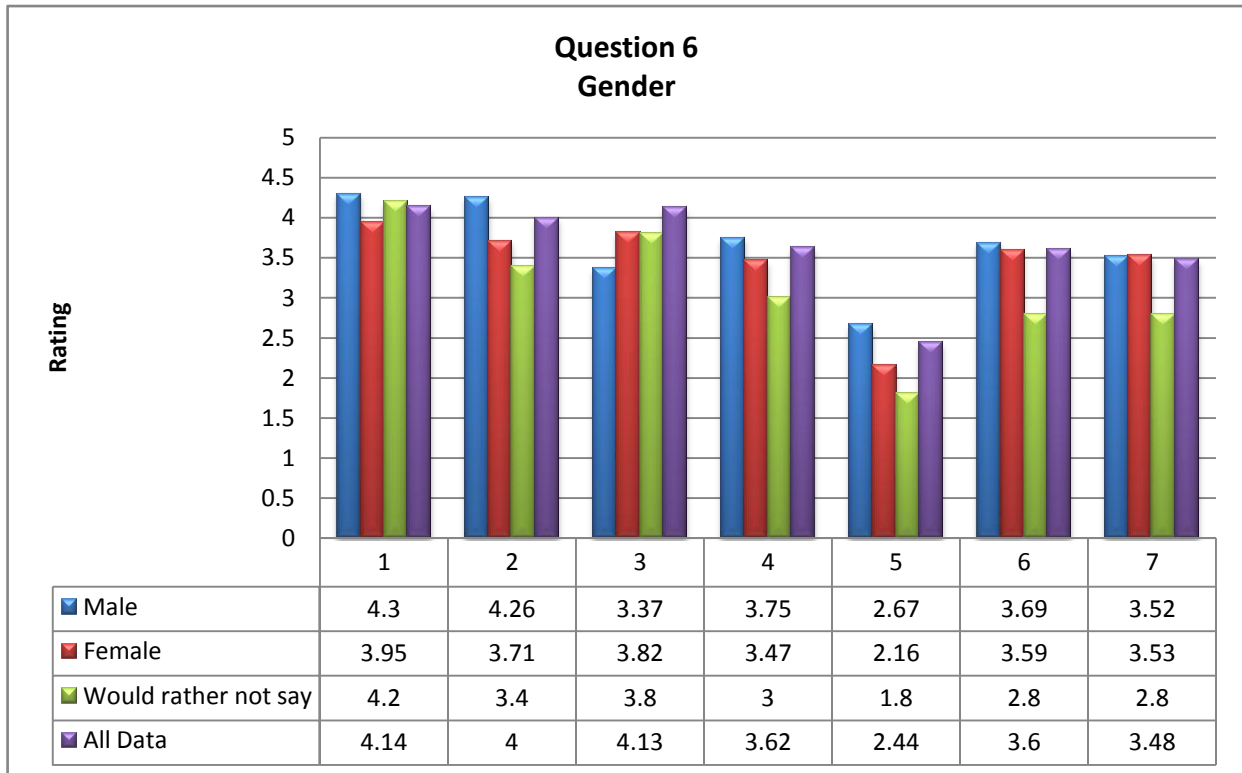


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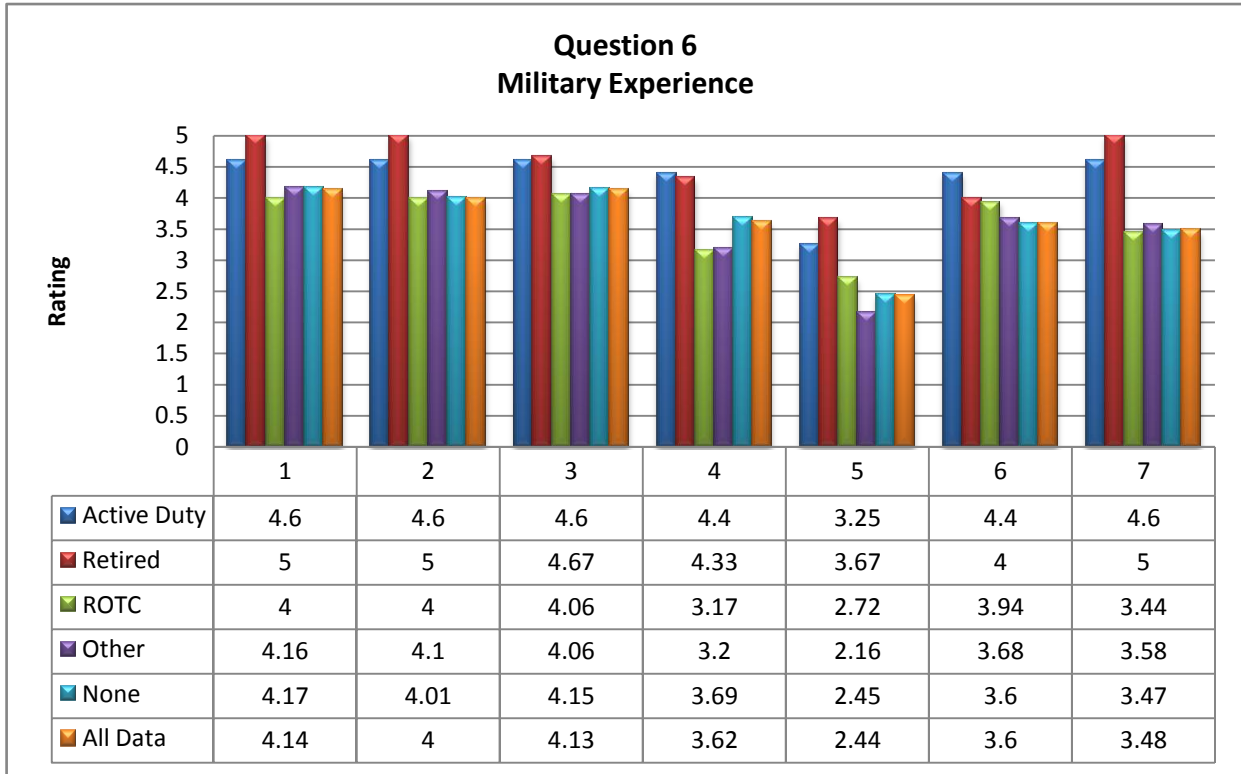
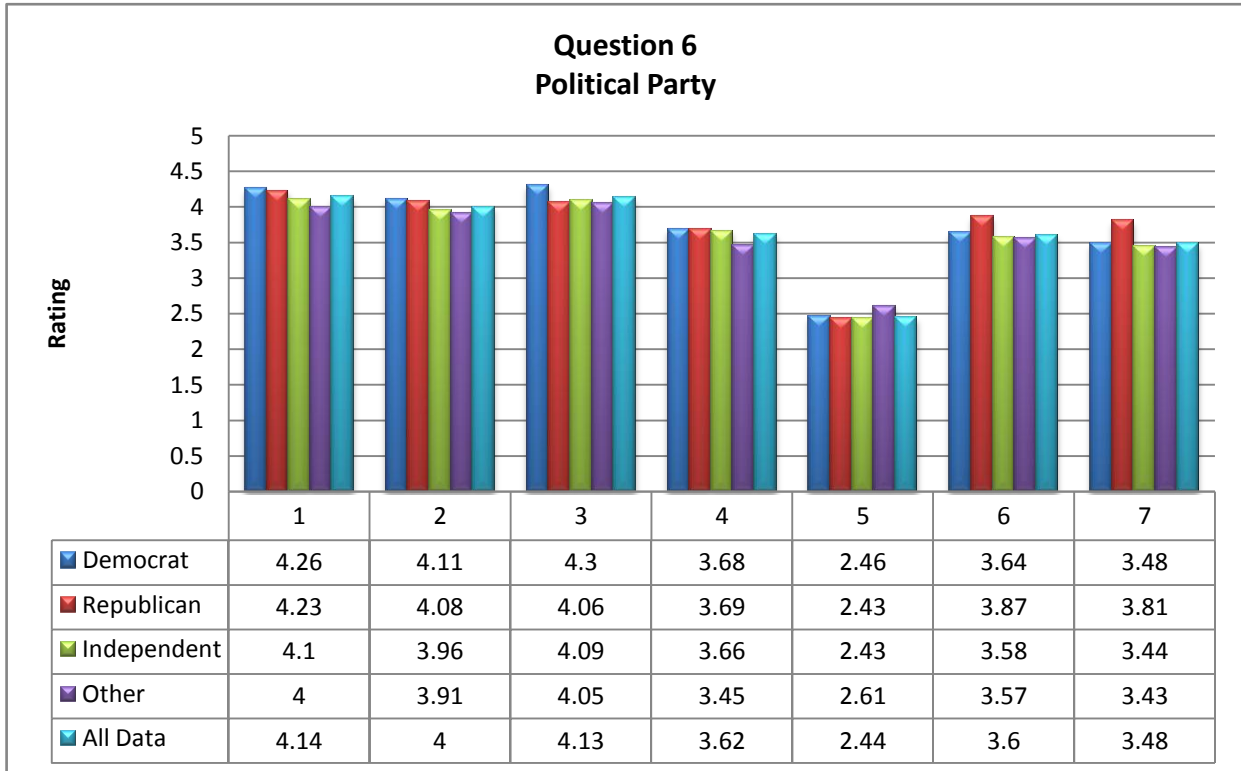


Chart A.4.20



Appendix A.4

Chart A.4.21

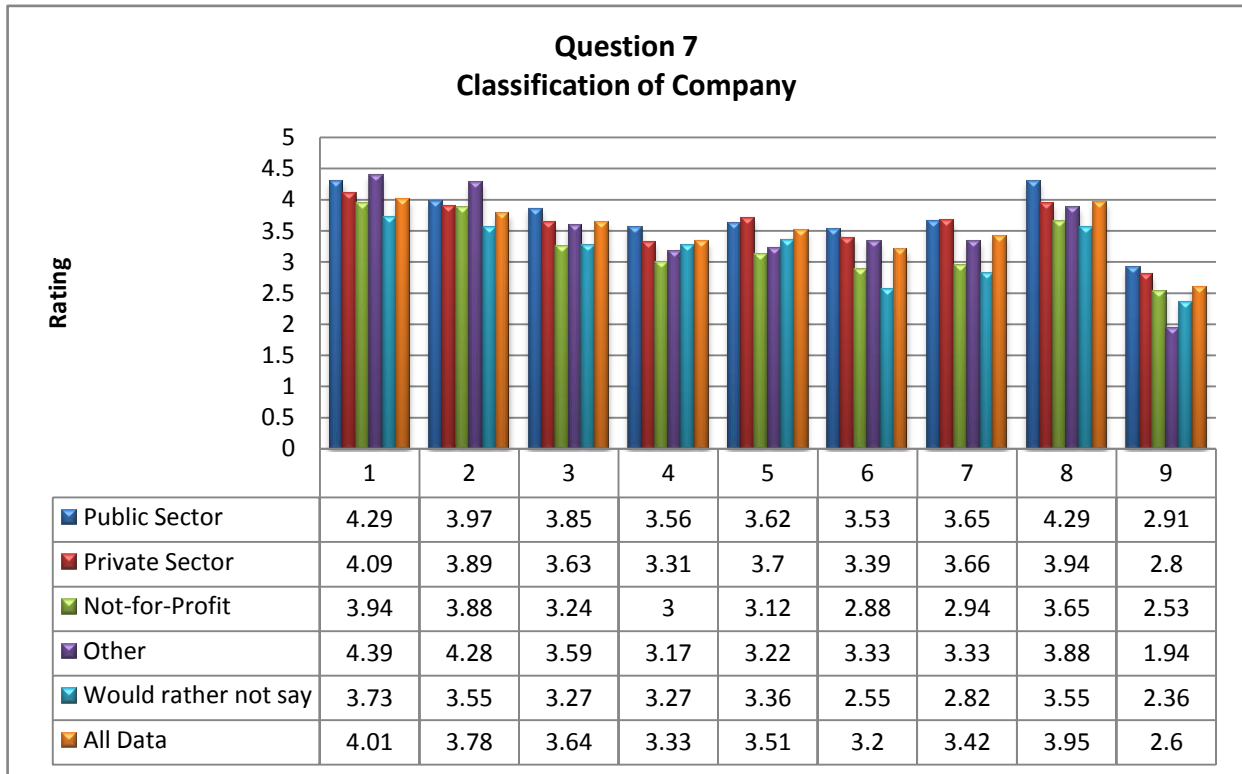


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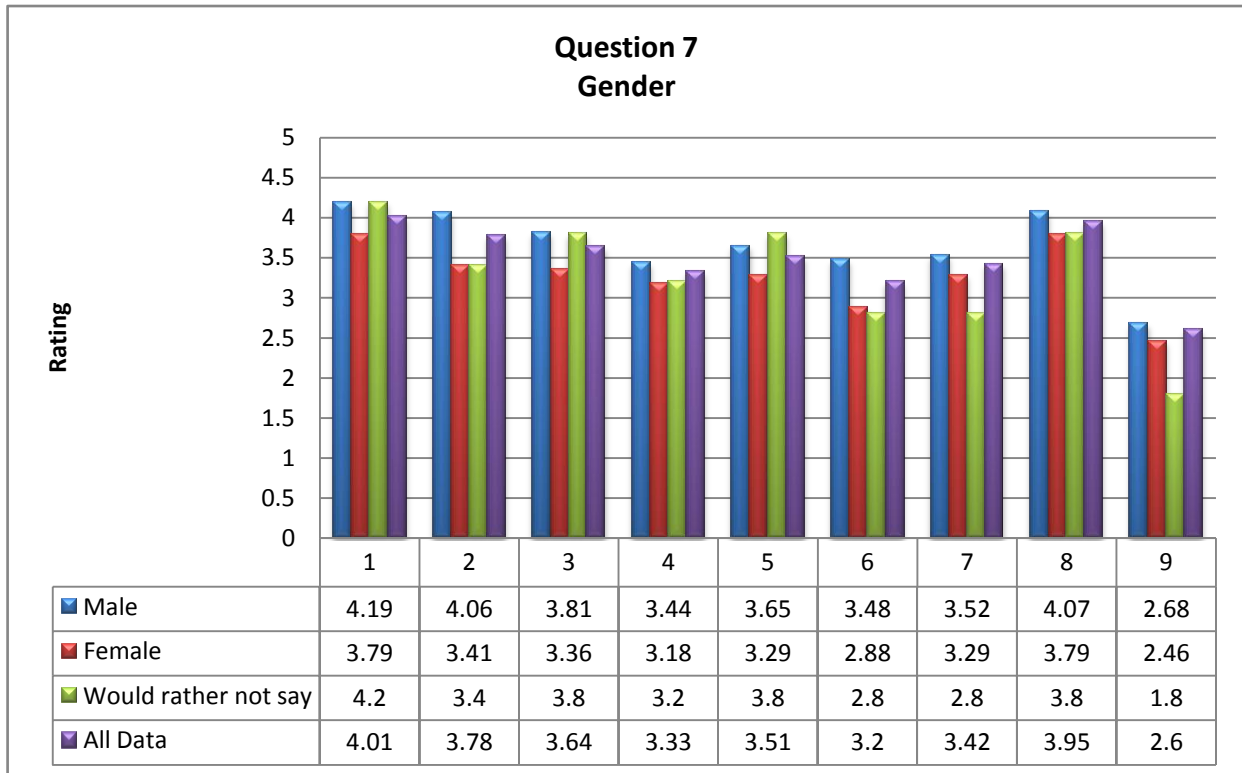


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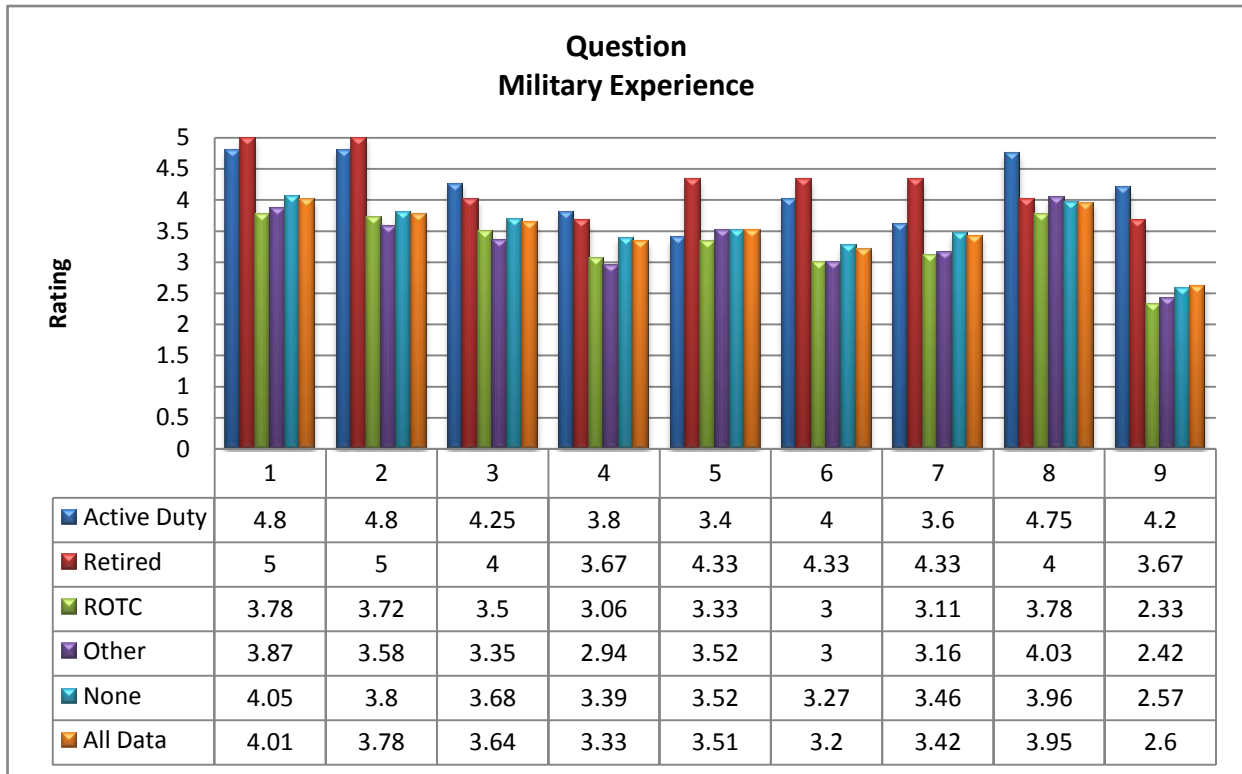


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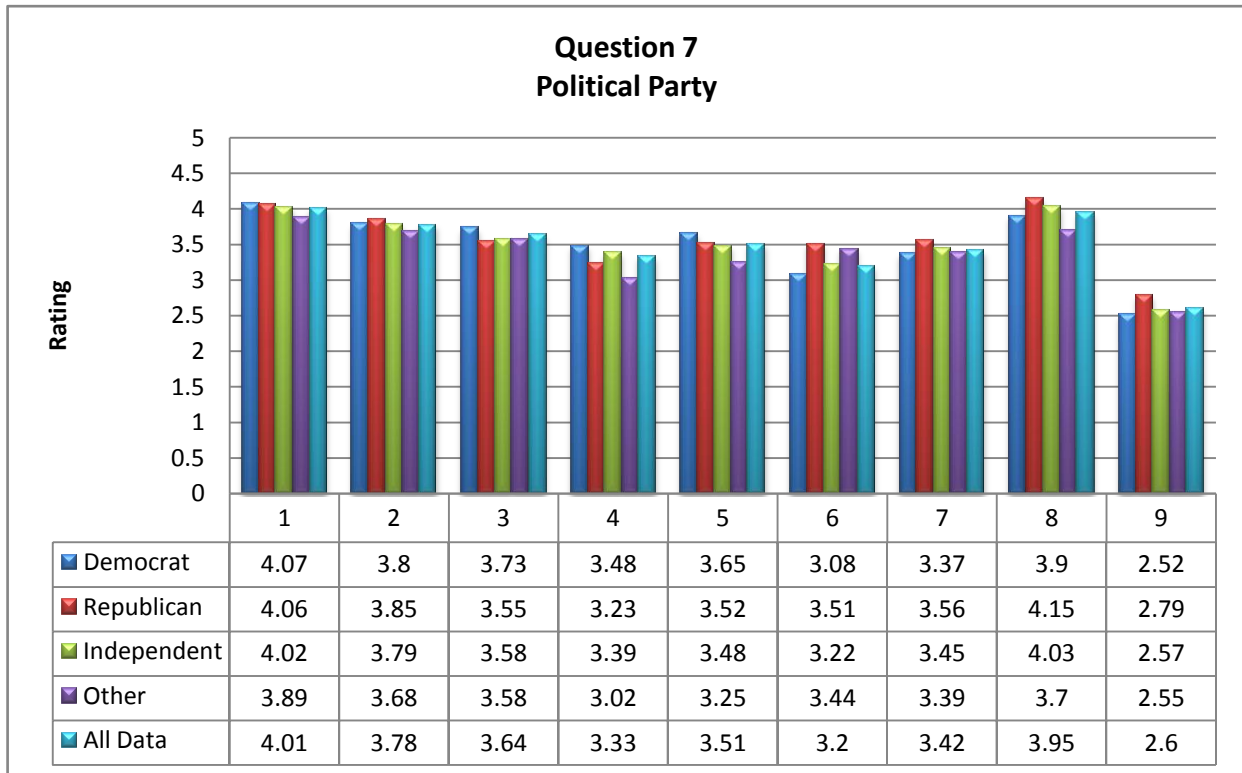


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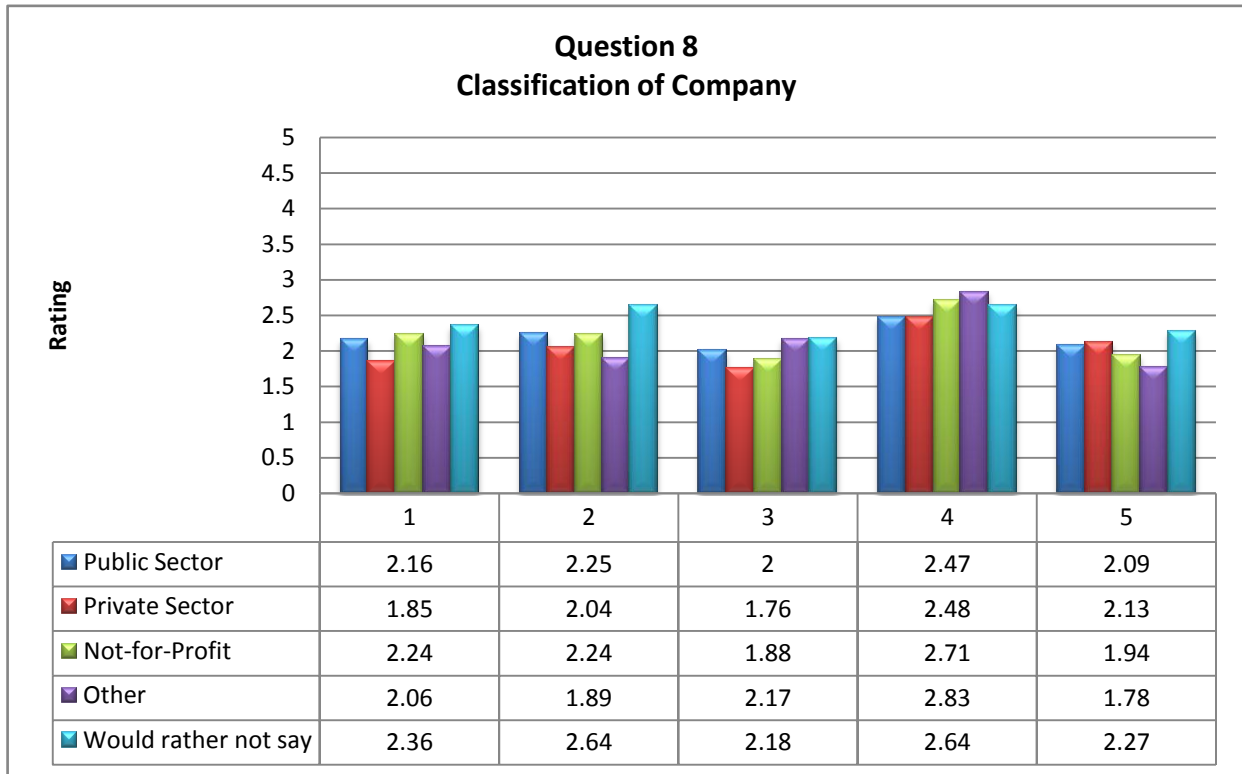


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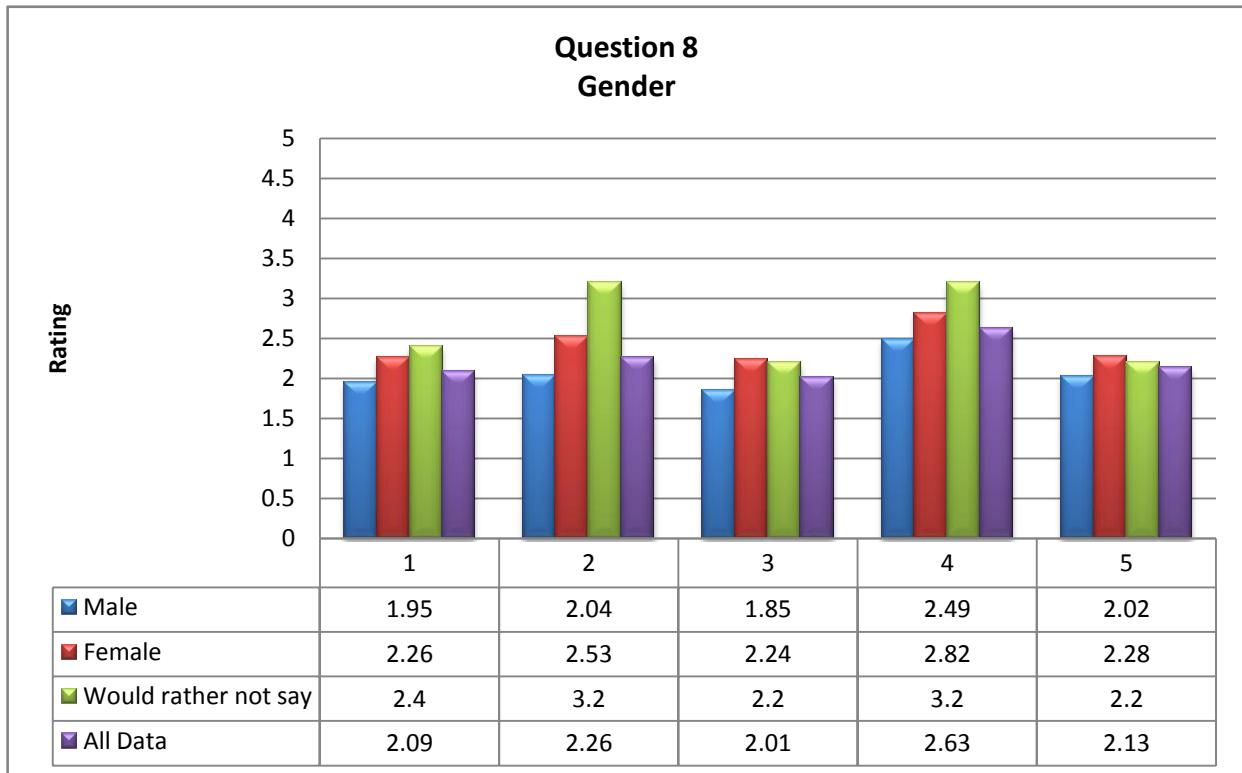


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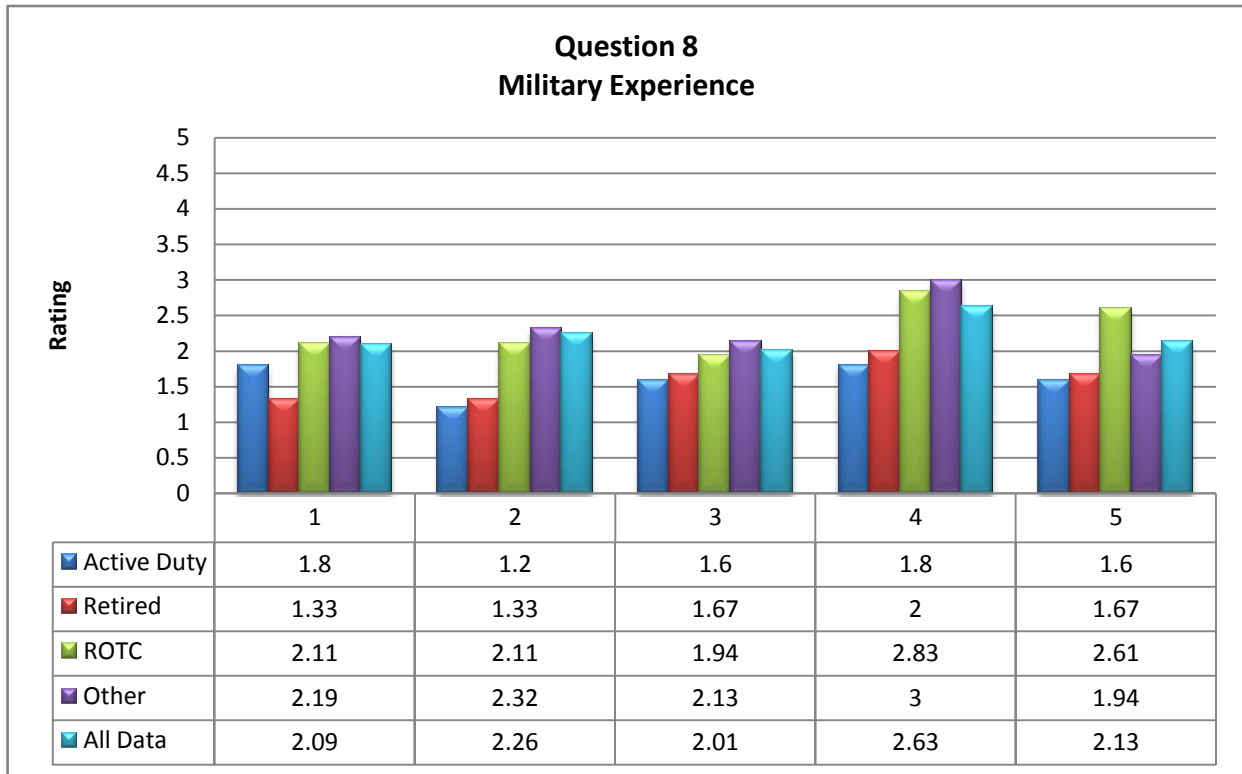


Chart A.4.28

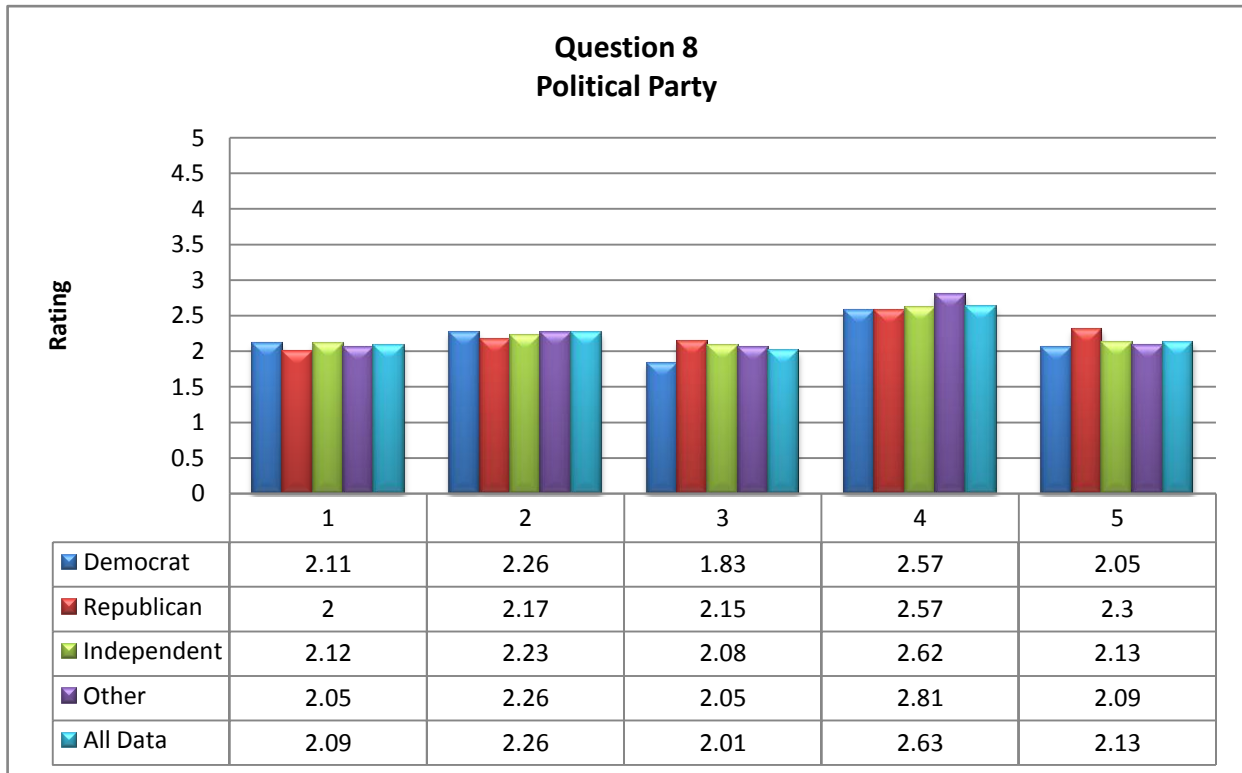


Chart A.4.29

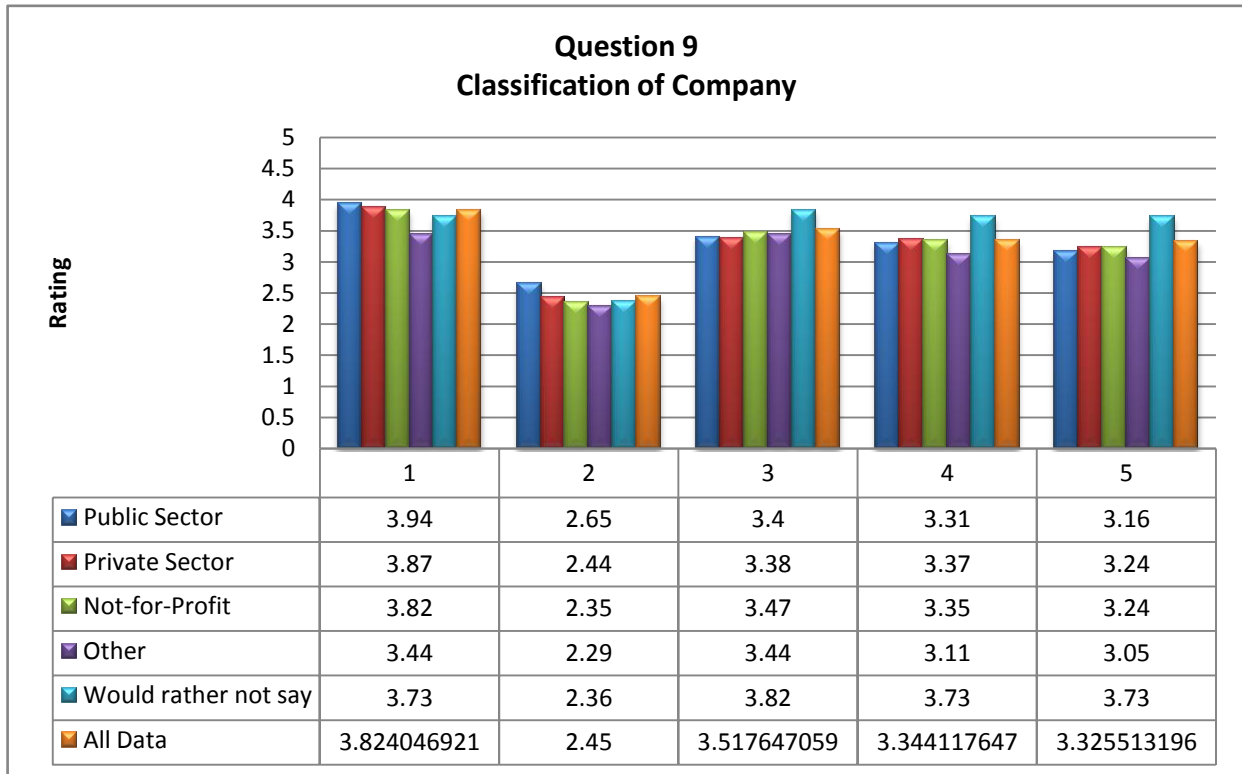
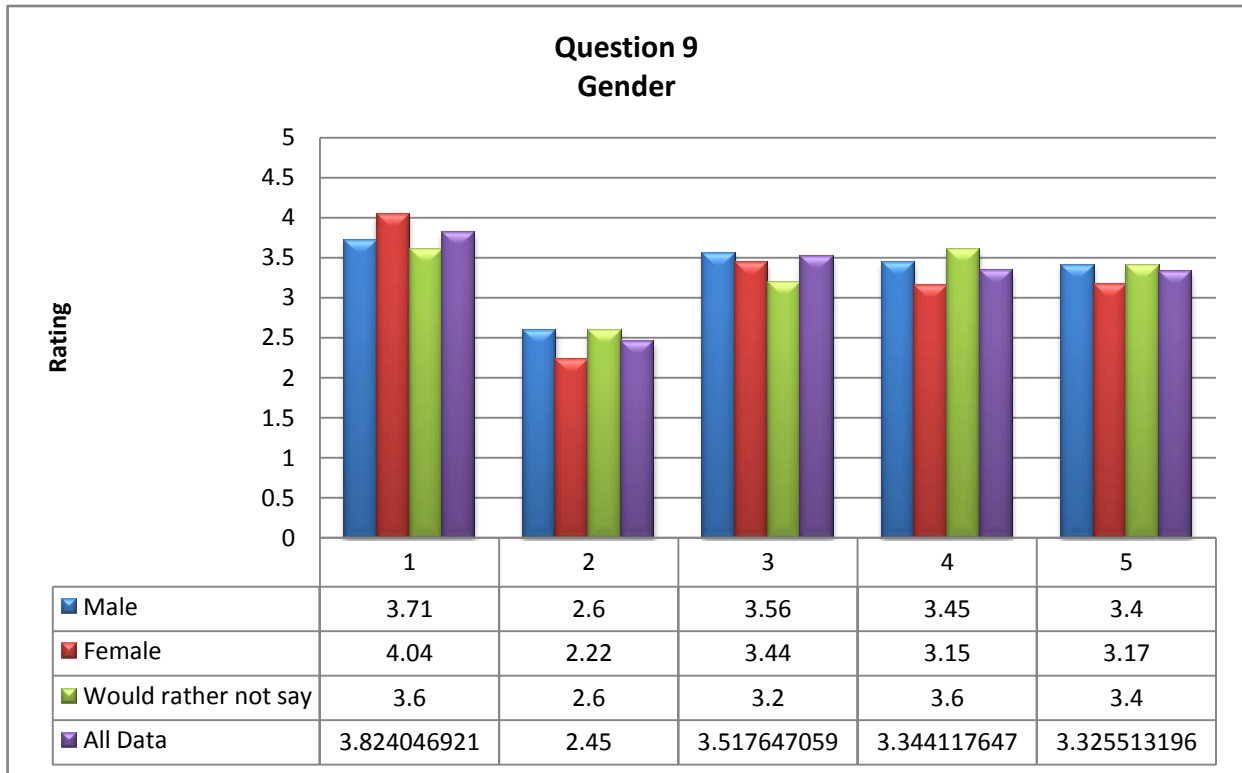


Chart A.4.30



Appendix A.4

Chart A.4.31

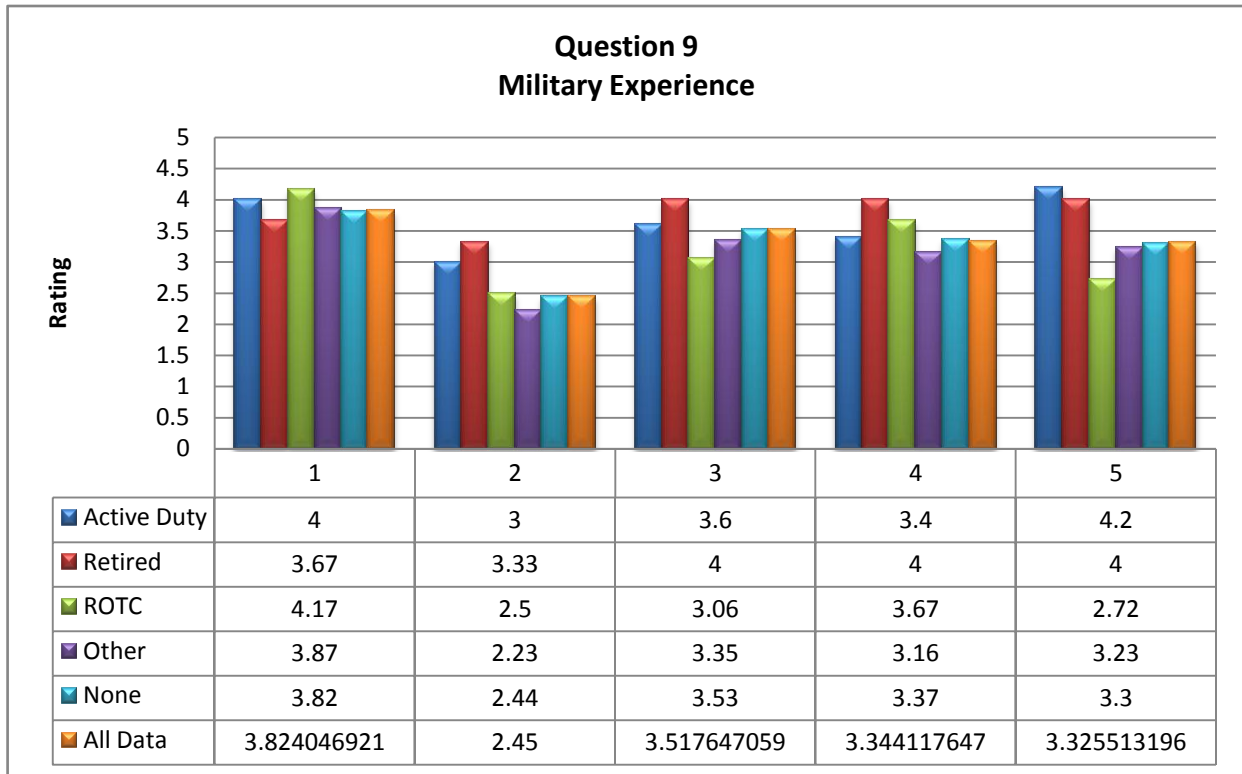


Chart A.4.32

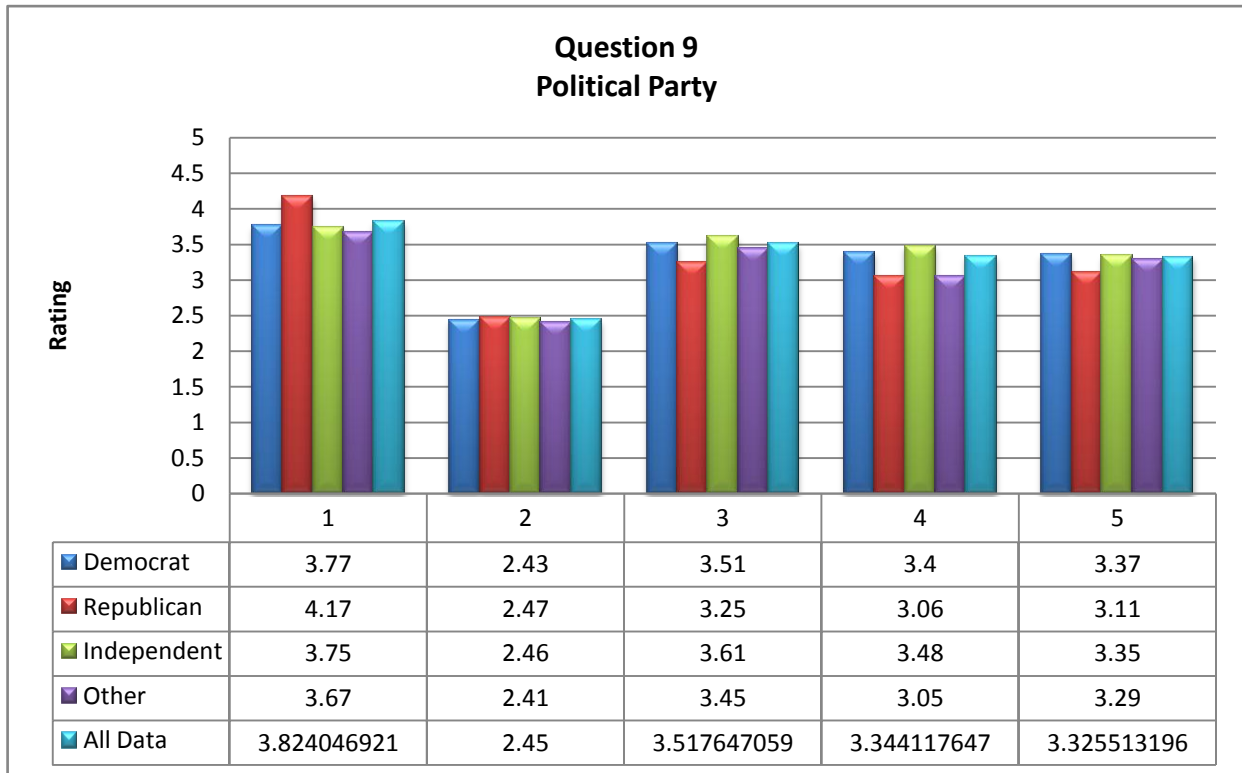


Chart A.4.33

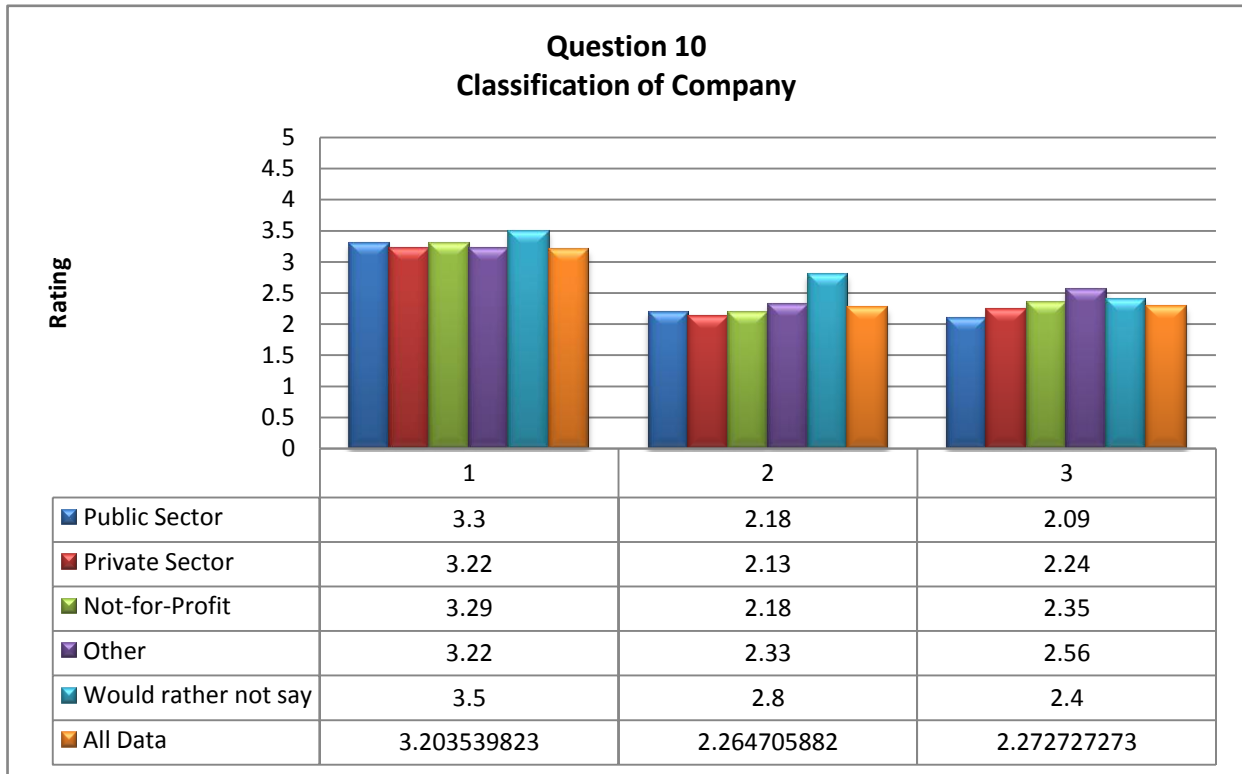


Chart A.4.34

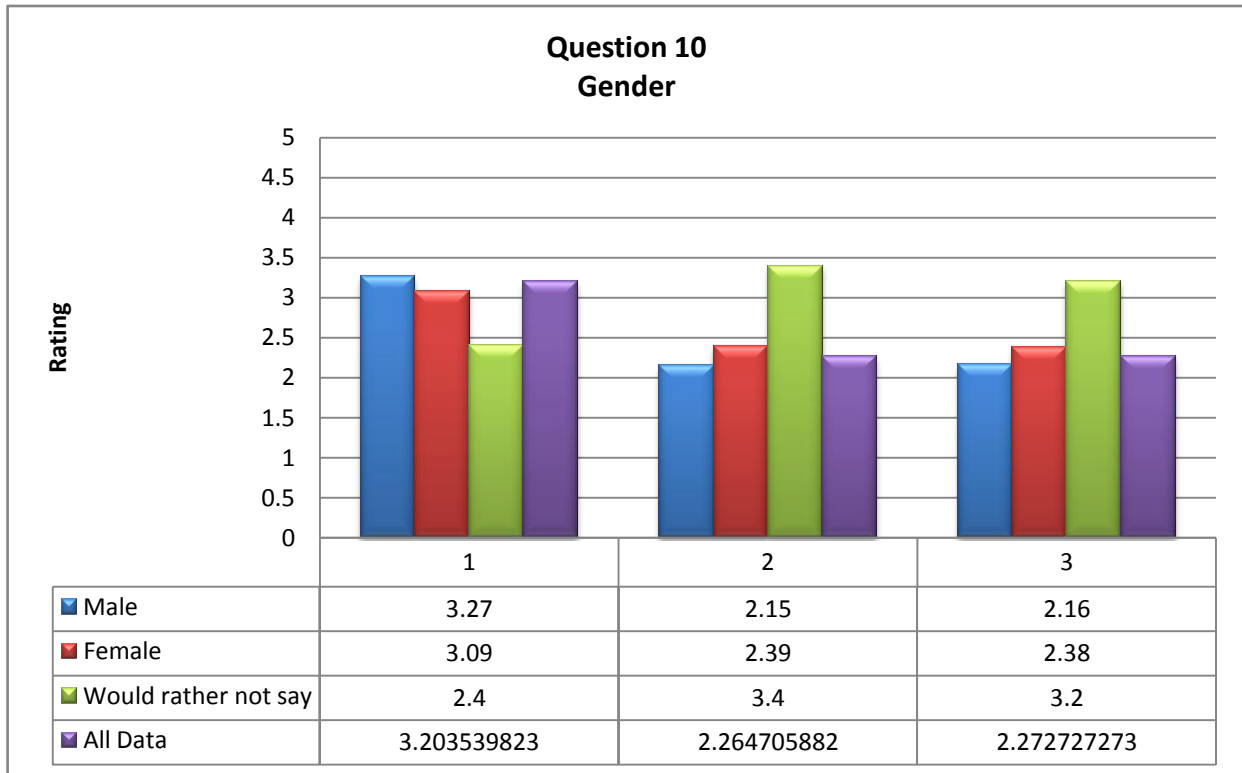


Chart A.4.35

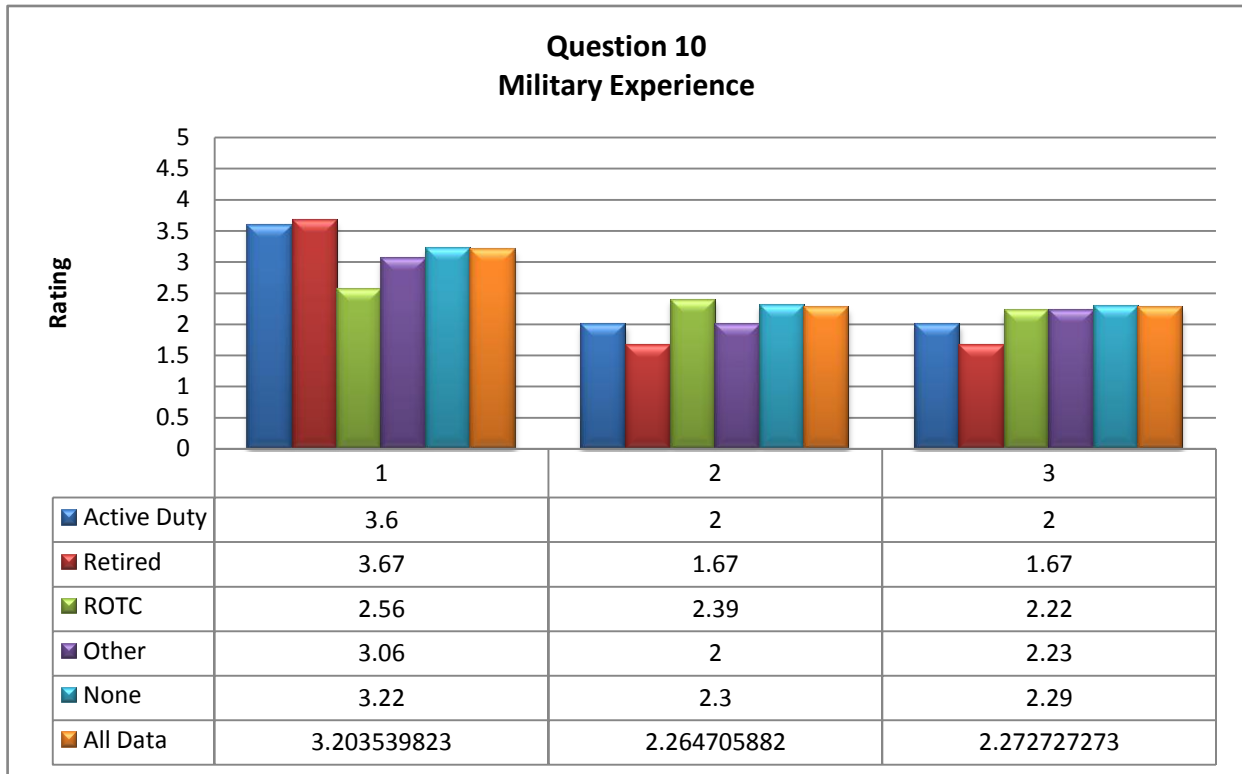


Chart A.4.36

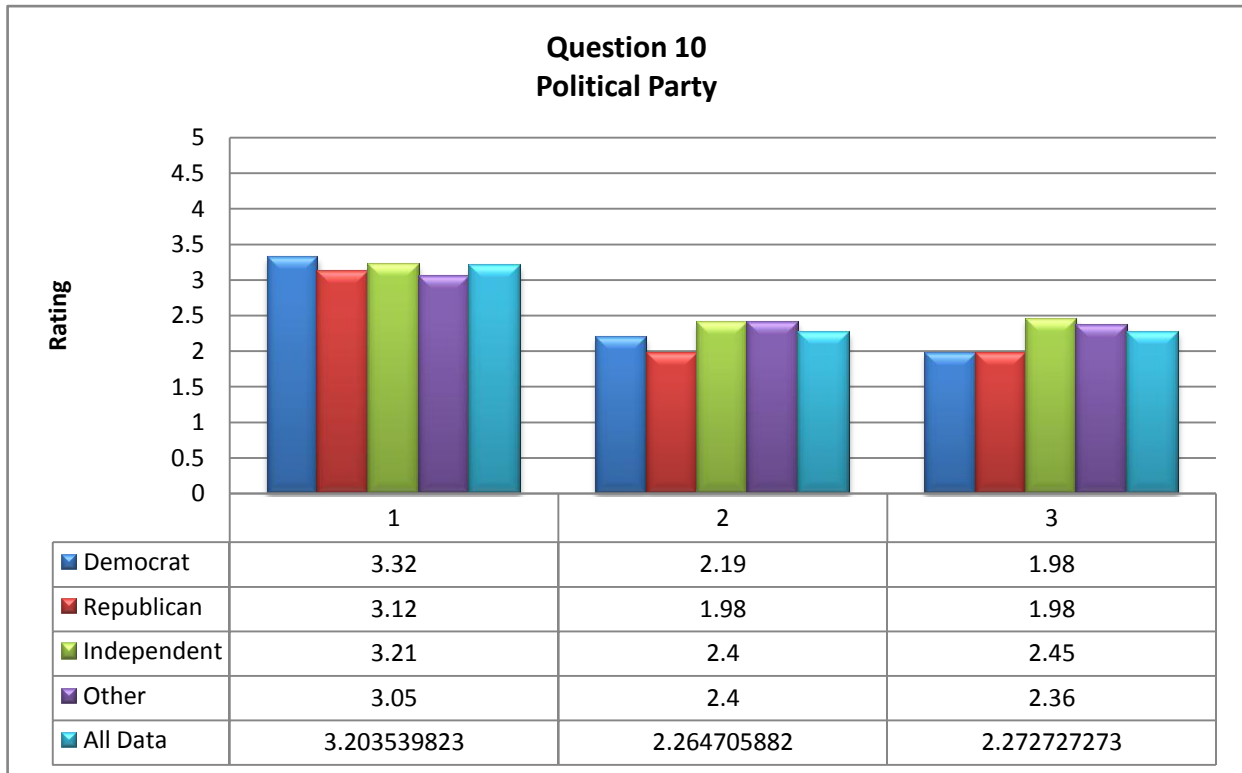


Chart A.4.37

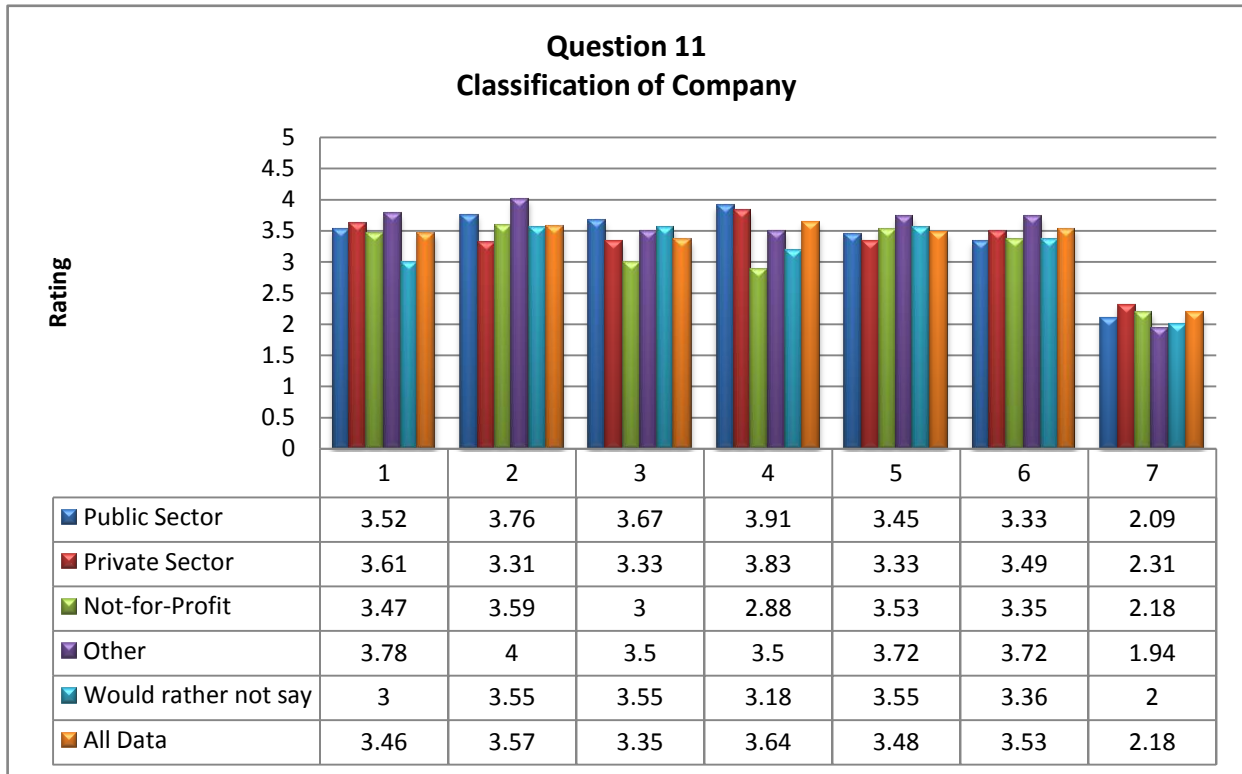


Chart A.4.38

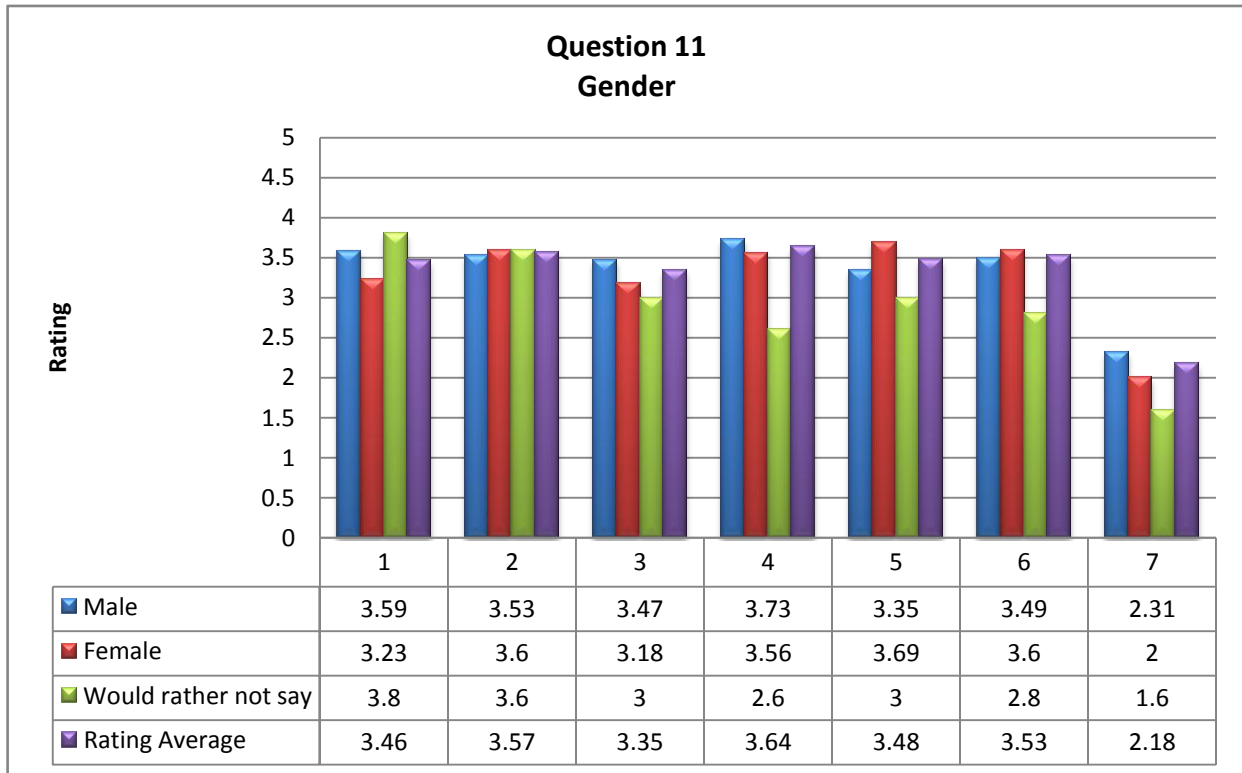


Chart A.4.39

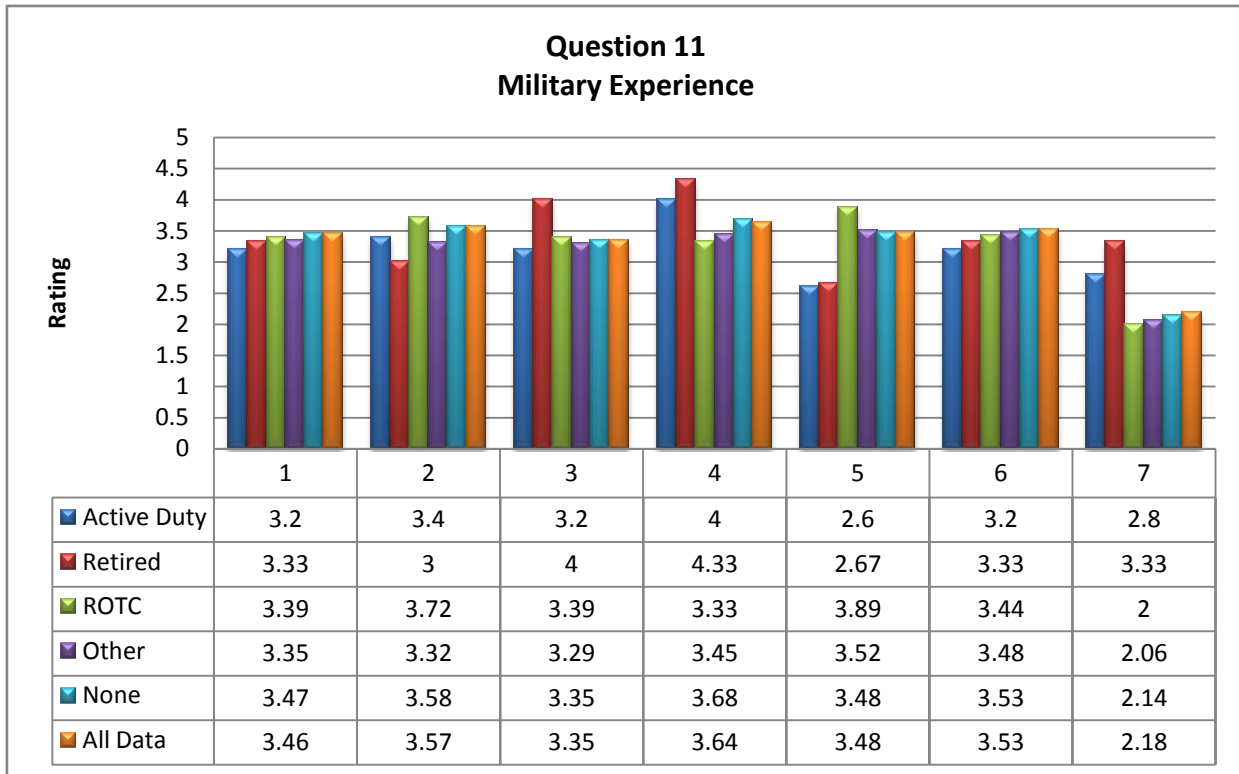


Chart A.4.40

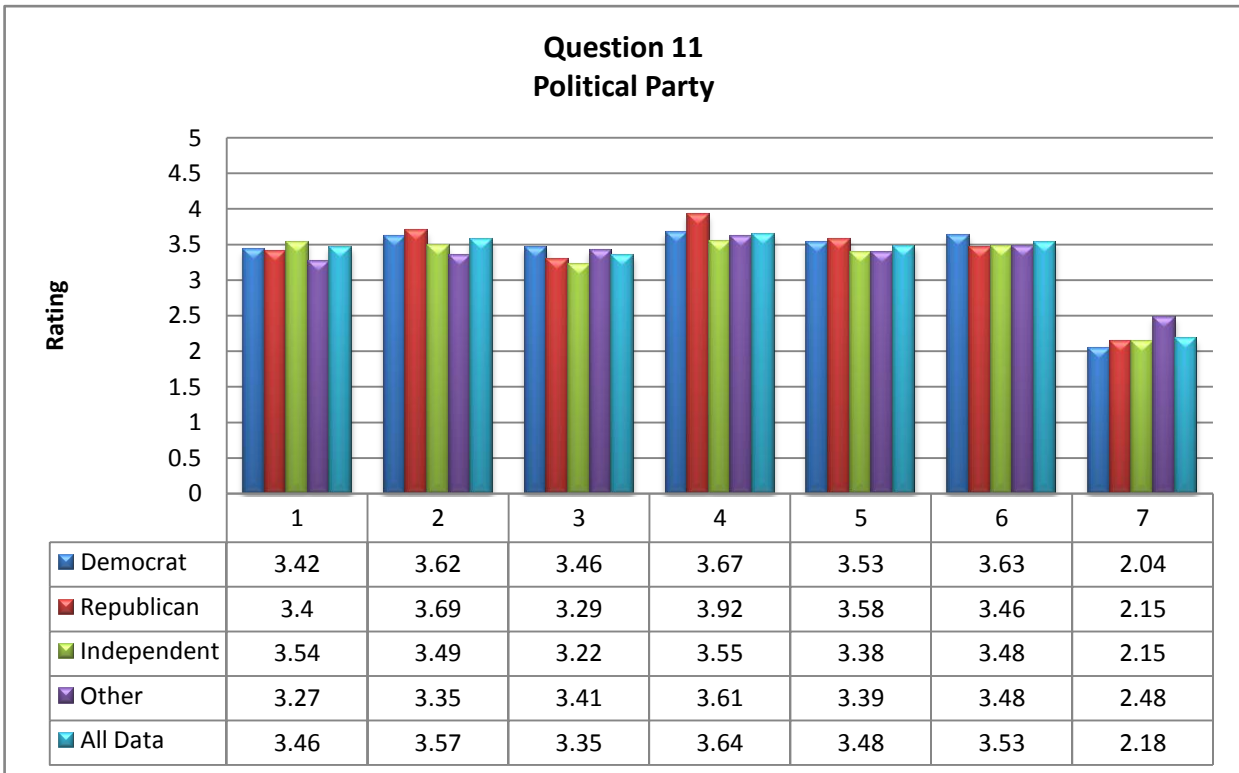


Chart A.4.41

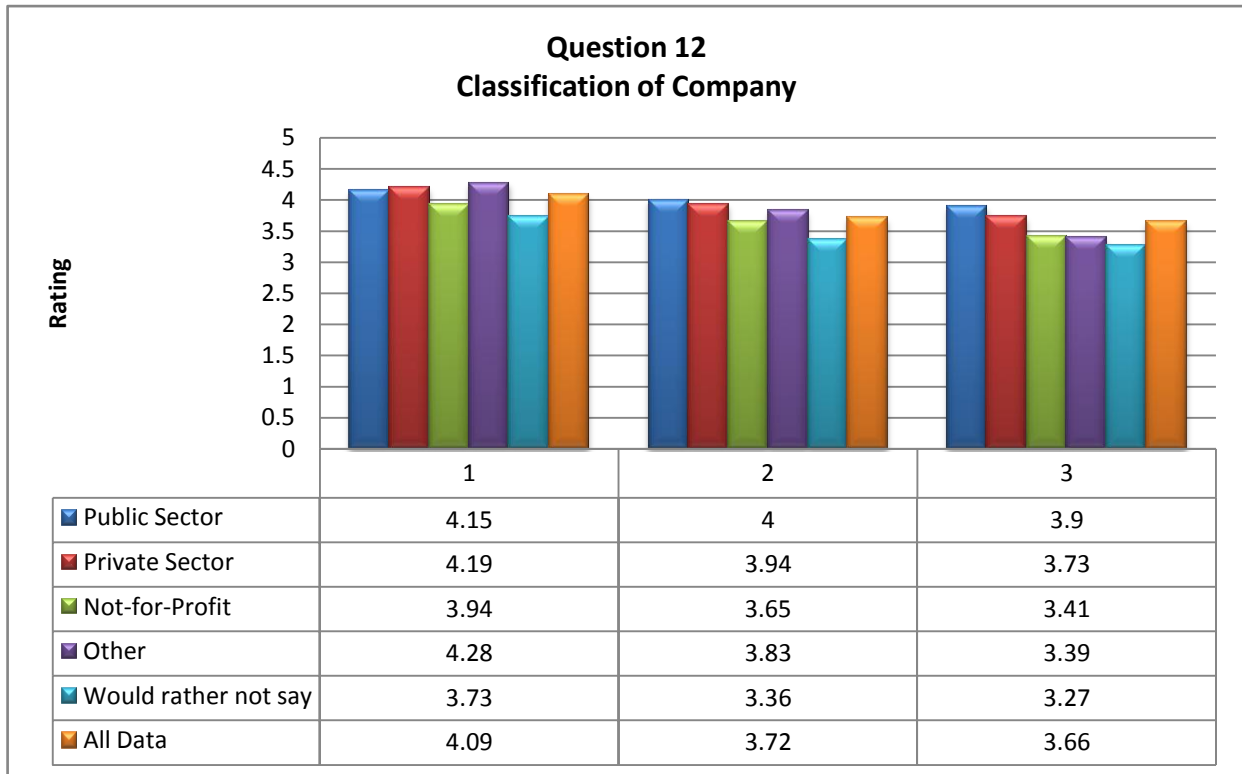


Chart A.4.42

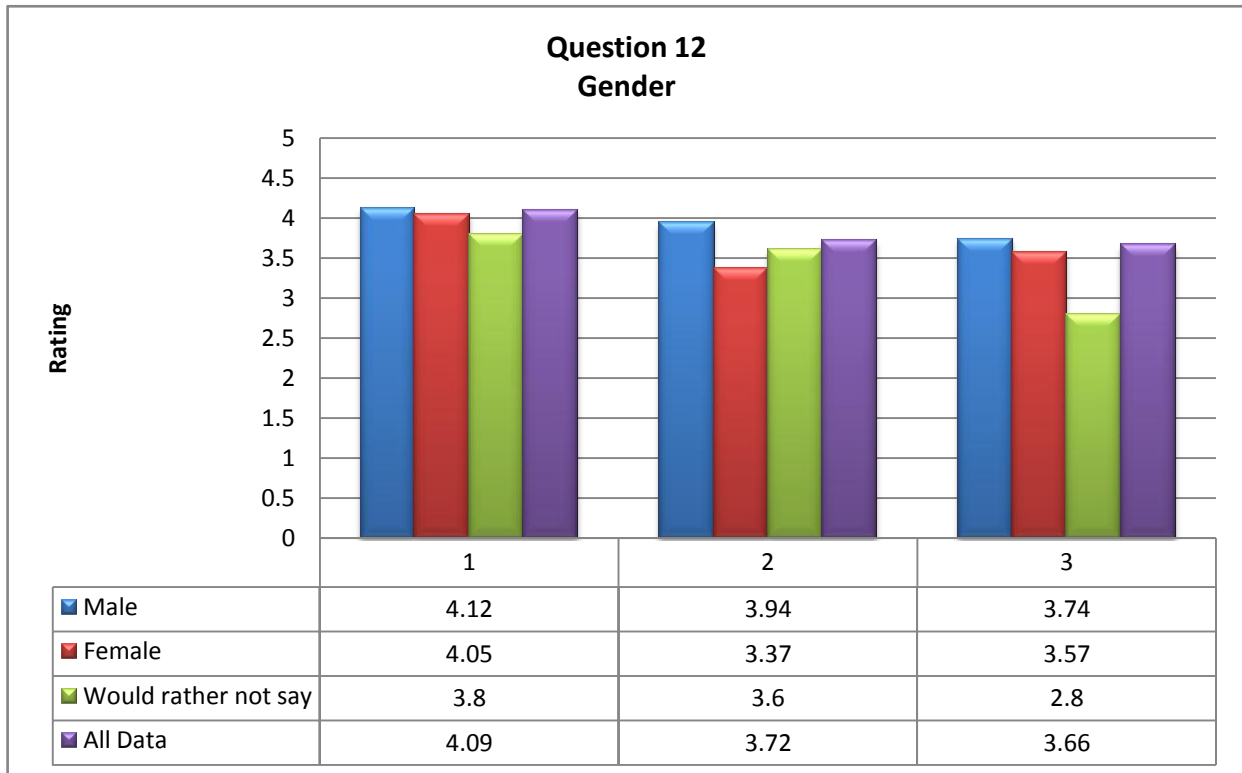


Chart A.4.43

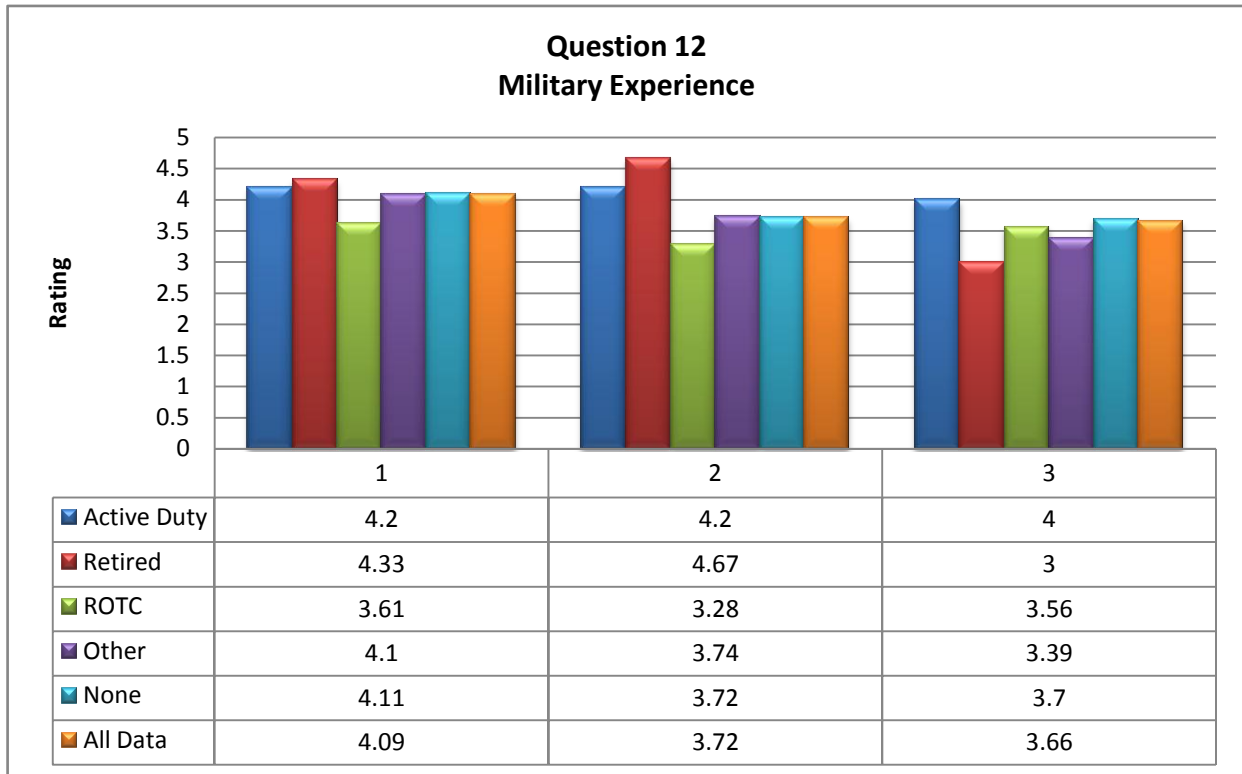


Chart A.4.44

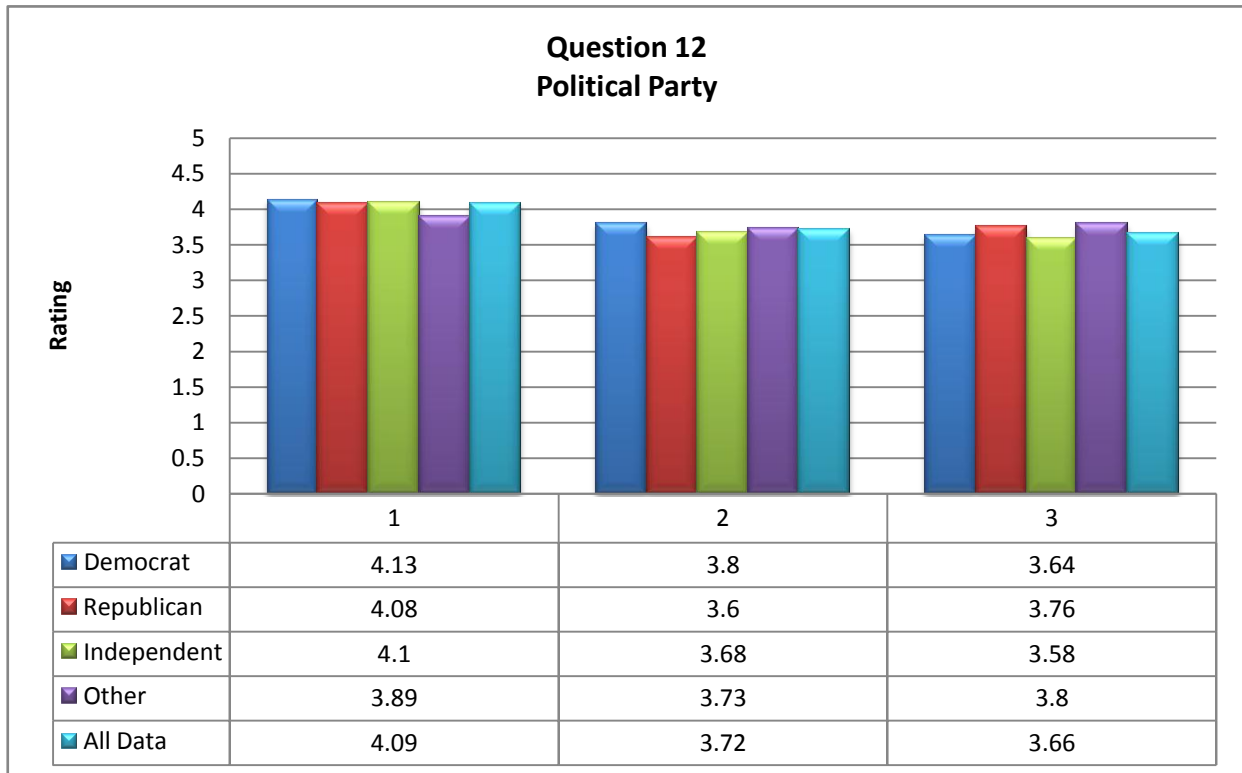


Chart A.4.45

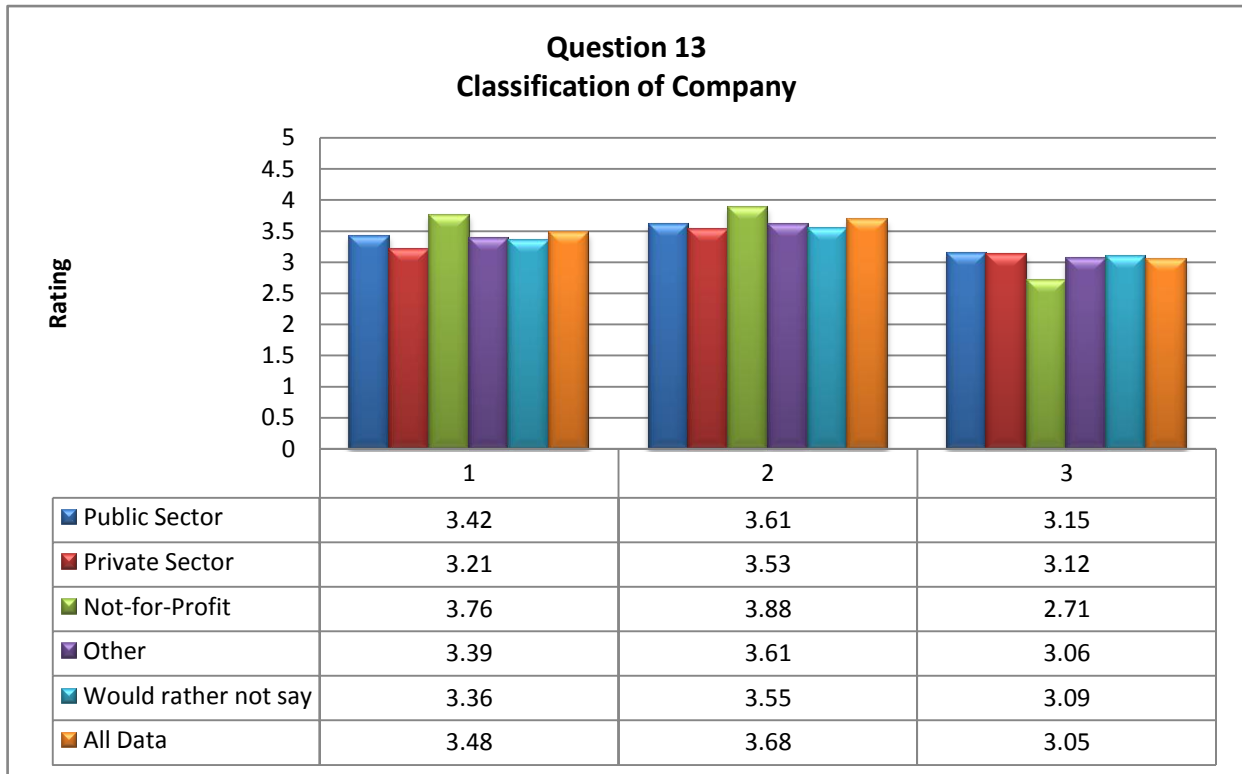


Chart A.4.46

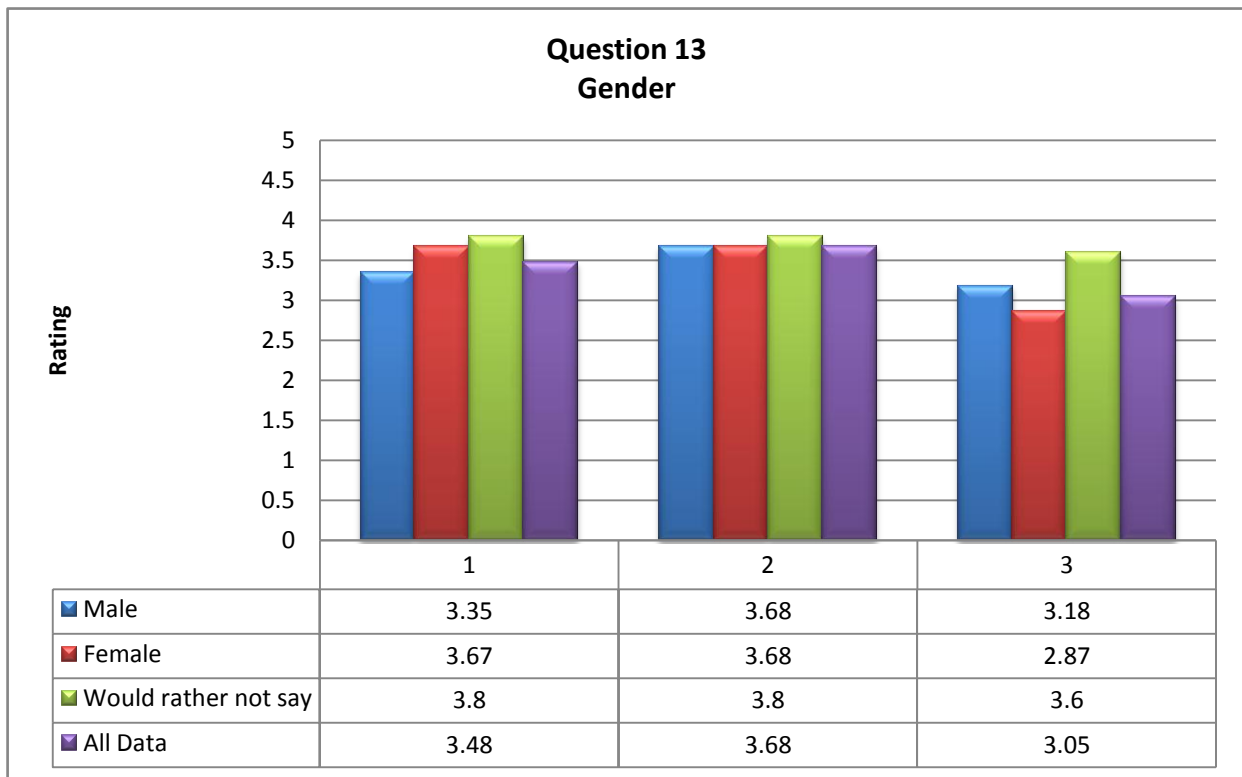


Chart A.4.47

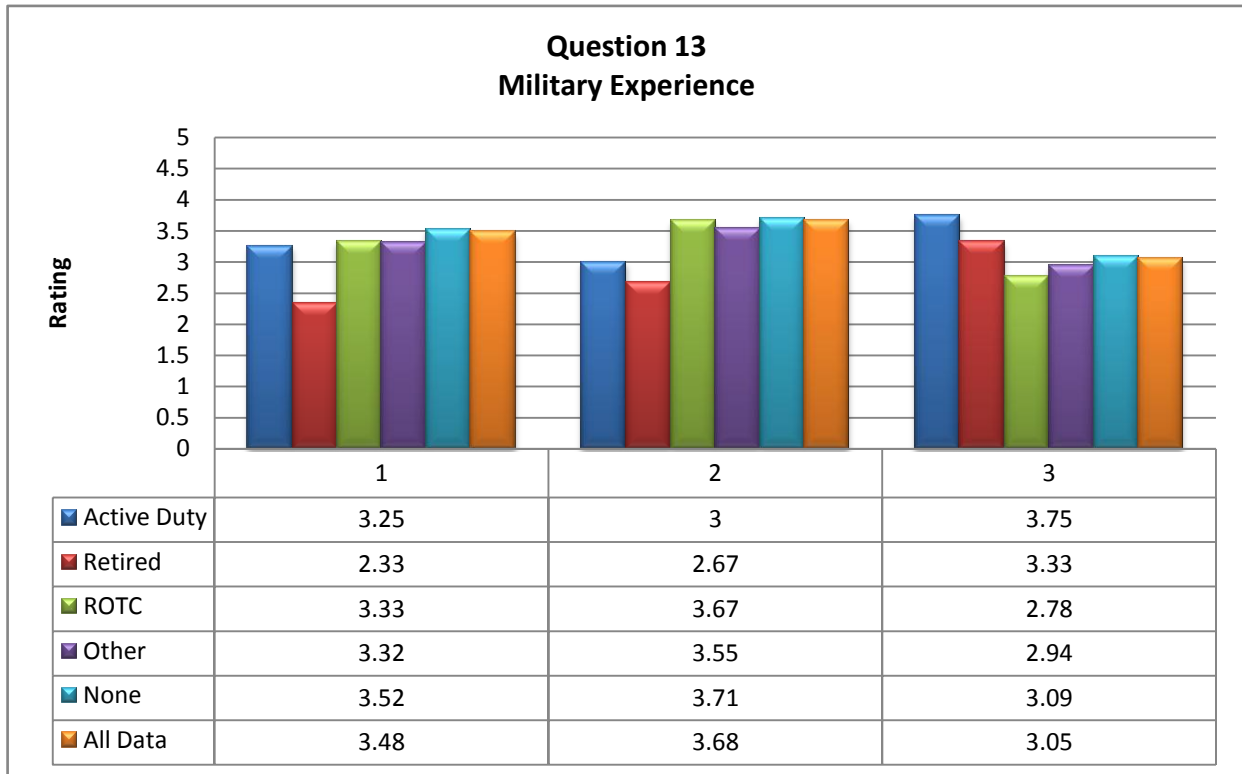
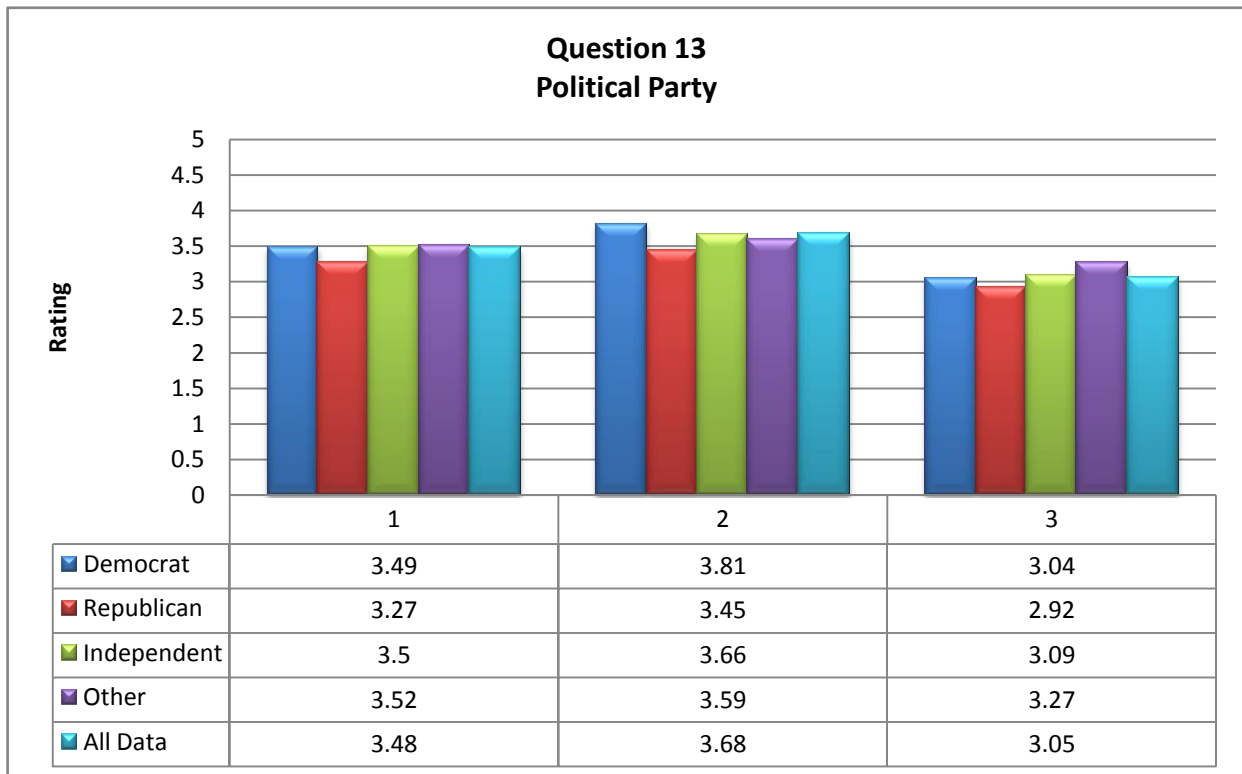


Chart A.4.48



Appendix B.1

Table B.1.1

Classification of Company - Question 1							
Informed Consent Agreement for Participation in a Research Study							
	What is the classification of the company you are employed by?						
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Response Frequency	Response Count
I do NOT consent to participate in this study	0	0	0	0	0	0.0%	0
I do consent to participate in this study	34	55	17	18	12	100.0%	136
<i>answered question</i>							136
<i>skipped question</i>							0

Appendix B.1

Table B.1.2

Classification of Company - Question 2								
Please use the definition posted below to answer the following questions. Robot: any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner (Encyclopedia Britannica). Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). A robot is defined as an automated...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
2.1: Ground vehicle that navigates around obstacles to a given location (e.g. Tank, car)								
Strongly Disagree (1)	1	3	1	1	1			
Disagree (2)	2	2	2	0	2			
Neither Agree not Disagree (3)	5	0	2	3	2			
Agree (4)	11	27	6	3	3			
Strongly Agree (5)	14	23	6	10	4			
	4.06 (33)	4.18 (55)	3.82 (17)	4.24 (17)	3.58 (12)	4.06	134	
2.2: Ground vehicle that can fire a weapon on command (e.g. Tank, car)								
Strongly Disagree (1)	3	6	1	3	1			
Disagree (2)	2	6	4	1	4			
Neither Agree not Disagree (3)	5	8	4	2	2			
Agree (4)	13	21	3	7	4			
Strongly Agree (5)	10	14	5	4	1			
	3.76 (33)	3.56 (55)	3.41 (17)	3.47 (17)	3.00 (12)	3.53	134	
2.3: Aircraft that can fire a weapon on command (e.g. Jet, helicopter)								
Strongly Disagree (1)	3	5	2	2	1			
Disagree (2)	3	10	5	3	4			
Neither Agree not Disagree (3)	6	7	3	1	3			
Agree (4)	11	20	2	7	3			
Strongly Agree (5)	10	13	5	4	1			
	3.67 (33)	3.47 (55)	3.18 (17)	3.47 (17)	2.92 (12)	3.43	134	
2.4: Defense mechanism (e.g. missile, torpedo)								
Strongly Disagree (1)	4	7	2	3	3			
Disagree (2)	9	19	4	2	3			
Neither Agree not Disagree (3)	5	7	6	5	3			
Agree (4)	9	15	3	4	2			
Strongly Agree (5)	6	7	2	3	1			
	3.12 (33)	2.93 (55)	2.94 (17)	3.12 (17)	2.58 (12)	2.97	134	
<i>answered question</i>							134	
<i>skipped question</i>							2	

Appendix B.1

Table B.1.3

Classification of Company - Question 3								
Please use the definition posted below to answer the following questions. Remote Controlled: The control of an activity, process, or machine from a distance, as by radioed instructions or coded signals (The American Heritage Dictionary) A robot is defined as a remote controlled...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
3.1: Ground vehicle (e.g. tank, car)								
Strongly Disagree (1)	1	3	2	2	1			
Disagree (2)	6	6	3	2	0			
Neither Agree not Disagree (3)	0	5	2	1	4			
Agree (4)	19	19	8	5	4			
Strongly Agree (5)	8	21	2	7	3			
	3.79 (34)	3.91 (54)	3.29 (17)	3.76 (17)	3.67 (12)	3.76	134	
3.2: Aircraft (e.g. jet, helicopter)								
Strongly Disagree (1)	1	3	2	2	1			
Disagree (2)	7	7	4	3	0			
Neither Agree not Disagree (3)	2	4	2	0	4			
Agree (4)	17	20	7	6	4			
Strongly Agree (5)	7	20	2	6	3			
	3.65 (34)	3.87 (54)	3.18 (17)	3.65 (17)	3.67 (12)	3.68	134	
3.3: Device that can pick up or close around objects (e.g. mechanical claw)								
Strongly Disagree (1)	1	4	2	1	1			
Disagree (2)	2	2	3	2	0			
Neither Agree not Disagree (3)	2	3	2	0	3			
Agree (4)	17	20	6	5	0			
Strongly Agree (5)	12	25	4	9	3			
	4.09 (34)	4.11 (54)	3.41 (17)	4.12 (17)	3.75 (12)	3.99	134	
						<i>answered question</i>	134	
						<i>skipped question</i>	2	

Appendix B.1

Table B.1.4

Classification of Company - Question 4								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a defense mechanism (e.g. weapon) that...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
4.1: Will ask permission before firing								
Strongly Disagree (1)	0	3	1	2	1			
Disagree (2)	6	7	4	0	2			
Neither Agree not Disagree (3)	4	14	3	4	5			
Agree (4)	15	19	8	5	3			
Strongly Agree (5)	9	10	1	6	1			
	3.79 (34)	3.49 (53)	3.24 (17)	3.76 (17)	3.08 (12)	3.53	133	
4.2: Will fire automatically at threatening stationary or moving targets								
Strongly Disagree (1)	7	12	2	2	1			
Disagree (2)	6	10	2	4	3			
Neither Agree not Disagree (3)	3	7	3	2	3			
Agree (4)	14	15	9	5	4			
Strongly Agree (5)	4	9	1	4	1			
	3.06 (34)	2.98 (53)	3.29 (17)	3.29 (17)	3.08 (12)	3.09	133	
						<i>answered question</i>	133	
						<i>skipped question</i>	3	

Appendix B.1

Table B.1.5

Classification of Company - Question 5								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
5.1: A ground vehicle that responds to voice commands (e.g. tank, car)								
Strongly Disagree (1)	1	3	1	1	1			
Disagree (2)	3	10	3	0	1			
Neither Agree not Disagree (3)	6	4	5	4	2			
Agree (4)	17	27	7	6	6			
Strongly Agree (5)	7	10	1	6	2			
	3.76 (34)	3.57 (54)	3.24 (17)	3.94 (17)	3.58 (12)	3.63	134	
5.2: An aircraft that responds to voice commands (e.g. jet, helicopter)								
Strongly Disagree (1)	1	3	1	1	1			
Disagree (2)	6	12	5	3	1			
Neither Agree not Disagree (3)	6	3	5	5	2			
Agree (4)	15	27	5	4	6			
Strongly Agree (5)	6	9	1	4	2			
	3.56 (34)	3.50 (54)	3.00 (17)	3.41 (17)	3.58 (12)	3.45	134	
						<i>answered question</i>	134	
						<i>skipped question</i>	2	

Appendix B.1

Table B.1.6.1

Classification of Company - Question 6								
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
6.1: Perform surveillance military operations								
Strongly Disagree (1)	0	1	1	0	0			
Disagree (2)	1	2	1	1	0			
Neither Agree not Disagree (3)	0	1	1	0	3			
Agree (4)	19	25	8	7	5			
Strongly Agree (5)	14	26	6	10	3			
	4.35 (34)	4.33 (55)	4.00 (17)	4.44 (18)	4.00 (11)	4.28	135	
6.2: Perform reconnaissance military operations								
Strongly Disagree (1)	0	1	1	0	0			
Disagree (2)	3	7	1	0	0			
Neither Agree not Disagree (3)	2	4	1	2	3			
Agree (4)	16	18	8	6	6			
Strongly Agree (5)	13	24	6	10	2			
	4.15 (34)	4.06 (54)	4.00 (17)	4.44 (18)	3.91 (11)	4.11	134	
6.3: Perform bomb disposal military operations								
Strongly Disagree (1)	0	2	0	0	1			
Disagree (2)	3	4	0	0	0			
Neither Agree not Disagree (3)	3	3	0	2	2			
Agree (4)	9	18	12	9	6			
Strongly Agree (5)	19	28	5	7	2			
	4.29 (34)	4.20 (55)	4.29 (17)	4.28 (18)	3.73 (11)	4.21	135	
6.4: Perform defense military operations								
Strongly Disagree (1)	1	1	0	0	1			
Disagree (2)	3	10	3	2	1			
Neither Agree not Disagree (3)	7	11	4	6	4			
Agree (4)	14	20	8	7	3			
Strongly Agree (5)	9	13	2	3	2			
	3.79 (34)	3.62 (55)	3.53 (17)	3.61 (18)	3.36 (11)	3.63	135	
6.5: Recognize friend from foe								
Strongly Disagree (1)	4	18	5	3	4			
Disagree (2)	14	17	5	7	2			
Neither Agree not Disagree (3)	6	7	4	5	5			
Agree (4)	10	6	3	2	0			
Strongly Agree (5)	0	7	0	0	0			
	2.65 (34)	2.40 (55)	2.29 (17)	2.35 (17)	2.09 (11)	2.42	134	

Appendix B.1

Table B.1.6.2

Classification of Company - Question 6								
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
6.6: Carry a defense mechanism properly (e.g. weapon without misuse or misfire)								
Strongly Disagree (1)	1	1	1	0	2			
Disagree (2)	3	9	3	0	4			
Neither Agree not Disagree (3)	6	9	2	8	1			
Agree (4)	16	23	10	6	3			
Strongly Agree (5)	8	14	1	4	1			
	3.79 (34)	3.73 (55)	3.41 (17)	3.78 (18)	2.73 (11)	3.63	135	
6.7: Use lethal force with permission of a human								
Strongly Disagree (1)	3	5	3	1	2			
Disagree (2)	4	8	2	2	2			
Neither Agree not Disagree (3)	5	4	3	1	2			
Agree (4)	14	25	7	9	5			
Strongly Agree (5)	8	13	2	5	0			
	3.59 (34)	3.60 (55)	3.18 (17)	3.83 (18)	2.91 (11)	3.52	135	
						<i>answered question</i>	135	
						<i>skipped question</i>	1	

Appendix B.1

Table B.1.7.1

Classification of Company - Question 7								
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
7.1: Perform surveillance military operations								
Strongly Disagree (1)	0	3	1	1	1			
Disagree (2)	2	3	2	0	1			
Neither Agree not Disagree (3)	1	3	0	0	3			
Agree (4)	16	22	8	7	5			
Strongly Agree (5)	15	23	6	10	2			
	4.29 (34)	4.09 (54)	3.94 (17)	4.39 (18)	3.73 (11)	4.13	134	
7.2: Perform reconnaissance military operations								
Strongly Disagree (1)	0	3	1	1	0			
Disagree (2)	5	7	2	0	2			
Neither Agree not Disagree (3)	4	5	1	2	3			
Agree (4)	12	17	7	5	4			
Strongly Agree (5)	13	22	6	10	2			
	3.97 (34)	3.89 (54)	3.88 (17)	4.28 (18)	3.55 (11)	3.93	134	
7.3: Perform bomb disposal military operations								
Strongly Disagree (1)	1	3	1	2	2			
Disagree (2)	6	13	6	3	1			
Neither Agree not Disagree (3)	3	3	1	0	2			
Agree (4)	11	17	6	7	4			
Strongly Agree (5)	13	18	3	5	2			
	3.85 (34)	3.63 (54)	3.24 (17)	3.59 (17)	3.27 (11)	3.60	133	
7.4: Perform defense military operations								
Strongly Disagree (1)	1	5	2	3	1			
Disagree (2)	6	15	5	2	1			
Neither Agree not Disagree (3)	8	4	3	6	4			
Agree (4)	11	18	5	3	4			
Strongly Agree (5)	8	12	2	4	1			
	3.56 (34)	3.31 (54)	3.00 (17)	3.17 (18)	3.27 (11)	3.31	134	
7.5: Fly an aircraft (e.g. Jet or airplane)								
Strongly Disagree (1)	0	3	2	3	1			
Disagree (2)	9	8	5	3	1			
Neither Agree not Disagree (3)	3	7	0	5	2			
Agree (4)	14	20	9	1	1			
Strongly Agree (5)	8	16	1	6	0			
	3.62 (34)	3.70 (54)	3.12 (17)	3.22 (18)	3.36 (11)	3.51	134	

Appendix B.1

Table B.1.7.2

Classification of Company - Question 7								
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
7.6: Guard a facility assuming it could recognize friend from foe								
Strongly Disagree (1)	0	7	4	3	2			
Disagree (2)	9	9	4	2	3			
Neither Agree not Disagree (3)	6	4	0	2	4			
Agree (4)	11	24	8	8	2			
Strongly Agree (5)	8	10	1	3	0			
	3.53 (34)	3.39 (54)	2.88 (17)	3.33 (18)	2.55 (11)	3.28	134	
7.7: Defend itself with weapons without using lethal force								
Strongly Disagree (1)	1	1	4	2	2			
Disagree (2)	4	10	3	4	2			
Neither Agree not Disagree (3)	8	6	3	1	3			
Agree (4)	14	25	4	8	4			
Strongly Agree (5)	7	11	3	3	0			
	3.65 (34)	3.66 (53)	2.94 (17)	3.33 (18)	2.82 (11)	3.45	133	
7.8: Detect and dispose of explosives								
Strongly Disagree (1)	0	1	1	2	1			
Disagree (2)	1	7	1	1	1			
Neither Agree not Disagree (3)	3	4	3	1	2			
Agree (4)	15	23	10	6	0			
Strongly Agree (5)	15	18	2	7	2			
	4.29 (34)	3.94 (53)	3.65 (17)	3.88 (17)	3.55 (11)	3.95	132	
7.9: Use lethal force								
Strongly Disagree (1)	4	13	5	8	4			
Disagree (2)	13	15	4	4	2			
Neither Agree not Disagree (3)	4	5	4	5	3			
Agree (4)	8	12	2	1	1			
Strongly Agree (5)	5	9	2	0	1			
	2.91 (34)	2.80 (54)	2.53 (17)	1.94 (18)	2.36 (11)	2.64	134	
						<i>answered question</i>	134	
						<i>skipped question</i>	2	

Appendix B.1

Table B.1.8

Classification of Company - Question 8								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Execution of Operations:								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
8.1: Only humans should perform surveillance military operations								
Strongly Disagree (1)	6	19	3	5	2			
Disagree (2)	19	26	11	9	3			
Neither Agree not Disagree (3)	4	7	1	2	6			
Agree (4)	2	2	0	2	0			
Strongly Agree (5)	1	0	2	0	0			
	2.16 (32)	1.85 (54)	2.24 (17)	2.06 (18)	2.36 (11)	2.05	132	
8.2: Only humans should perform reconnaissance military operations								
Strongly Disagree (1)	6	20	3	6	2			
Disagree (2)	18	20	11	8	2			
Neither Agree not Disagree (3)	3	7	1	4	6			
Agree (4)	4	6	0	0	0			
Strongly Agree (5)	1	1	2	0	1			
	2.25 (32)	2.04 (54)	2.24 (17)	1.89 (18)	2.64 (11)	2.14	132	
8.3: Only humans should perform bomb disposal military operations								
Strongly Disagree (1)	10	28	6	5	3			
Disagree (2)	15	18	8	7	4			
Neither Agree not Disagree (3)	4	2	2	4	3			
Agree (4)	3	5	1	2	1			
Strongly Agree (5)	0	1	0	0	0			
	2.00 (32)	1.76 (54)	1.88 (17)	2.17 (18)	2.18 (11)	1.92	132	
8.4: Only humans should perform defense military operations								
Strongly Disagree (1)	5	13	1	2	2			
Disagree (2)	15	17	9	5	2			
Neither Agree not Disagree (3)	6	11	3	7	5			
Agree (4)	4	11	2	2	2			
Strongly Agree (5)	2	2	2	2	0			
	2.47 (32)	2.48 (54)	2.71 (17)	2.83 (18)	2.64 (11)	2.57	132	
8.5: Battlefield robots should look like humans								
Strongly Disagree (1)	12	20	5	8	2			
Disagree (2)	8	14	8	6	4			
Neither Agree not Disagree (3)	9	15	4	4	5			
Agree (4)	3	3	0	0	0			
Strongly Agree (5)	0	2	0	0	0			
	2.09 (32)	2.13 (54)	1.94 (17)	1.78 (18)	2.27 (11)	2.06	132	
						<i>answered question</i>	132	
						<i>skipped question</i>	4	

Appendix B.1

Table B.1.9

Classification of Company - Question 9								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Purpose of Robots: Robots should...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
9.1: Be a supplement for the military, not a replacement for soldiers								
Strongly Disagree (1)	0	2	1	1	0			
Disagree (2)	4	4	2	3	0			
Neither Agree not Disagree (3)	2	8	1	2	4			
Agree (4)	18	25	9	7	6			
Strongly Agree (5)	8	15	4	5	1			
	3.94 (32)	3.87 (54)	3.82 (17)	3.44 (18)	3.73 (11)	3.76	132	
9.2: Conduct military operations without the direct command of human soldiers								
Strongly Disagree (1)	5	10	5	4	2			
Disagree (2)	11	26	5	7	5			
Neither Agree not Disagree (3)	8	7	3	4	2			
Agree (4)	6	6	4	1	2			
Strongly Agree (5)	2	5	0	1	0			
	2.65 (32)	2.44 (54)	2.35 (17)	2.29 (17)	2.36 (11)	2.42	131	
9.3: Be used instead of human drivers for ground vehicles (e.g. convoy purposes)								
Strongly Disagree (1)	2	4	1	1	0			
Disagree (2)	6	9	4	4	0			
Neither Agree not Disagree (3)	7	9	2	3	4			
Agree (4)	11	25	6	6	5			
Strongly Agree (5)	6	6	4	4	2			
	3.40 (32)	3.38 (53)	3.47 (17)	3.44 (18)	3.82 (11)	3.50	131	
9.4: Be used instead of human pilots for aircraft (e.g. supply drops)								
Strongly Disagree (1)	3	3	1	1	0			
Disagree (2)	5	8	4	4	0			
Neither Agree not Disagree (3)	8	15	4	7	0			
Agree (4)	11	22	4	4	6			
Strongly Agree (5)	5	6	4	2	1			
	3.31 (32)	3.37 (53)	3.35 (17)	3.11 (18)	3.73 (11)	3.37	132	
9.5: Be used instead of soldiers on the battlefield whenever possible								
Strongly Disagree (1)	1	5	2	3	0			
Disagree (2)	11	10	2	3	0			
Neither Agree not Disagree (3)	8	15	7	5	1			
Agree (4)	6	15	2	4	2			
Strongly Agree (5)	6	9	4	3	3			
	3.16 (32)	3.24 (54)	3.24 (17)	3.05 (18)	3.73 (11)	3.28	132	
						<i>answered question</i>	132	
						<i>skipped question</i>	4	

Appendix B.1

Table B.1.10

Classification of Company - Question 10								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Ethics:								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
10.1: The safety provided to soldiers by the use of robots is worth the potential loss of the soldiers' expertise								
Strongly Disagree (1)	2	4	1	2	0			
Disagree (2)	7	9	4	3	0			
Neither Agree not Disagree (3)	7	15	4	5	1			
Agree (4)	13	23	5	5	2			
Strongly Agree (5)	4	3	3	3	2			
	3.30 (33)	3.22 (54)	3.29 (17)	3.22 (18)	3.50 (10)	3.31	132	
10.2: Robots designed for use during combat is against the rules of warfare								
Strongly Disagree (1)	12	18	4	5	1			
Disagree (2)	7	16	8	7	2			
Neither Agree not Disagree (3)	10	16	3	3	5			
Agree (4)	4	3	2	1	2			
Strongly Agree (5)	0	1	0	2	0			
	2.18 (33)	2.13 (54)	2.18 (17)	2.33 (18)	2.80 (10)	2.32	132	
10.3: Robots designed for use during combat is unethical								
Strongly Disagree (1)	10	16	6	5	2			
Disagree (2)	12	19	6	5	3			
Neither Agree not Disagree (3)	9	10	1	4	4			
Agree (4)	2	8	1	1	1			
Strongly Agree (5)	0	1	3	3	0			
	2.09 (33)	2.24 (54)	2.35 (17)	2.56 (18)	2.40 (10)	2.34	132	
						<i>answered question</i>	132	
						<i>skipped question</i>	4	

Appendix B.1

Table B.1.11.1

Classification of Company - Question 11								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
11.1: Replace human security guards if able to assume friend from foe, spot an intrusion, alert proper authorities, but take no further action								
Strongly Disagree (1)	1	4	2	0	1			
Disagree (2)	7	4	3	2	3			
Neither Agree not Disagree (3)	5	10	1	3	3			
Agree (4)	14	27	7	10	3			
Strongly Agree (5)	6	9	4	3	1			
	3.52 (33)	3.61 (54)	3.47 (17)	3.78 (18)	3.00 (11)	3.54	133	
11.2: Accompany human security guards but not have the ability to operate autonomously (i.e. without the permission of a human security guard)								
Strongly Disagree (1)	0	2	1	0	0			
Disagree (2)	6	10	2	0	1			
Neither Agree not Disagree (3)	2	16	5	5	3			
Agree (4)	19	21	4	8	7			
Strongly Agree (5)	6	5	5	5	0			
	3.76 (33)	3.31 (54)	3.59 (17)	4.00 (18)	3.55 (11)	3.57	133	
11.3: Operate without human control, but should be supervised by human security guards								
Strongly Disagree (1)	1	3	2	0	0			
Disagree (2)	3	13	5	3	1			
Neither Agree not Disagree (3)	5	8	3	5	3			
Agree (4)	21	23	5	8	7			
Strongly Agree (5)	3	7	2	2	0			
	3.67 (33)	3.33 (54)	3.00 (17)	3.50 (18)	3.55 (11)	3.41	133	
11.4: Be able to defend themselves without using lethal force if necessary against intruders assuming it can recognize friend from foe								
Strongly Disagree (1)	0	0	1	3	0			
Disagree (2)	4	4	7	0	4			
Neither Agree not Disagree (3)	3	10	3	5	2			
Agree (4)	17	31	5	5	0			
Strongly Agree (5)	8	9	1	5	1			
	3.91 (32)	3.83 (54)	2.88 (17)	3.50 (18)	3.18 (11)	3.63	132	
11.5: Only be used in conjunction with human security guards								
Strongly Disagree (1)	0	3	0	0	0			
Disagree (2)	6	9	2	2	1			
Neither Agree not Disagree (3)	8	18	5	5	3			
Agree (4)	17	15	9	7	1			
Strongly Agree (5)	2	9	1	4	0			
	3.45 (33)	3.33 (54)	3.53 (17)	3.72 (18)	3.55 (11)	3.46	133	

Appendix B.1

Table B.1.11.2

Classification of Company - Question 11								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
11.6: Be used to hold stationary guard positions and use lethal force if necessary without the permission of a human soldier								
Strongly Disagree (1)	10	16	5	8	5			
Disagree (2)	14	19	8	5	2			
Neither Agree not Disagree (3)	5	9	0	3	3			
Agree (4)	4	6	4	2	1			
Strongly Agree (5)	0	4	0	0	0			
	2.09 (33)	2.31 (54)	2.18 (17)	1.94 (18)	2.00 (11)	2.17	133	
11.7: Be allowed to hold stationary guard positions, but only be allowed to use lethal force to defend a territory if granted permission by a human soldier								
Strongly Disagree (1)	3	4	3	1	0			
Disagree (2)	6	9	1	2	2			
Neither Agree not Disagree (3)	6	7	3	4	3			
Agree (4)	13	23	7	5	1			
Strongly Agree (5)	5	10	3	6	0			
	3.33 (33)	3.49 (53)	3.35 (17)	3.72 (18)	3.36 (11)	3.45	132	
						<i>answered question</i>	133	
						<i>skipped question</i>	3	

Appendix B.1

Table B.1.12

Classification of Company - Question 12								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Reconnaissance: Robots should...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
12.1: Accompany a platoon as they explore territory								
Strongly Disagree (1)	0	0	1	0	0			
Disagree (2)	1	2	0	0	0			
Neither Agree not Disagree (3)	6	2	2	1	5			
Agree (4)	14	33	10	11	0			
Strongly Agree (5)	13	16	4	6	2			
	4.15 (34)	4.19 (53)	3.94 (17)	4.28 (18)	3.73 (11)	4.12	133	
12.2: Explore territory without human control								
Strongly Disagree (1)	0	1	2	1	0			
Disagree (2)	3	4	1	1	0			
Neither Agree not Disagree (3)	5	7	1	1	1			
Agree (4)	15	26	10	12	2			
Strongly Agree (5)	11	15	3	3	1			
	4.00 (34)	3.94 (53)	3.65 (17)	3.83 (18)	3.36 (11)	3.86	133	
12.3: Be able to defend themselves without using lethal force against attackers if necessary								
Strongly Disagree (1)	0	2	1	2	0			
Disagree (2)	3	2	3	2	0			
Neither Agree not Disagree (3)	4	14	3	4	0			
Agree (4)	20	24	8	7	0			
Strongly Agree (5)	0	10	2	3	0			
	3.91 (34)	3.73 (52)	3.41 (17)	3.39 (18)	3.27 (11)	3.65	132	
						<i>answered question</i>	133	
						<i>skipped question</i>	3	

Appendix B.1

Table B.1.13

Classification of Company - Question 13								
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Bombs: Robots with the ability to handle (i.e. find and disengage) bombs should...								
	What is the classification of the company you are employed by?							
Answer Options	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say	Rating Average	Response Count	
13.1: Be under the constant surveillance of a human soldier								
Strongly Disagree (1)	0	3	0	1	1			
Disagree (2)	7	14	2	4	1			
Neither Agree not Disagree (3)	8	9	5	3	3			
Agree (4)	15	23	5	7	5			
Strongly Agree (5)	3	4	5	3	1			
	3.42 (33)	3.21 (53)	3.76 (17)	3.39 (18)	3.36 (11)	3.37	132	
13.2: Be allowed to find bombs, but only be allowed to proceed with disengage the bomb with the permission of a human								
Strongly Disagree (1)	0	2	0	2	1			
Disagree (2)	6	7	2	1	1			
Neither Agree not Disagree (3)	4	14	0	3	2			
Agree (4)	20	21	13	8	5			
Strongly Agree (5)	3	9	2	4	2			
	3.61 (33)	3.53 (53)	3.88 (17)	3.61 (18)	3.55 (11)	3.61	132	
13.3: Be allowed to set down, find and disengage explosives without direct human control								
Strongly Disagree (1)	1	2	2	2	2			
Disagree (2)	7	17	6	4	2			
Neither Agree not Disagree (3)	4	13	5	5	2			
Agree (4)	18	13	3	5	3			
Strongly Agree (5)	24	7	1	2	2			
	3.15 (33)	3.12 (52)	2.71 (17)	3.06 (18)	3.09 (11)	3.06	131	
						<i>answered question</i>	132	
						<i>skipped question</i>	4	

Appendix B.2

Table B.2.1

Classification of Company - Question 18							
Are you?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Male	24	39	15	11	5	69.6%	94
Female	9	16	2	7	5	28.9%	39
Would rather not say	0	0	0	0	2	1.5%	2
<i>answered question</i>							135
<i>skipped question</i>							1

Table B.2.2

Classification of Company - Question 19							
What is your age?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Under 18	0	0	0	0	1	0.7%	1
18-24	27	33	4	16	8	64.7%	88
25-34	3	13	5	1	0	16.2%	22
35-44	3	1	1	1	1	5.1%	7
45-54	1	7	4	0	0	8.8%	12
55-64	0	1	1	0	1	2.2%	3
65 or older	0	0	1	0	0	0.7%	1
Would rather not say	0	0	1	0	1	1.5%	2
<i>answered question</i>							136
<i>skipped question</i>							0

Appendix B.2

Table B.2.3

Classification of Company - Question 20							
What is the highest level of education you have completed?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Less than high school	0	0	0	0	0	0.0%	0
High School/ Vocational School	7	4	0	3	0	10.4%	14
Some College	17	25	3	13	6	47.4%	64
Associate's Degree	0	1	0	0	0	0.7%	1
Bachelor's Degree	6	11	3	2	3	18.5%	25
Master's Degree	6	12	5	0	1	17.8%	24
Doctoral Degree	0	3	5	1	1	7.4%	10
Professional Degree	0	0	0	0	0	0.0%	0
Would rather not say	0	0	0	0	1	0.7%	1
<i>answered question</i>							135
<i>skipped question</i>							1

Appendix B.2

Table B.2.4

Classification of Company - Question 23							
What is the classification of the company you are employed by?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Public Sector	34	0	0	0	0	25.0%	34
Private Sector	0	55	0	0	0	40.4%	55
Not-for-Profit	0	0	17	0	0	12.5%	17
Don't Know	0	0	0	0	0	0.0%	0
Other	0	0	0	18	0	13.2%	18
Not Employed	0	0	0	0	0	0.0%	0
Would rather not say	0	0	0	0	12	8.8%	12
<i>answered question</i>							136
<i>skipped question</i>							0

Table B.2.5

Classification of Company - Question 25							
Do you consider yourself?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Democrat	6	14	6	4	6	27.1%	36
Republican	9	11	0	3	0	17.3%	23
Independent	15	23	20	8	3	44.4%	59
Other	3	7	1	2	2	11.3%	15
<i>answered question</i>							133
<i>skipped question</i>							3

Table B.2.6

Classification of Company - Classification of Company - Question 26							
What is your experience, if any, with the military?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Active Duty	3	0	1	1	0	3.8%	5
Retired	0	3	0	0	0	2.3%	3
Reserve	0	0	0	0	0	0.0%	0
ROTC	5	3	0	1	0	6.8%	9
Other	2	8	2	1	2	11.3%	15
None	24	40	14	15	8	75.9%	101
<i>answered question</i>							133
<i>skipped question</i>							3

Appendix B.2

Table B.2.7

Classification of Company - Question 27							
How would you rate your familiarity and knowledge of...?							
Answer Options	What is the classification of the company you are					Rating Average	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Military							
Very unfamiliar and knowledgeable	1	1	0	0	2		
Somewhat unfamiliar and knowledgeable	1	5	1	3	3		
Neither familiar or unfamiliar	7	13	7	5	2		
Somewhat familiar and knowledgeable	12	26	8	4	2		
Very familiar and knowledgeable	12	10	1	5	1		
	4.00 (33)	3.71 (55)	3.53 (17)	3.65 (17)	2.70 (10)	3.67	132
Robotics							
Very unfamiliar and knowledgeable	2	3	1	0	2		
Somewhat unfamiliar and knowledgeable	7	4	1	1	1		
Neither familiar or unfamiliar	8	17	5	8	1		
Somewhat familiar and knowledgeable	12	23	8	5	4		
Very familiar and knowledgeable	8	4	1	3	1		
	3.59 (34)	3.33 (54)	3.44 (16)	3.59 (17)	3.11 (9)	3.43	130
<i>answered question</i>							133
<i>skipped question</i>							3

Table B.2.8

Classification of Company - Question 28							
What is your experience, if any, with robotics?							
Answer Options	What is the classification of the company you are					Response Frequency	Response Count
	Public Sector	Private Sector	Not-for-Profit	Other	Would rather not say		
Robotics related major	6	7	0	3	1	13.1%	17
FIRST	10	8	1	2	3	18.5%	24
Job related to robotics	6	8	2	3	0	14.6%	19
Teaching position	3	2	2	1	0	6.2%	8
Other	14	21	8	7	1	39.2%	51
None	11	23	7	8	5	41.5%	54
<i>answered question</i>							130
<i>skipped question</i>							6

Appendix C.1

Table C.1.1

Gender - Question 1					
Informed Consent Agreement for Participation in a Research Study					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
I do NOT consent to participate in this study	0	0	0	0.0%	0
I do consent to participate in this study	203	131	5	100.0%	339
<i>answered question</i>					339
<i>skipped question</i>					0

Appendix C.1

Table C.1.2

Gender - Question 2					
Please use the definition posted below to answer the following questions. Robot: any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner (Encyclopedia Britannica). Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). A robot is defined as an automated...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
2.1: Ground vehicle that navigates around obstacles to a given location (e.g. Tank, car)					
Strongly Disagree (1)	9	6	0	4.10	335
Disagree (2)	11	7	0		
Neither Agree not Disagree (3)	15	10	0		
Agree (4)	69	67	3		
Strongly Agree (5)	97	39	2		
	4.16 (201)	3.98 (129)	4.40 (5)		
2.2: Ground vehicle that can fire a weapon on command (e.g. Tank, car)					
Strongly Disagree (1)	20	4	1	3.62	335
Disagree (2)	23	19	0		
Neither Agree not Disagree (3)	32	15	0		
Agree (4)	72	66	3		
Strongly Agree (5)	54	25	1		
	3.58 (201)	3.69 (129)	3.60 (5)		
2.3: Aircraft that can fire a weapon on command (e.g. Jet, helicopter)					
Strongly Disagree (1)	20	3	1	3.53	335
Disagree (2)	31	26	0		
Neither Agree not Disagree (3)	30	17	0		
Agree (4)	68	60	3		
Strongly Agree (5)	52	23	1		
	3.50 (201)	3.57 (129)	3.60 (5)		
2.4: Defense mechanism (e.g. missile, torpedo)					
Strongly Disagree (1)	20	10	2	3.16	334
Disagree (2)	50	34	1		
Neither Agree not Disagree (3)	41	28	0		
Agree (4)	52	40	1		
Strongly Agree (5)	37	17	1		
	3.18 (200)	3.16 (129)	2.60 (5)		
<i>answered question</i>					335
<i>skipped question</i>					4

Appendix C.1

Table C.1.3

Gender - Question 3					
Please use the definition posted below to answer the following questions. Remote Controlled: The control of an activity, process, or machine from a distance, as by radioed instructions or coded signals (The American Heritage Dictionary) A robot is defined as a remote controlled...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
3.1: Ground vehicle (e.g. tank, car)					
Strongly Disagree (1)	11	5	0		
Disagree (2)	25	12	1		
Neither Agree not Disagree (3)	20	17	1		
Agree (4)	87	65	2		
Strongly Agree (5)	57	31	1		
	3.77 (200)	3.81 (130)	3.60 (5)	3.78	335
3.2: Aircraft (e.g. jet, helicopter)					
Strongly Disagree (1)	11	4	0		
Disagree (2)	25	21	0		
Neither Agree not Disagree (3)	20	22	2		
Agree (4)	90	55	2		
Strongly Agree (5)	54	28	1		
	3.76 (200)	3.63 (130)	3.80 (5)	3.71	335
3.3: Device that can pick up or close around objects (e.g. mechanical claw)					
Strongly Disagree (1)	10	5	0		
Disagree (2)	16	3	0		
Neither Agree not Disagree (3)	21	9	1		
Agree (4)	84	66	1		
Strongly Agree (5)	69	47	3		
	3.93 (200)	4.13 (130)	4.40 (5)	4.01	335
<i>answered question</i>					335
<i>skipped question</i>					4

Appendix C.1

Table C.1.4

Gender - Question 4						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a defense mechanism (e.g. weapon) that...						
Answer Options	Are you?			Rating Average	Response Count	
	Male	Female	Would rather not say			
4.1: Will ask permission before firing						
Strongly Disagree (1)	6	5	1			
Disagree (2)	28	23	0			
Neither Agree not Disagree (3)	45	22	2			
Agree (4)	74	52	1			
Strongly Agree (5)	46	27	1			
	3.63 (199)	3.57 (129)	3.20 (5)	3.60	333	
4.2: Will fire automatically at threatening stationary or moving targets						
Strongly Disagree (1)	29	17	1			
Disagree (2)	29	32	1			
Neither Agree not Disagree (3)	32	17	0			
Agree (4)	70	47	2			
Strongly Agree (5)	39	16	1			
	3.31 (199)	3.10 (129)	3.20 (5)	3.23	333	
					<i>answered question</i>	334
					<i>skipped question</i>	5

Appendix C.1

Table C.1.5

Gender - Question 5					
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
5.1: A ground vehicle that responds to voice commands (e.g. tank, car)					
Strongly Disagree (1)	8	3	0		
Disagree (2)	23	11	1		
Neither Agree not Disagree (3)	38	13	0		
Agree (4)	87	85	3		
Strongly Agree (5)	44	18	1		
	3.68 (200)	3.80 (130)	3.80 (5)	3.73	335
5.2: An aircraft that responds to voice commands (e.g. jet, helicopter)					
Strongly Disagree (1)	9	4	0		
Disagree (2)	32	13	1		
Neither Agree not Disagree (3)	37	19	0		
Agree (4)	82	78	3		
Strongly Agree (5)	40	16	1		
	3.56 (200)	3.68 (130)	3.80 (5)	3.61	335
<i>answered question</i>					335
<i>skipped question</i>					4

Appendix C.1

Table C.1.6.1

Gender - Question 6					
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
6.1: Perform surveillance military operations					
Strongly Disagree (1)	3	4	0		
Disagree (2)	6	8	0		
Neither Agree not Disagree (3)	14	10	1		
Agree (4)	82	76	2		
Strongly Agree (5)	96	32	2		
	4.30 (201)	3.95 (130)	4.20 (5)	4.17	336
6.2: Perform reconnaissance military operations					
Strongly Disagree (1)	3	3	0		
Disagree (2)	11	14	1		
Neither Agree not Disagree (3)	14	23	2		
Agree (4)	76	67	1		
Strongly Agree (5)	96	22	1		
	4.26 (200)	3.71 (129)	3.40 (5)	4.03	334
6.3: Perform bomb disposal military operations					
Strongly Disagree (1)	1	5	0		
Disagree (2)	6	18	1		
Neither Agree not Disagree (3)	14	11	0		
Agree (4)	76	56	3		
Strongly Agree (5)	103	39	1		
	4.37 (200)	3.82 (129)	3.80 (5)	4.15	334
6.4: Perform defense military operations					
Strongly Disagree (1)	5	4	1		
Disagree (2)	19	23	0		
Neither Agree not Disagree (3)	41	25	2		
Agree (4)	91	64	2		
Strongly Agree (5)	44	14	0		
	3.75 (200)	3.47 (130)	3.00 (5)	3.63	335
6.5: Recognize friend from foe					
Strongly Disagree (1)	35	30	2		
Disagree (2)	64	65	2		
Neither Agree not Disagree (3)	47	21	1		
Agree (4)	40	9	0		
Strongly Agree (5)	14	4	0		
	2.67 (200)	2.16 (129)	1.80 (5)	2.46	334

Appendix C.1

Table C.1.6.2

Gender - Question 6					
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
6.6: Carry a defense mechanism properly (e.g. weapon without misuse or misfire)					
Strongly Disagree (1)	8	4	1		
Disagree (2)	21	18	1		
Neither Agree not Disagree (3)	38	27	1		
Agree (4)	93	59	2		
Strongly Agree (5)	41	22	0		
	3.69 (201)	3.59 (130)	2.80 (5)	3.64	336
6.7: Use lethal force with permission of a human					
Strongly Disagree (1)	25	5	1		
Disagree (2)	19	20	2		
Neither Agree not Disagree (3)	28	23	0		
Agree (4)	85	65	1		
Strongly Agree (5)	44	17	1		
	3.52 (201)	3.53 (130)	2.80 (5)	3.51	336
<i>answered question</i>					336
<i>skipped question</i>					3

Appendix C.1

Table C.1.7.1

Gender - Question 7					
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
7.1: Perform surveillance military operations					
Strongly Disagree (1)	6	7	0		
Disagree (2)	10	11	0		
Neither Agree not Disagree (3)	13	11	1		
Agree (4)	83	73	2		
Strongly Agree (5)	88	27	2		
	4.19 (200)	3.79 (129)	4.20 (5)	4.03	334
7.2: Perform reconnaissance military operations					
Strongly Disagree (1)	8	6	0		
Disagree (2)	14	24	1		
Neither Agree not Disagree (3)	19	26	2		
Agree (4)	76	55	1		
Strongly Agree (5)	83	17	1		
	4.06 (200)	3.41 (128)	3.40 (5)	3.80	333
7.3: Perform bomb disposal military operations					
Strongly Disagree (1)	9	11	0		
Disagree (2)	25	27	1		
Neither Agree not Disagree (3)	24	17	0		
Agree (4)	77	49	3		
Strongly Agree (5)	64	23	1		
	3.81 (199)	3.36 (127)	3.80 (5)	3.64	331
7.4: Perform defense military operations					
Strongly Disagree (1)	12	12	1		
Disagree (2)	38	29	0		
Neither Agree not Disagree (3)	39	23	1		
Agree (4)	72	52	3		
Strongly Agree (5)	39	12	0		
	3.44 (200)	3.18 (128)	3.20 (5)	3.34	333
7.5: Fly an aircraft (e.g. Jet or airplane)					
Strongly Disagree (1)	11	6	0		
Disagree (2)	25	29	1		
Neither Agree not Disagree (3)	32	31	0		
Agree (4)	85	46	3		
Strongly Agree (5)	46	16	1		
	3.65 (199)	3.29 (128)	3.80 (5)	3.52	332

Appendix C.1

Table C.1.7.2

Gender - Question 7					
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
7.6: Guard a facility assuming it could recognize friend from foe					
Strongly Disagree (1)	16	23	1		
Disagree (2)	30	33	2		
Neither Agree not Disagree (3)	36	16	0		
Agree (4)	76	50	1		
Strongly Agree (5)	41	7	1		
	3.48 (199)	2.88 (129)	2.80 (5)	3.24	333
7.7: Defend itself with weapons without using lethal force					
Strongly Disagree (1)	15	11	2		
Disagree (2)	25	27	0		
Neither Agree not Disagree (3)	37	16	0		
Agree (4)	85	63	3		
Strongly Agree (5)	37	12	0		
	3.52 (199)	3.29 (129)	2.80 (5)	3.42	333
7.8: Detect and dispose of explosives					
Strongly Disagree (1)	4	4	0		
Disagree (2)	9	14	1		
Neither Agree not Disagree (3)	24	17	0		
Agree (4)	93	63	3		
Strongly Agree (5)	68	30	1		
	4.07 (198)	3.79 (128)	3.80 (5)	3.96	331
7.9: Use lethal force					
Strongly Disagree (1)	49	34	3		
Disagree (2)	46	43	1		
Neither Agree not Disagree (3)	42	19	0		
Agree (4)	43	25	1		
Strongly Agree (5)	19	8	0		
	2.68 (199)	2.46 (129)	1.80 (5)	2.58	333
<i>answered question</i>					334
<i>skipped question</i>					5

Appendix C.1

Table C.1.8

Gender - Question 8						
Please answer the following questions by selecting the number on the scale that best corresponds to your response.						
Execution of Operations:						
Answer Options	Are you?			Rating Average	Response Count	
	Male	Female	Would rather not say			
8.1: Only humans should perform surveillance military operations						
Strongly Disagree (1)	62	14	0			
Disagree (2)	97	80	3			
Neither Agree not Disagree (3)	28	26	2			
Agree (4)	6	8	0			
Strongly Agree (5)	4	2	0			
	1.95 (197)	2.26 (130)	2.40 (5)	2.08	332	
8.2: Only humans should perform reconnaissance military operations						
Strongly Disagree (1)	62	10	0			
Disagree (2)	88	67	1			
Neither Agree not Disagree (3)	30	31	3			
Agree (4)	12	13	0			
Strongly Agree (5)	5	7	1			
	2.04 (197)	2.53 (128)	3.20 (5)	2.25	330	
8.3: Only humans should perform bomb disposal military operations						
Strongly Disagree (1)	82	26	2			
Disagree (2)	76	70	1			
Neither Agree not Disagree (3)	27	15	1			
Agree (4)	10	15	1			
Strongly Agree (5)	2	4	0			
	1.85 (197)	2.24 (130)	2.20 (5)	2.01	332	
8.4: Only humans should perform defense military operations						
Strongly Disagree (1)	35	6	0			
Disagree (2)	79	58	1			
Neither Agree not Disagree (3)	47	27	3			
Agree (4)	24	32	0			
Strongly Agree (5)	12	7	1			
	2.49 (197)	2.82 (130)	3.20 (5)	2.63	332	
8.5: Battlefield robots should look like humans						
Strongly Disagree (1)	74	32	2			
Disagree (2)	54	48	0			
Neither Agree not Disagree (3)	62	36	3			
Agree (4)	5	10	0			
Strongly Agree (5)	2	4	0			
	2.02 (197)	2.28 (130)	2.20 (5)	2.12	332	
					<i>answered question</i>	332
					<i>skipped question</i>	7

Appendix C.1

Table C.1.9

Gender - Question 9						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Purpose of Robots: Robots should...						
Answer Options	Are you?			Rating Average	Response Count	
	Male	Female	Would rather not say			
9.1: Be a supplement for the military, not a replacement for soldiers						
Strongly Disagree (1)	10	4	0			
Disagree (2)	22	5	1			
Neither Agree not Disagree (3)	35	10	1			
Agree (4)	80	75	2			
Strongly Agree (5)	51	37	1			
	3.71 (198)	4.04 (131)	3.60 (5)	3.78	334	
9.2: Conduct military operations without the direct command of human soldiers						
Strongly Disagree (1)	37	35	1			
Disagree (2)	65	52	2			
Neither Agree not Disagree (3)	46	27	0			
Agree (4)	38	14	2			
Strongly Agree (5)	11	3	0			
	2.60 (197)	2.22 (131)	2.60 (5)	2.47	333	
9.3: Be used instead of human drivers for ground vehicles (e.g. convoy purposes)						
Strongly Disagree (1)	10	5	1			
Disagree (2)	27	18	0			
Neither Agree not Disagree (3)	38	36	1			
Agree (4)	86	58	3			
Strongly Agree (5)	36	14	0			
	3.56 (197)	3.44 (131)	3.20 (5)	3.40	333	
9.4: Be used instead of human pilots for aircraft (e.g. supply drops)						
Strongly Disagree (1)	11	7	0			
Disagree (2)	30	27	0			
Neither Agree not Disagree (3)	47	41	2			
Agree (4)	79	49	3			
Strongly Agree (5)	31	6	0			
	3.45 (198)	3.15 (130)	3.60 (5)	3.40	333	
9.5: Be used instead of soldiers on the battlefield whenever possible						
Strongly Disagree (1)	14	10	1			
Disagree (2)	29	26	0			
Neither Agree not Disagree (3)	62	39	1			
Agree (4)	50	44	2			
Strongly Agree (5)	43	12	1			
	3.40 (198)	3.17 (131)	3.40 (5)	3.32	334	
					<i>answered question</i>	334
					<i>skipped question</i>	5

Appendix C.1

Table C.1.10

Gender - Question 10						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Ethics:						
Answer Options	Are you?			Rating Average	Response Count	
	Male	Female	Would rather not say			
10.1: The safety provided to soldiers by the use of robots is worth the potential loss of the soldiers' expertise						
Strongly Disagree (1)	12	8	2			
Disagree (2)	41	30	0			
Neither Agree not Disagree (3)	50	43	2			
Agree (4)	69	40	1			
Strongly Agree (5)	25	9	0			
	3.27 (197)	3.09 (130)	2.40 (5)	2.92	332	
10.2: Robots designed for use during combat is against the rules of warfare						
Strongly Disagree (1)	68	20	1			
Disagree (2)	64	53	0			
Neither Agree not Disagree (3)	44	45	1			
Agree (4)	15	8	2			
Strongly Agree (5)	8	3	1			
	2.15 (199)	2.39 (129)	3.40 (5)	2.65	333	
10.3: Robots designed for use during combat is unethical						
Strongly Disagree (1)	75	20	1			
Disagree (2)	58	59	0			
Neither Agree not Disagree (3)	36	36	2			
Agree (4)	19	11	1			
Strongly Agree (5)	11	4	1			
	2.16 (199)	2.38 (130)	3.20 (5)	2.58	334	
					<i>answered question</i>	334
					<i>skipped question</i>	5

Appendix C.1

Table C.1.11.1

Gender - Question 11					
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
11.1: Replace human security guards if able to assume friend from foe, spot an intrusion, alert proper authorities, but take no further action					
Strongly Disagree (1)	10	10	0		
Disagree (2)	25	30	0		
Neither Agree not Disagree (3)	32	22	2		
Agree (4)	101	58	2		
Strongly Agree (5)	30	11	1		
	3.59 (198)	3.23 (131)	3.80 (5)	3.45	334
11.2: Accompany human security guards but not have the ability to operate autonomously (i.e. without the permission of a human security guard)					
Strongly Disagree (1)	7	2	0		
Disagree (2)	26	18	0		
Neither Agree not Disagree (3)	52	23	3		
Agree (4)	81	74	1		
Strongly Agree (5)	32	13	1		
	3.53 (198)	3.60 (130)	3.60 (5)	3.56	333
11.3: Operate without human control, but should be supervised by human security guards					
Strongly Disagree (1)	11	7	1		
Disagree (2)	25	31	0		
Neither Agree not Disagree (3)	46	29	2		
Agree (4)	91	59	2		
Strongly Agree (5)	25	5	0		
	3.47 (198)	3.18 (131)	3.00 (5)	3.35	334
11.4: Be able to defend themselves without using lethal force if necessary against intruders assuming it can recognize friend from foe					
Strongly Disagree (1)	7	6	1		
Disagree (2)	20	17	1		
Neither Agree not Disagree (3)	31	19	2		
Agree (4)	101	76	1		
Strongly Agree (5)	38	13	0		
	3.73 (197)	3.56 (131)	2.60 (5)	3.64	333
11.5: Only be used in conjunction with human security guards					
Strongly Disagree (1)	6	2	0		
Disagree (2)	34	9	1		
Neither Agree not Disagree (3)	58	35	3		
Agree (4)	81	65	1		
Strongly Agree (5)	17	19	0		
	3.35 (196)	3.69 (130)	3.00 (5)	3.48	331

Appendix C.1

Table C.1.11.2

Gender - Question 11					
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
11.6: Be allowed to hold stationary guard positions, but only be allowed to use lethal force to defend a territory if granted permission by a human soldier					
Strongly Disagree (1)	16	6	1	3.53	331
Disagree (2)	20	17	1		
Neither Agree not Disagree (3)	37	19	1		
Agree (4)	97	69	2		
Strongly Agree (5)	26	19	0		
	3.49 (196)	3.60 (130)	2.80 (5)		
11.7: Be used to hold stationary guard positions and use lethal force if necessary without the permission of a human soldier					
Strongly Disagree (1)	53	39	3	2.18	333
Disagree (2)	74	62	1		
Neither Agree not Disagree (3)	37	20	1		
Agree (4)	25	8	0		
Strongly Agree (5)	9	1	0		
	2.31 (198)	2.00 (130)	1.60 (5)		
<i>answered question</i>					334
<i>skipped question</i>					5

Appendix C.1

Table C.1.12

Gender - Question 12					
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Reconnaissance: Robots should...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
12.1: Accompany a platoon as they explore territory					
Strongly Disagree (1)	3	1	0		
Disagree (2)	3	2	0		
Neither Agree not Disagree (3)	22	12	2		
Agree (4)	110	89	2		
Strongly Agree (5)	60	26	1		
	4.12 (198)	4.05 (130)	3.80 (5)	4.09	333
12.2: Explore territory without human control					
Strongly Disagree (1)	4	6	0		
Disagree (2)	14	28	0		
Neither Agree not Disagree (3)	23	27	2		
Agree (4)	106	50	3		
Strongly Agree (5)	51	19	0		
	3.94 (198)	3.37 (130)	3.60 (5)	3.71	333
12.3: Be able to defend themselves without using lethal force against attackers if necessary					
Strongly Disagree (1)	11	5	0		
Disagree (2)	12	18	1		
Neither Agree not Disagree (3)	35	23	4		
Agree (4)	98	65	0		
Strongly Agree (5)	41	18	0		
	3.74 (197)	3.57 (129)	2.80 (5)	3.66	331
<i>answered question</i>					333
<i>skipped question</i>					6

Appendix C.1

Table C.1.13

Gender - Question 13					
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Bombs: Robots with the ability to handle (i.e. find and disengage) bombs should...					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
13.1: Be under the constant surveillance of a human soldier					
Strongly Disagree (1)	6	4	0		
Disagree (2)	46	12	1		
Neither Agree not Disagree (3)	48	28	1		
Agree (4)	67	65	1		
Strongly Agree (5)	30	21	2		
	3.35 (197)	3.67 (130)	3.80 (5)	3.48	332
13.2: Be allowed to find bombs, but only be allowed to proceed with disengage the bomb with the permission of a human					
Strongly Disagree (1)	5	4	0		
Disagree (2)	24	13	0		
Neither Agree not Disagree (3)	36	22	1		
Agree (4)	97	73	4		
Strongly Agree (5)	35	18	0		
	3.68 (197)	3.68 (130)	3.80 (5)	3.68	332
13.3: Be allowed to set down, find and disengage explosives without direct human control					
Strongly Disagree (1)	12	11	0		
Disagree (2)	47	53	0		
Neither Agree not Disagree (3)	56	23	2		
Agree (4)	56	28	3		
Strongly Agree (5)	25	15	0		
	3.18 (196)	2.87 (130)	3.60 (5)	3.06	331
<i>answered question</i>					332
<i>skipped question</i>					7

Appendix C.2

Table C.2.1

Gender - Question 18					
Are you?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Male	203	0	0	59.9%	203
Female	0	131	0	38.6%	131
Would rather not say	0	0	5	1.5%	5
<i>answered question</i>					339
<i>skipped question</i>					0

Table C.2.2

Gender - Question 19					
What is your age?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Under 18	5	3	0	2.4%	8
18-24	157	117	4	82.2%	278
25-34	21	6	0	8.0%	27
35-44	4	3	0	2.1%	7
45-54	10	2	0	3.6%	12
55-64	3	0	0	0.9%	3
65 or older	1	0	0	0.3%	1
Would rather not say	1	0	1	0.6%	2
<i>answered question</i>					338
<i>skipped question</i>					1

Table C.2.3

Gender - Question 20					
What is the highest level of education you have completed?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Less than high school	1	0	0	0.3%	1
High School/ Vocational School	28	23	0	15.1%	51
Some College	124	92	4	65.1%	220
Associate's Degree	2	0	0	0.6%	2
Bachelor's Degree	23	15	0	11.2%	38
Master's Degree	25	3	0	8.3%	28
Doctoral Degree	9	2	0	3.3%	11
Professional Degree	0	0	0	0.0%	0
Would rather not say	0	0	1	0.3%	1
<i>answered question</i>					338
<i>skipped question</i>					1

Appendix C.2

Table C.2.4

Gender - Question 23					
What is the classification of the company you are employed by?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Public Sector	24	9	0	10.4%	33
Private Sector	39	16	0	17.3%	55
Not-for-Profit	15	2	0	5.3%	17
Don't Know	8	12	0	6.3%	20
Other	11	7	0	5.7%	18
Not Employed	89	71	3	51.3%	163
Would rather not say	5	5	2	3.8%	12
<i>answered question</i>					318
<i>skipped question</i>					21

Table C.2.5

Gender - Question 25					
Do you consider yourself?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Democrat	60	47	1	33.0%	108
Republican	31	21	0	15.9%	52
Independent	78	42	2	37.3%	122
Other	29	14	2	13.8%	45
<i>answered question</i>					327
<i>skipped question</i>					12

Table C.2.6

Gender - Question 26					
What is your experience, if any, with the military?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Active Duty	4	1	0	1.5%	5
Retired	3	0	0	0.9%	3
Reserve	0	0	0	0.0%	0
ROTC	12	6	0	5.4%	18
Other	18	13	1	9.6%	32
None	163	108	3	82.5%	274
<i>answered question</i>					332
<i>skipped question</i>					7

Appendix C.2

Table C.2.7

Gender - Question 27					
How would you rate your familiarity and knowledge of...?					
Answer Options	Are you?			Rating Average	Response Count
	Male	Female	Would rather not say		
Military					
Very unfamiliar and knowledgeable	4	12	1		
Somewhat unfamiliar and knowledgeable	23	38	1		
Neither familiar or unfamiliar	52	37	1		
Somewhat familiar and knowledgeable	86	29	2		
Very familiar and knowledgeable	33	11	0		
	3.61 (198)	2.91 (127)	2.80 (5)	3.33	330
Robotics					
Very unfamiliar and knowledgeable	9	16	1		
Somewhat unfamiliar and knowledgeable	17	37	0		
Neither familiar or unfamiliar	45	35	1		
Somewhat familiar and knowledgeable	92	29	3		
Very familiar and knowledgeable	31	11	0		
	3.61 (194)	2.86 (128)	3.20 (5)	3.31	327
<i>answered question</i>					332
<i>skipped question</i>					7

Table C.2.8

Gender - Question 28					
What is your experience, if any, with robotics?					
Answer Options	Are you?			Response Frequency	Response Count
	Male	Female	Would rather not say		
Robotics related major	46	12	2	18.3%	60
FIRST	53	20	1	22.6%	74
Job related to robotics	20	8	0	8.5%	28
Teaching position	7	2	0	2.7%	9
Other	72	26	1	30.2%	99
None	75	86	0	49.1%	161
<i>answered question</i>					328
<i>skipped question</i>					11

Appendix D.1

Table D.1.1

Military Experience - Question 1							
Informed Consent Agreement for Participation in a Research Study							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
I do NOT consent to participate in this study	0	0	0	0	0	0.0%	0
I do consent to participate in this study	5	3	18	32	275	100.0%	333
<i>answered question</i>							333
<i>skipped question</i>							0

Appendix D.1

Table D.1.2

Military Experience - Question 2							
Please use the definition posted below to answer the following questions. Robot: any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner (Encyclopedia Britannica). Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). A robot is defined as an automated...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
2.1: Ground vehicle that navigates around obstacles to a given location (e.g. Tank, car)							
Strongly Disagree (1)	1	0	1	2	11		
Disagree (2)	0	0	0	1	16		
Neither Agree not Disagree (3)	0	0	3	4	17		
Agree (4)	1	0	9	16	113		
Strongly Agree (5)	3	3	5	9	115		
	4.00 (5)	5.00 (3)	3.94 (18)	3.91 (32)	4.12 (272)	4.10	330
2.2: Ground vehicle that can fire a weapon on command (e.g. Tank, car)							
Strongly Disagree (1)	1	1	1	5	17		
Disagree (2)	1	0	3	2	35		
Neither Agree not Disagree (3)	0	0	1	7	39		
Agree (4)	0	0	9	11	119		
Strongly Agree (5)	3	2	4	7	62		
	3.60 (5)	3.67 (3)	3.67 (18)	3.41 (32)	3.64 (272)	3.62	330
2.3: Aircraft that can fire a weapon on command (e.g. Jet, helicopter)							
Strongly Disagree (1)	1	1	1	5	16		
Disagree (2)	1	0	2	4	49		
Neither Agree not Disagree (3)	0	0	3	7	36		
Agree (4)	0	0	7	11	112		
Strongly Agree (5)	3	2	5	5	59		
	3.60 (5)	3.67 (3)	3.72 (18)	3.22 (32)	3.55 (272)	3.53	330
2.4: Defense mechanism (e.g. missile, torpedo)							
Strongly Disagree (1)	1	1	0	10	19		
Disagree (2)	0	0	5	6	73		
Neither Agree not Disagree (3)	3	0	3	6	56		
Agree (4)	0	1	6	7	79		
Strongly Agree (5)	1	1	4	3	44		
	3.00 (5)	3.33 (3)	3.50 (18)	2.59 (32)	3.21 (271)	3.16	329
<i>answered question</i>							330
<i>skipped question</i>							3

Appendix D.1

Table D.1.3

Military Experience - Question 3							
Please use the definition posted below to answer the following questions. Remote Controlled: The control of an activity, process, or machine from a distance, as by radioed instructions or coded signals (The American Heritage Dictionary) A robot is defined as a remote controlled...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
3.1: Ground vehicle (e.g. tank, car)							
Strongly Disagree (1)	1	0	0	3	12		
Disagree (2)	2	0	1	2	32		
Neither Agree not Disagree (3)	0	0	3	6	27		
Agree (4)	1	1	11	12	129		
Strongly Agree (5)	1	2	3	9	72		
	2.80 (5)	4.67 (3)	3.89 (18)	3.69 (32)	3.80 (272)	3.78	330
3.2: Aircraft (e.g. jet, helicopter)							
Strongly Disagree (1)	1	0	0	3	11		
Disagree (2)	2	0	2	3	39		
Neither Agree not Disagree (3)	0	0	4	6	31		
Agree (4)	1	1	9	11	124		
Strongly Agree (5)	1	2	3	9	67		
	2.80 (5)	4.67 (3)	3.72 (18)	3.63 (32)	3.72 (272)	3.71	330
3.3: Device that can pick up or close around objects (e.g. mechanical claw)							
Strongly Disagree (1)	0	0	2	2	11		
Disagree (2)	1	0	0	3	15		
Neither Agree not Disagree (3)	0	0	2	7	20		
Agree (4)	1	1	11	9	127		
Strongly Agree (5)	3	2	3	11	99		
	4.20 (5)	4.67 (3)	3.72 (18)	3.75 (32)	4.06 (272)	4.02	330
<i>answered question</i>							330
<i>skipped question</i>							3

Appendix D.1

Table D.1.4

Military Experience - Question 4							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a defense mechanism (e.g. weapon) that...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
4.1: Will ask permission before firing							
Strongly Disagree (1)	0	0	1	2	9		
Disagree (2)	2	0	4	5	40		
Neither Agree not Disagree (3)	1	0	1	7	56		
Agree (4)	0	2	9	13	103		
Strongly Agree (5)	2	1	3	5	62		
	3.40 (5)	4.33 (3)	3.50 (18)	3.44 (32)	3.63 (270)	3.60	328
4.2: Will fire automatically at threatening stationary or moving targets							
Strongly Disagree (1)	1	0	0	6	40		
Disagree (2)	1	0	7	2	52		
Neither Agree not Disagree (3)	1	1	2	8	35		
Agree (4)	2	2	7	13	94		
Strongly Agree (5)	0	0	2	3	49		
	2.80 (5)	3.67 (3)	3.22 (18)	3.16 (32)	3.22 (270)	3.21	328
						<i>answered question</i>	329
						<i>skipped question</i>	4

Appendix D.1

Table D.1.5

Military Experience - Question 5							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
5.1: A ground vehicle that responds to voice commands (e.g. tank, car)							
Strongly Disagree (1)	0	0	1	3	7		
Disagree (2)	1	0	1	3	30		
Neither Agree not Disagree (3)	0	0	3	5	42		
Agree (4)	1	1	10	20	142		
Strongly Agree (5)	3	2	3	1	51		
	4.20 (5)	4.67 (3)	3.72 (18)	3.41 (32)	3.74 (272)	3.72	330
5.2: An aircraft that responds to voice commands (e.g. jet, helicopter)							
Strongly Disagree (1)	0	0	2	3	8		
Disagree (2)	2	0	0	5	39		
Neither Agree not Disagree (3)	0	0	3	5	47		
Agree (4)	1	1	10	18	131		
Strongly Agree (5)	2	2	3	1	47		
	3.60 (5)	4.67 (3)	3.67 (18)	3.28 (32)	3.63 (272)	3.60	330
<i>answered question</i>							330
<i>skipped question</i>							3

Appendix D.1

Table D.1.6.1

Military Experience - Question 6							
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
6.1: Perform surveillance military operations							
Strongly Disagree (1)	0	0	1	1	5		
Disagree (2)	0	0	0	2	12		
Neither Agree not Disagree (3)	0	0	2	3	18		
Agree (4)	2	0	10	10	135		
Strongly Agree (5)	3	3	5	15	104		
	4.60 (5)	5.00 (3)	4.00 (18)	4.16 (31)	4.17 (274)	4.18	331
6.2: Perform reconnaissance military operations							
Strongly Disagree (1)	0	0	0	1	5		
Disagree (2)	0	0	2	1	23		
Neither Agree not Disagree (3)	0	0	2	6	28		
Agree (4)	2	0	8	9	124		
Strongly Agree (5)	3	3	6	14	92		
	4.60 (5)	5.00 (3)	4.00 (18)	4.10 (31)	4.01 (272)	4.04	329
6.3: Perform bomb disposal military operations							
Strongly Disagree (1)	0	0	0	2	3		
Disagree (2)	0	0	2	1	22		
Neither Agree not Disagree (3)	1	0	2	4	18		
Agree (4)	0	1	7	10	116		
Strongly Agree (5)	4	2	7	14	113		
	4.60 (5)	4.67 (3)	4.06 (18)	4.06 (31)	4.15 (272)	4.15	329
6.4: Perform defense military operations							
Strongly Disagree (1)	0	0	1	2	6		
Disagree (2)	0	0	5	8	29		
Neither Agree not Disagree (3)	1	1	4	6	54		
Agree (4)	1	0	6	10	139		
Strongly Agree (5)	3	2	2	4	46		
	4.40 (5)	4.33 (3)	3.17 (18)	3.20 (30)	3.69 (274)	3.64	330
6.5: Recognize friend from foe							
Strongly Disagree (1)	0	0	2	10	54		
Disagree (2)	1	0	8	9	112		
Neither Agree not Disagree (3)	1	2	3	9	52		
Agree (4)	2	0	3	3	41		
Strongly Agree (5)	0	1	2	0	14		
	3.25 (4)	3.67 (3)	2.72 (18)	2.16 (31)	2.45 (273)	2.46	329

Appendix D.1

Table D.1.6.2

Military Experience - Question 6							
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
6.6: Carry a defense mechanism properly (e.g. weapon without misuse or misfire)							
Strongly Disagree (1)	0	0	0	2	10		
Disagree (2)	0	0	2	1	36		
Neither Agree not Disagree (3)	0	1	1	9	55		
Agree (4)	3	1	11	12	125		
Strongly Agree (5)	2	1	4	7	48		
	4.40 (5)	4.00 (3)	3.94 (18)	3.68 (31)	3.60 (274)	3.64	331
6.7: Use lethal force with permission of a human							
Strongly Disagree (1)	0	0	0	3	28		
Disagree (2)	0	0	5	2	34		
Neither Agree not Disagree (3)	0	0	2	5	42		
Agree (4)	2	0	9	16	122		
Strongly Agree (5)	3	3	2	5	48		
	4.60 (5)	5.00 (3)	3.44 (18)	3.58 (31)	3.47 (274)	3.51	331
						<i>answered question</i>	331
						<i>skipped question</i>	2

Appendix D.1

Table D.1.7.1

Military Experience - Question 7							
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
7.1: Perform surveillance military operations							
Strongly Disagree (1)	0	0	2	3	8		
Disagree (2)	0	0	0	2	19		
Neither Agree not Disagree (3)	0	0	2	3	19		
Agree (4)	1	0	10	11	133		
Strongly Agree (5)	4	3	4	12	94		
	4.80 (5)	5.00 (3)	3.78 (18)	3.87 (31)	4.05 (273)	4.04	330
7.2: Perform reconnaissance military operations							
Strongly Disagree (1)	0	0	1	3	10		
Disagree (2)	0	0	2	3	34		
Neither Agree not Disagree (3)	0	0	2	8	36		
Agree (4)	1	0	9	7	113		
Strongly Agree (5)	4	3	4	10	79		
	4.80 (5)	5.00 (3)	3.72 (18)	3.58 (31)	3.80 (272)	3.80	329
7.3: Perform bomb disposal military operations							
Strongly Disagree (1)	0	0	1	5	13		
Disagree (2)	1	1	3	4	44		
Neither Agree not Disagree (3)	0	0	3	4	34		
Agree (4)	0	0	8	11	107		
Strongly Agree (5)	3	2	3	7	73		
	4.25 (4)	4.00 (3)	3.50 (18)	3.35 (31)	3.68 (271)	3.65	327
7.4: Perform defense military operations							
Strongly Disagree (1)	0	0	1	3	20		
Disagree (2)	1	1	5	9	51		
Neither Agree not Disagree (3)	1	0	6	10	46		
Agree (4)	1	1	4	5	114		
Strongly Agree (5)	2	1	2	4	41		
	3.80 (5)	3.67 (3)	3.06 (18)	2.94 (31)	3.39 (272)	3.33	329
7.5: Fly an aircraft (e.g. Jet or airplane)							
Strongly Disagree (1)	0	0	1	2	13		
Disagree (2)	2	0	4	4	45		
Neither Agree not Disagree (3)	1	0	4	7	50		
Agree (4)	0	2	6	12	113		
Strongly Agree (5)	2	1	3	6	50		
	3.40 (5)	4.33 (3)	3.33 (18)	3.52 (31)	3.52 (271)	3.52	328

Appendix D.1

Table D.1.7.2

Military Experience - Question 7							
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
7.6: Guard a facility assuming it could recognize friend from foe							
Strongly Disagree (1)	0	0	1	6	30		
Disagree (2)	1	0	6	3	56		
Neither Agree not Disagree (3)	0	0	5	9	38		
Agree (4)	2	2	4	9	109		
Strongly Agree (5)	2	1	2	3	40		
	4.00 (5)	4.33 (3)	3.00 (18)	3.00 (30)	3.27 (273)	3.25	329
7.7: Defend itself with weapons without using lethal force							
Strongly Disagree (1)	0	0	2	3	22		
Disagree (2)	2	0	2	6	42		
Neither Agree not Disagree (3)	0	0	7	7	39		
Agree (4)	1	2	6	13	127		
Strongly Agree (5)	2	1	1	2	42		
	3.60 (5)	4.33 (3)	3.11 (18)	3.16 (31)	3.46 (272)	3.42	329
7.8: Detect and dispose of explosives							
Strongly Disagree (1)	0	0	1	0	6		
Disagree (2)	0	0	4	1	19		
Neither Agree not Disagree (3)	0	1	1	7	32		
Agree (4)	1	1	4	13	138		
Strongly Agree (5)	3	1	8	10	76		
	4.75 (4)	4.00 (3)	3.78 (18)	4.03 (31)	3.96 (271)	3.96	327
7.9: Use lethal force							
Strongly Disagree (1)	0	0	3	9	72		
Disagree (2)	0	1	9	9	72		
Neither Agree not Disagree (3)	1	0	3	7	49		
Agree (4)	2	1	3	3	59		
Strongly Agree (5)	2	1	0	3	20		
	4.20 (5)	3.67 (3)	2.33 (18)	2.42 (31)	2.57 (272)	2.58	329
						<i>answered question</i>	330
						<i>skipped question</i>	3

Appendix D.1

Table D.1.8

Military Experience - Question 8							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Execution of Operations:							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
8.1: Only humans should perform surveillance military operations							
Strongly Disagree (1)	3	2	5	7	57		
Disagree (2)	1	1	8	14	154		
Neither Agree not Disagree (3)	0	0	4	8	43		
Agree (4)	1	0	0	1	12		
Strongly Agree (5)	0	0	1	1	4		
	1.80 (5)	1.33 (3)	2.11 (18)	2.19 (31)	2.08 (270)	2.08	327
8.2: Only humans should perform reconnaissance military operations							
Strongly Disagree (1)	4	2	5	6	54		
Disagree (2)	1	1	9	13	132		
Neither Agree not Disagree (3)	0	0	2	9	50		
Agree (4)	0	0	1	2	22		
Strongly Agree (5)	0	0	1	1	10		
	1.20 (5)	1.33 (3)	2.11 (18)	2.32 (31)	2.26 (268)	2.23	325
8.3: Only humans should perform bomb disposal military operations							
Strongly Disagree (1)	3	1	7	9	89		
Disagree (2)	1	2	7	12	123		
Neither Agree not Disagree (3)	1	0	2	8	31		
Agree (4)	0	0	2	1	22		
Strongly Agree (5)	0	0	0	1	5		
	1.60 (5)	1.67 (3)	1.94 (18)	2.13 (31)	2.00 (270)	2.00	327
8.4: Only humans should perform defense military operations							
Strongly Disagree (1)	3	1	1	2	33		
Disagree (2)	1	1	8	10	117		
Neither Agree not Disagree (3)	0	1	3	8	63		
Agree (4)	1	0	5	8	41		
Strongly Agree (5)	0	0	1	3	16		
	1.80 (5)	2.00 (3)	2.83 (18)	3.00 (31)	2.59 (270)	2.63	327
8.5: Battlefield robots should look like humans							
Strongly Disagree (1)	3	2	5	14	82		
Disagree (2)	1	0	2	6	92		
Neither Agree not Disagree (3)	1	1	7	10	81		
Agree (4)	0	0	3	1	11		
Strongly Agree (5)	0	0	1	0	4		
	1.60 (5)	1.67 (3)	2.61 (18)	1.94 (31)	2.12 (270)	2.12	327
<i>answered question</i>							327
<i>skipped question</i>							6

Appendix D.1

Table D.1.9

Military Experience - Question 9							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Purpose of Robots: Robots should...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
9.1: Be a supplement for the military, not a replacement for soldiers							
Strongly Disagree (1)	0	0	0	2	11		
Disagree (2)	1	1	2	2	22		
Neither Agree not Disagree (3)	0	0	2	3	39		
Agree (4)	2	1	5	15	133		
Strongly Agree (5)	2	1	9	9	67		
	4.00 (5)	3.67 (3)	4.17 (18)	3.87 (31)	3.82 (272)	3.91	329
9.2: Conduct military operations without the direct command of human soldiers							
Strongly Disagree (1)	2	0	3	11	56		
Disagree (2)	0	1	6	7	104		
Neither Agree not Disagree (3)	0	1	7	9	55		
Agree (4)	2	0	1	3	47		
Strongly Agree (5)	1	1	1	1	9		
	3.00 (5)	3.33 (3)	2.50 (18)	2.23 (31)	2.44 (271)	2.70	328
9.3: Be used instead of human drivers for ground vehicles (e.g. convoy purposes)							
Strongly Disagree (1)	1	0	2	4	9		
Disagree (2)	0	0	4	3	38		
Neither Agree not Disagree (3)	1	1	4	7	62		
Agree (4)	1	1	7	12	125		
Strongly Agree (5)	2	1	1	5	37		
	3.60 (5)	4.00 (3)	3.06 (18)	3.35 (31)	3.53 (271)	3.51	328
9.4: Be used instead of human pilots for aircraft (e.g. supply drops)							
Strongly Disagree (1)	1	0	4	3	10		
Disagree (2)	0	0	5	2	50		
Neither Agree not Disagree (3)	1	1	4	14	70		
Agree (4)	2	1	3	11	111		
Strongly Agree (5)	1	1	2	1	30		
	3.40 (5)	4.00 (3)	2.67 (18)	3.16 (31)	3.37 (271)	3.32	328
9.5: Be used instead of soldiers on the battlefield whenever possible							
Strongly Disagree (1)	0	0	3	5	17		
Disagree (2)	1	0	6	3	45		
Neither Agree not Disagree (3)	0	1	3	10	89		
Agree (4)	1	1	5	6	81		
Strongly Agree (5)	3	1	1	7	40		
	4.20 (5)	4.00 (3)	2.72 (18)	3.23 (31)	3.30 (272)	3.49	329
<i>answered question</i>							329
<i>skipped question</i>							4

Appendix D.1

Table D.1.10

Military Experience - Question 10							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Ethics:							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
10.1: The safety provided to soldiers by the use of robots is worth the potential loss of the soldiers' expertise							
Strongly Disagree (1)	0	0	3	5	14		
Disagree (2)	2	1	8	5	55		
Neither Agree not Disagree (3)	0	0	2	5	86		
Agree (4)	1	1	4	15	87		
Strongly Agree (5)	2	1	1	1	28		
	3.60 (5)	3.67 (3)	2.56 (18)	3.06 (31)	3.22 (270)	3.22	327
10.2: Robots designed for use during combat is against the rules of warfare							
Strongly Disagree (1)	2	1	4	13	66		
Disagree (2)	2	2	6	11	96		
Neither Agree not Disagree (3)	0	0	6	4	79		
Agree (4)	1	0	1	0	22		
Strongly Agree (5)	0	0	1	3	8		
	2.00 (5)	1.67 (3)	2.39 (18)	2.00 (31)	2.30 (271)	2.07	328
10.3: Robots designed for use during combat is unethical							
Strongly Disagree (1)	3	1	5	10	74		
Disagree (2)	1	2	7	11	95		
Neither Agree not Disagree (3)	0	0	4	6	63		
Agree (4)	0	0	1	1	29		
Strongly Agree (5)	1	0	1	3	11		
	2.00 (5)	1.67 (3)	2.22 (18)	2.23 (31)	2.29 (272)	2.08	329
<i>answered question</i>							329
<i>skipped question</i>							4

Appendix D.1

Table D.1.11.1

Military Experience - Question 11							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
11.1: Replace human security guards if able to assume friend from foe, spot an intrusion, alert proper authorities, but take no further action							
Strongly Disagree (1)	1	0	0	4	15		
Disagree (2)	1	1	4	5	42		
Neither Agree not Disagree (3)	0	0	4	4	48		
Agree (4)	2	2	9	12	134		
Strongly Agree (5)	1	0	1	6	33		
	3.20 (5)	3.33 (3)	3.39 (18)	3.35 (31)	3.47 (272)	3.45	329
11.2: Accompany human security guards but not have the ability to operate autonomously (i.e. without the permission of a human security guard)							
Strongly Disagree (1)	0	0	0	2	7		
Disagree (2)	2	1	2	5	34		
Neither Agree not Disagree (3)	0	1	2	9	64		
Agree (4)	2	1	13	11	127		
Strongly Agree (5)	1	0	1	4	39		
	3.40 (5)	3.00 (3)	3.72 (18)	3.32 (31)	3.58 (271)	3.55	328
11.3: Operate without human control, but should be supervised by human security guards							
Strongly Disagree (1)	0	0	1	2	15		
Disagree (2)	1	0	2	7	46		
Neither Agree not Disagree (3)	2	0	6	5	62		
Agree (4)	2	3	7	14	126		
Strongly Agree (5)	0	0	2	3	23		
	3.20 (5)	4.00 (3)	3.39 (18)	3.29 (31)	3.35 (272)	3.35	329
11.4: Be able to defend themselves without using lethal force if necessary against intruders assuming it can recognize friend from foe							
Strongly Disagree (1)	0	0	0	3	10		
Disagree (2)	0	0	4	3	30		
Neither Agree not Disagree (3)	1	0	4	5	41		
Agree (4)	3	2	10	17	145		
Strongly Agree (5)	1	1	0	3	45		
	4.00 (5)	4.33 (3)	3.33 (18)	3.45 (31)	3.68 (271)	3.65	328
11.5: Only be used in conjunction with human security guards							
Strongly Disagree (1)	0	0	0	1	6		
Disagree (2)	3	1	0	5	35		
Neither Agree not Disagree (3)	1	2	4	8	79		
Agree (4)	1	0	12	11	123		
Strongly Agree (5)	0	0	2	6	27		
	2.60 (5)	2.67 (3)	3.89 (18)	3.52 (31)	3.48 (270)	3.49	327

Appendix D.1

Table D.1.11.2

Military Experience - Question 11							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
11.6: Be allowed to hold stationary guard positions, but only be allowed to use lethal force to defend a territory if granted permission by a human soldier							
Strongly Disagree (1)	0	0	0	5	18		
Disagree (2)	1	1	4	2	30		
Neither Agree not Disagree (3)	3	0	3	3	48		
Agree (4)	0	2	10	15	138		
Strongly Agree (5)	1	0	1	6	36		
	3.20 (5)	3.33 (3)	3.44 (18)	3.48 (31)	3.53 (270)	3.52	327
11.7: Be used to hold stationary guard positions and use lethal force if necessary without the permission of a human soldier							
Strongly Disagree (1)	0	0	5	10	81		
Disagree (2)	2	1	8	12	113		
Neither Agree not Disagree (3)	2	1	5	6	43		
Agree (4)	1	0	0	3	28		
Strongly Agree (5)	0	1	0	0	7		
	2.80 (5)	3.33 (3)	2.00 (18)	2.06 (31)	2.14 (272)	2.15	329
<i>answered question</i>							329
<i>skipped question</i>							4

Appendix D.1

Table D.1.12

Military Experience - Question 12							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Reconnaissance: Robots should...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
12.1: Accompany a platoon as they explore territory							
Strongly Disagree (1)	0	0	2	1	1		
Disagree (2)	0	0	0	1	4		
Neither Agree not Disagree (3)	1	0	3	4	27		
Agree (4)	2	2	11	13	172		
Strongly Agree (5)	2	1	2	12	68		
	4.20 (5)	4.33 (3)	3.61 (18)	4.10 (31)	4.11 (272)	4.09	329
12.2: Explore territory without human control							
Strongly Disagree (1)	0	0	0	3	7		
Disagree (2)	0	0	5	2	35		
Neither Agree not Disagree (3)	0	0	5	5	39		
Agree (4)	4	1	6	11	136		
Strongly Agree (5)	1	2	2	10	55		
	4.20 (5)	4.67 (3)	3.28 (18)	3.74 (31)	3.72 (272)	3.72	329
12.3: Be able to defend themselves without using lethal force against attackers if necessary							
Strongly Disagree (1)	0	1	0	2	13		
Disagree (2)	0	0	1	5	25		
Neither Agree not Disagree (3)	1	0	7	6	46		
Agree (4)	3	2	9	15	133		
Strongly Agree (5)	1	0	1	3	53		
	4.00 (5)	3.00 (3)	3.56 (18)	3.39 (31)	3.70 (270)	3.66	327
<i>answered question</i>							329
<i>skipped question</i>							4

Appendix D.1

Table D.1.13

Military Experience - Question 13							
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Bombs: Robots with the ability to handle (i.e. find and disengage) bombs should...							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
13.1: Be under the constant surveillance of a human soldier							
Strongly Disagree (1)	0	0	1	1	7		
Disagree (2)	1	2	4	6	47		
Neither Agree not Disagree (3)	2	1	4	10	59		
Agree (4)	0	0	6	10	116		
Strongly Agree (5)	1	0	3	4	43		
	3.25 (4)	2.33 (3)	3.33 (18)	3.32 (31)	3.52 (272)	3.48	328
13.2: Be allowed to find bombs, but only be allowed to proceed with disengage the bomb with the permission of a human							
Strongly Disagree (1)	0	0	0	1	7		
Disagree (2)	1	1	4	3	29		
Neither Agree not Disagree (3)	2	2	0	10	43		
Agree (4)	1	0	12	12	149		
Strongly Agree (5)	0	0	2	5	44		
	3.00 (4)	2.67 (3)	3.67 (18)	3.55 (31)	3.71 (272)	3.68	328
13.3: A21Be allowed to set down, find and disengage explosives without direct human control							
Strongly Disagree (1)	0	0	2	3	16		
Disagree (2)	1	1	4	8	86		
Neither Agree not Disagree (3)	0	1	9	10	61		
Agree (4)	2	0	2	8	74		
Strongly Agree (5)	1	1	1	2	34		
	3.75 (4)	3.33 (3)	2.78 (18)	2.94 (31)	3.09 (271)	3.07	327
<i>answered question</i>							328
<i>skipped question</i>							5

Appendix D.2

Table D.2.1

Military Experience - Question 18							
Are you?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Male	4	3	12	18	163	60.2%	200
Female	1	0	6	13	108	38.6%	128
Would rather not say	0	0	0	1	3	1.2%	4
<i>answered question</i>							332
<i>skipped question</i>							1

Table D.2.2

Military Experience - Question 19							
What is your age?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Under 18	0	0	0	1	7	2.4%	8
18-24	2	0	18	25	230	82.6%	275
25-34	0	0	0	6	20	7.8%	26
35-44	2	0	0	0	5	2.1%	7
45-54	0	2	0	0	10	3.6%	12
55-64	0	1	0	0	2	0.9%	3
65 or older	0	0	0	0	1	0.3%	1
Would rather not say	1	0	0	0	0	0.3%	1
<i>answered question</i>							333
<i>skipped question</i>							0

Appendix D.2

Table D.2.3

Military Experience - Question 20							
What is the highest level of education you have completed?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Less than high school	0	0	0	0	1	0.3%	1
High School/ Vocational School	0	0	6	2	42	15.1%	50
Some College	1	0	12	21	182	65.1%	216
Associate's Degree	0	0	0	0	1	0.3%	1
Bachelor's Degree	1	0	1	3	34	11.7%	39
Master's Degree	2	3	0	6	17	8.4%	28
Doctoral Degree	0	0	0	0	10	3.0%	10
Professional Degree	0	0	0	0	0	0.0%	0
Would rather not say	0	0	0	0	0	0.0%	0
<i>answered question</i>							332
<i>skipped question</i>							1

Table D.2.4

Military Experience - Question 23							
What is the classification of the company you are employed by?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Public Sector	3	0	5	2	24	10.8%	34
Private Sector	0	3	3	8	40	17.2%	54
Not-for-Profit	1	0	0	2	14	5.4%	17
Don't Know	0	0	2	4	13	6.1%	19
Other	1	0	1	1	15	5.7%	18
Not Employed	0	0	6	12	144	51.6%	162
Would rather not say	0	0	0	2	8	3.2%	10
<i>answered question</i>							314
<i>skipped question</i>							19

Appendix D.2

Table D.2.5

Military Experience - Question 25							
Do you consider yourself?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Democrat	1	0	4	11	91	33.0%	107
Republican	1	2	7	6	37	16.4%	53
Independent	3	1	4	9	104	37.3%	121
Other	0	0	1	5	37	13.3%	43
<i>answered question</i>							324
<i>skipped question</i>							9

Table D.2.6

Military Experience - Question 26							
What is your experience, if any, with the military?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Active Duty	5	0	0	0	0	1.5%	5
Retired	0	3	0	0	0	0.9%	3
Reserve	0	0	0	0	0	0.0%	0
ROTC	0	0	18	0	0	5.4%	18
Other	0	0	0	32	0	9.6%	32
None	0	0	0	0	275	82.6%	275
<i>answered question</i>							333
<i>skipped question</i>							0

Appendix D.2

Table D.2.7

Military Experience - Question 27							
How would you rate your familiarity and knowledge of...?							
Answer Options	What is your experience, if any, with the					Rating Average	Response Count
	Active Duty	Retired	ROTC	Other	None		
Military							
Very unfamiliar and knowledgeable	0	0	1	1	14		
Somewhat unfamiliar and knowledgeable	0	0	0	2	59		
Neither familiar or unfamiliar	1	0	0	6	82		
Somewhat familiar and knowledgeable	1	0	8	13	96		
Very familiar and knowledgeable	3	3	9	7	21		
	4.40 (5)	5.00 (3)	4.33 (18)	3.79 (29)	3.19 (272)	3.34	327
Robotics							
Very unfamiliar and knowledgeable	0	0	2	1	21		
Somewhat unfamiliar and knowledgeable	1	0	5	2	46		
Neither familiar or unfamiliar	1	1	5	10	64		
Somewhat familiar and knowledgeable	2	1	5	12	103		
Very familiar and knowledgeable	1	1	1	5	34		
	3.60 (5)	4.00 (3)	2.89 (18)	3.60 (30)	3.31 (268)	3.32	324
<i>answered question</i>							329
<i>skipped question</i>							4

Table D.2.8

Military Experience - Question 28							
What is your experience, if any, with robotics?							
Answer Options	What is your experience, if any, with the					Response Frequency	Response Count
	Active Duty	Retired	ROTC	Other	None		
Robotics related major	1	0	2	4	53	18.3%	60
FIRST	1	1	3	7	61	22.3%	73
Job related to robotics	2	1	1	2	22	8.6%	28
Teaching position	0	1	0	0	8	2.8%	9
Other	2	0	5	13	80	30.6%	100
None	1	1	9	12	137	48.9%	160
<i>answered question</i>							327
<i>skipped question</i>							6

Appendix E.1

Table E.1.1

Political Party - Question 1						
Informed Consent Agreement for Participation in a Research Study						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
I do NOT consent to participate in this study	0	0	0	0	0.0%	0
I do consent to participate in this study	108	53	122	45	100.0%	328
<i>answered question</i>						328
<i>skipped question</i>						0

Appendix E.1

Table E.1.2

Political Party - Question 2						
Please use the definition posted below to answer the following questions. Robot: any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a human like manner (Encyclopedia Britannica). Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). A robot is defined as an automated...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
2.1: Ground vehicle that navigates around obstacles to a given location (e.g. Tank, car)						
Strongly Disagree (1)	2	2	8	3		
Disagree (2)	5	2	8	2		
Neither Agree not Disagree (3)	11	3	5	4		
Agree (4)	41	20	61	15		
Strongly Agree (5)	48	25	40	19		
	4.20 (107)	4.23 (52)	3.96 (122)	4.05 (43)	4.09	324
2.2: Ground vehicle that can fire a weapon on command (e.g. Tank, car)						
Strongly Disagree (1)	7	3	10	4		
Disagree (2)	13	4	18	6		
Neither Agree not Disagree (3)	14	5	20	9		
Agree (4)	45	24	51	15		
Strongly Agree (5)	28	16	23	9		
	3.69 (107)	3.88 (52)	3.48 (122)	3.44 (43)	3.61	324
2.3: Aircraft that can fire a weapon on command (e.g. Jet, helicopter)						
Strongly Disagree (1)	8	3	9	4		
Disagree (2)	20	4	24	7		
Neither Agree not Disagree (3)	15	4	17	9		
Agree (4)	39	26	48	14		
Strongly Agree (5)	25	15	24	9		
	3.50 (107)	3.88 (52)	3.44 (122)	3.40 (43)	3.52	324
2.4: Defense mechanism (e.g. missile, torpedo)						
Strongly Disagree (1)	5	5	15	7		
Disagree (2)	23	14	35	7		
Neither Agree not Disagree (3)	27	10	19	10		
Agree (4)	31	15	36	10		
Strongly Agree (5)	21	7	17	9		
	3.37 (107)	3.10 (51)	3.04 (122)	3.16 (43)	3.18	323
					<i>answered question</i>	324
					<i>skipped question</i>	4

Appendix E.1

Table E.1.3

Political Party - Question 3						
Please use the definition posted below to answer the following questions. Remote Controlled: The control of an activity, process, or machine from a distance, as by radioed instructions or coded signals (The American Heritage Dictionary) A robot is defined as a remote controlled...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
3.1: Ground vehicle (e.g. tank, car)						
Strongly Disagree (1)	2	2	10	2		
Disagree (2)	11	6	16	4		
Neither Agree not Disagree (3)	17	9	7	5		
Agree (4)	48	21	57	21		
Strongly Agree (5)	28	15	32	11		
	3.84 (106)	3.77 (53)	3.70 (122)	3.81 (43)	3.77	324
3.2: Aircraft (e.g. jet, helicopter)						
Strongly Disagree (1)	2	2	9	2		
Disagree (2)	17	8	17	4		
Neither Agree not Disagree (3)	20	8	6	8		
Agree (4)	40	21	59	19		
Strongly Agree (5)	27	14	31	10		
	3.69 (106)	3.70 (53)	3.70 (122)	3.72 (43)	3.70	324
3.3: Device that can pick up or close around objects (e.g. mechanical claw)						
Strongly Disagree (1)	3	3	9	0		
Disagree (2)	6	5	6	2		
Neither Agree not Disagree (3)	16	4	5	5		
Agree (4)	44	22	56	22		
Strongly Agree (5)	37	19	46	14		
	4.00 (106)	3.92 (53)	4.02 (122)	4.12 (43)	4.01	324
					<i>answered question</i>	324
					<i>skipped question</i>	4

Appendix E.1

Table E.1.4

Political Party - Question 4						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a defense mechanism (e.g. weapon) that...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
4.1: Will ask permission before firing						
Strongly Disagree (1)	3	2	7	0		
Disagree (2)	17	9	18	7		
Neither Agree not Disagree (3)	19	7	25	13		
Agree (4)	45	25	45	8		
Strongly Agree (5)	21	9	27	15		
	3.61 (105)	3.58 (52)	3.55 (122)	3.72 (43)	3.60	322
4.2: Will fire automatically at threatening stationary or moving targets						
Strongly Disagree (1)	14	3	21	8		
Disagree (2)	21	10	25	4		
Neither Agree not Disagree (3)	18	8	14	8		
Agree (4)	36	22	44	13		
Strongly Agree (5)	16	9	18	10		
	3.18 (105)	3.46 (52)	3.11 (122)	3.30 (43)	3.21	322
					<i>answered question</i>	323
					<i>skipped question</i>	5

Appendix E.1

Table E.1.5

Political Party - Question 5						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. A robot is defined as a...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
5.1: A ground vehicle that responds to voice commands (e.g. tank, car)						
Strongly Disagree (1)	2	1	7	1		
Disagree (2)	8	6	14	7		
Neither Agree not Disagree (3)	14	9	16	9		
Agree (4)	64	26	62	19		
Strongly Agree (5)	18	11	23	7		
	3.83 (106)	3.75 (53)	3.66 (122)	3.56 (43)	3.72	324
5.2: An aircraft that responds to voice commands (e.g. jet, helicopter)						
Strongly Disagree (1)	3	2	7	1		
Disagree (2)	10	6	19	11		
Neither Agree not Disagree (3)	18	10	17	8		
Agree (4)	58	25	58	17		
Strongly Agree (5)	17	10	21	6		
	3.72 (106)	3.66 (53)	3.55 (122)	3.37 (43)	3.60	324
					<i>answered question</i>	324
					<i>skipped question</i>	4

Appendix E.1

E.1.6.1

Political Party - Question 6						
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
6.1: Perform surveillance military operations						
Strongly Disagree (1)	3	1	1	2		
Disagree (2)	1	2	9	2		
Neither Agree not Disagree (3)	7	5	8	5		
Agree (4)	50	21	62	20		
Strongly Agree (5)	46	24	41	15		
	4.26 (107)	4.23 (53)	4.10 (121)	4.00 (44)	4.16	325
6.2: Perform reconnaissance military operations						
Strongly Disagree (1)	4	0	1	1		
Disagree (2)	1	4	16	4		
Neither Agree not Disagree (3)	13	9	8	8		
Agree (4)	49	19	57	16		
Strongly Agree (5)	39	21	38	15		
	4.11 (106)	4.08 (53)	3.96 (120)	3.91 (44)	4.02	323
6.3: Perform bomb disposal military operations						
Strongly Disagree (1)	1	1	2	1		
Disagree (2)	5	6	10	4		
Neither Agree not Disagree (3)	4	7	8	5		
Agree (4)	48	14	54	16		
Strongly Agree (5)	49	25	45	18		
	4.30 (107)	4.06 (53)	4.09 (119)	4.05 (44)	4.15	323
6.4: Perform defense military operations						
Strongly Disagree (1)	2	1	3	2		
Disagree (2)	12	7	16	6		
Neither Agree not Disagree (3)	22	11	21	12		
Agree (4)	53	21	60	18		
Strongly Agree (5)	18	12	21	6		
	3.68 (107)	3.69 (52)	3.66 (121)	3.45 (44)	3.65	324
6.5: Recognize friend from foe						
Strongly Disagree (1)	16	13	28	8		
Disagree (2)	49	21	43	13		
Neither Agree not Disagree (3)	21	6	25	14		
Agree (4)	16	9	18	6		
Strongly Agree (5)	4	4	6	3		
	2.46 (106)	2.43 (53)	2.43 (120)	2.61 (44)	2.46	323

Appendix E.1

E.1.6.2

Political Party - Question 6						
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Successful: Having a favorable outcome. Having obtained something desired or intended (The American Heritage Dictionary). Would you trust a robot to successfully...?						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
6.6: Carry a defense mechanism properly (e.g. weapon without misuse or misfire)						
Strongly Disagree (1)	5	1	5	1		
Disagree (2)	13	4	16	5		
Neither Agree not Disagree (3)	15	11	25	14		
Agree (4)	57	22	54	16		
Strongly Agree (5)	17	15	21	8		
	3.64 (107)	3.87 (53)	3.58 (121)	3.57 (44)	3.64	325
6.7: Use lethal force with permission of a human						
Strongly Disagree (1)	12	2	12	4		
Disagree (2)	11	6	15	8		
Neither Agree not Disagree (3)	16	6	19	8		
Agree (4)	50	25	58	13		
Strongly Agree (5)	18	14	17	11		
	3.48 (107)	3.81 (53)	3.44 (121)	3.43 (44)	3.51	325
					<i>answered question</i>	325
					<i>skipped question</i>	3

Appendix E.1

E.1.7.1

Political Party - Question 7						
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
7.1: Perform surveillance military operations						
Strongly Disagree (1)	5	2	4	2		
Disagree (2)	6	4	8	3		
Neither Agree not Disagree (3)	4	5	9	7		
Agree (4)	53	20	61	18		
Strongly Agree (5)	38	22	39	14		
	4.07 (106)	4.06 (53)	4.02 (121)	3.89 (44)	4.02	324
7.2: Perform reconnaissance military operations						
Strongly Disagree (1)	8	1	4	1		
Disagree (2)	8	7	18	5		
Neither Agree not Disagree (3)	13	10	12	12		
Agree (4)	45	16	51	15		
Strongly Agree (5)	32	19	35	11		
	3.80 (106)	3.85 (53)	3.79 (120)	3.68 (44)	3.79	323
7.3: Perform bomb disposal military operations						
Strongly Disagree (1)	4	5	8	2		
Disagree (2)	14	10	23	6		
Neither Agree not Disagree (3)	16	6	10	8		
Agree (4)	43	15	49	19		
Strongly Agree (5)	28	17	30	8		
	3.73 (105)	3.55 (53)	3.58 (120)	3.58 (43)	3.63	321
7.4: Perform defense military operations						
Strongly Disagree (1)	6	4	8	6		
Disagree (2)	20	12	24	8		
Neither Agree not Disagree (3)	16	12	21	13		
Agree (4)	44	18	49	13		
Strongly Agree (5)	19	7	19	4		
	3.48 (105)	3.23 (53)	3.39 (121)	3.02 (44)	3.34	323
7.5: Fly an aircraft (e.g. Jet or airplane)						
Strongly Disagree (1)	4	2	7	3		
Disagree (2)	17	9	19	10		
Neither Agree not Disagree (3)	16	12	24	8		
Agree (4)	44	18	49	19		
Strongly Agree (5)	25	11	21	4		
	3.65 (106)	3.52 (52)	3.48 (120)	3.25 (44)	3.51	322

Appendix E.1

E.1.7.2

Political Party - Question 7						
Please use the definition posted below to answer the following questions by selecting the number on the scale that best corresponds to your response. Automated: The automatic operation or control of equipment, a process, or a system (The American Heritage Dictionary). Would you trust a robot to autonomously...?						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
7.6: Guard a facility assuming it could recognize friend from foe						
Strongly Disagree (1)	19	2	14	2		
Disagree (2)	19	10	27	8		
Neither Agree not Disagree (3)	20	10	13	7		
Agree (4)	31	21	52	21		
Strongly Agree (5)	17	10	15	5		
	3.08 (106)	3.51 (53)	3.22 (121)	3.44 (43)	3.25	323
7.7: Defend itself with weapons without using lethal force						
Strongly Disagree (1)	11	2	9	4		
Disagree (2)	20	9	18	4		
Neither Agree not Disagree (3)	11	7	21	11		
Agree (4)	47	26	55	21		
Strongly Agree (5)	17	8	18	4		
	3.37 (106)	3.56 (52)	3.45 (121)	3.39 (44)	3.43	323
7.8: Detect and dispose of explosives						
Strongly Disagree (1)	3	1	2	1		
Disagree (2)	9	1	8	5		
Neither Agree not Disagree (3)	12	9	11	8		
Agree (4)	54	19	62	22		
Strongly Agree (5)	28	22	36	8		
	3.90 (106)	4.15 (52)	4.03 (119)	3.70 (44)	3.96	321
7.9: Use lethal force						
Strongly Disagree (1)	32	9	29	13		
Disagree (2)	24	17	39	9		
Neither Agree not Disagree (3)	21	9	19	9		
Agree (4)	21	12	23	11		
Strongly Agree (5)	8	6	11	2		
	2.52 (106)	2.79 (53)	2.57 (121)	2.55 (44)	2.59	324
					<i>answered question</i>	324
					<i>skipped question</i>	4

Appendix E.1

Table E.1.8

Political Party - Question 8						
Please answer the following questions by selecting the number on the scale that best corresponds to your response.						
Execution of Operations:						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
8.1: Only humans should perform surveillance military operations						
Strongly Disagree (1)	22	18	24	8		
Disagree (2)	60	22	67	26		
Neither Agree not Disagree (3)	16	10	20	8		
Agree (4)	6	1	6	1		
Strongly Agree (5)	2	2	2	0		
	2.11 (106)	2.00 (53)	2.12 (119)	2.05 (43)	2.09	321
8.2: Only humans should perform reconnaissance military operations						
Strongly Disagree (1)	20	16	27	7		
Disagree (2)	55	20	55	22		
Neither Agree not Disagree (3)	18	11	22	10		
Agree (4)	9	4	10	1		
Strongly Agree (5)	4	2	4	2		
	2.26 (106)	2.17 (53)	2.23 (118)	2.26 (42)	2.24	319
8.3: Only humans should perform bomb disposal military operations						
Strongly Disagree (1)	41	18	35	13		
Disagree (2)	50	19	56	18		
Neither Agree not Disagree (3)	8	8	15	9		
Agree (4)	6	6	10	3		
Strongly Agree (5)	1	2	3	0		
	1.83 (106)	2.15 (53)	2.08 (119)	2.05 (43)	2.00	321
8.4: Only humans should perform defense military operations						
Strongly Disagree (1)	13	8	14	4		
Disagree (2)	51	21	48	15		
Neither Agree not Disagree (3)	16	13	33	13		
Agree (4)	21	8	17	7		
Strongly Agree (5)	5	3	7	4		
	2.57 (106)	2.57 (53)	2.62 (119)	2.81 (43)	2.62	321
8.5: Battlefield robots should look like humans						
Strongly Disagree (1)	38	15	37	15		
Disagree (2)	36	15	35	10		
Neither Agree not Disagree (3)	24	16	43	17		
Agree (4)	5	6	3	1		
Strongly Agree (5)	3	1	1	0		
	2.05 (106)	2.30 (53)	2.13 (119)	2.09 (43)	2.12	321
					<i>answered question</i>	321
					<i>skipped question</i>	7

Appendix E.1

Table E.1.9

Political Party - Question 9						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Purpose of Robots: Robots should...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
9.1: Be a supplement for the military, not a replacement for soldiers						
Strongly Disagree (1)	4	1	6	3		
Disagree (2)	12	4	9	3		
Neither Agree not Disagree (3)	14	1	21	9		
Agree (4)	50	26	57	20		
Strongly Agree (5)	26	21	27	9		
	3.77 (106)	4.17 (53)	3.75 (120)	3.67 (44)	3.84	323
9.2: Conduct military operations without the direct command of human soldiers						
Strongly Disagree (1)	28	9	24	10		
Disagree (2)	31	20	51	14		
Neither Agree not Disagree (3)	24	16	16	12		
Agree (4)	19	6	21	8		
Strongly Agree (5)	4	2	7	0		
	2.43 (106)	2.47 (53)	2.46 (119)	2.41 (44)	2.44	322
9.3: Be used instead of human drivers for ground vehicles (e.g. convoy purposes)						
Strongly Disagree (1)	6	3	4	2		
Disagree (2)	15	11	15	4		
Neither Agree not Disagree (3)	20	14	22	18		
Agree (4)	49	20	60	12		
Strongly Agree (5)	16	5	18	8		
	3.51 (106)	3.25 (53)	3.61 (119)	3.45 (44)	3.46	322
9.4: Be used instead of human pilots for aircraft (e.g. supply drops)						
Strongly Disagree (1)	5	5	3	4		
Disagree (2)	18	14	16	8		
Neither Agree not Disagree (3)	26	13	35	16		
Agree (4)	44	15	52	12		
Strongly Agree (5)	13	6	14	3		
	3.40 (106)	3.06 (53)	3.48 (120)	3.05 (43)	3.25	322
9.5: Be used instead of soldiers on the battlefield whenever possible						
Strongly Disagree (1)	7	5	9	2		
Disagree (2)	14	11	18	11		
Neither Agree not Disagree (3)	36	17	37	10		
Agree (4)	31	13	34	14		
Strongly Agree (5)	18	7	22	7		
	3.37 (106)	3.11 (53)	3.35 (120)	3.29 (44)	3.28	323
					<i>answered question</i>	323
					<i>skipped question</i>	5

Appendix E.1

Table E.1.10

Political Party - Question 10						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Ethics:						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
10.1: The safety provided to soldiers by the use of robots is worth the potential loss of the soldiers' expertise						
Strongly Disagree (1)	6	5	7	2		
Disagree (2)	18	12	26	13		
Neither Agree not Disagree (3)	31	12	36	11		
Agree (4)	36	18	37	17		
Strongly Agree (5)	14	5	14	1		
	3.32 (105)	3.12 (52)	3.21 (120)	3.05 (44)	3.18	321
10.2: Robots designed for use during combat is against the rules of warfare						
Strongly Disagree (1)	27	19	28	11		
Disagree (2)	41	22	39	12		
Neither Agree not Disagree (3)	28	8	37	15		
Agree (4)	8	2	12	2		
Strongly Agree (5)	1	2	5	3		
	2.19 (105)	1.98 (53)	2.40 (121)	2.40 (43)	2.24	322
10.3: Robots designed for use during combat is unethical						
Strongly Disagree (1)	30	21	29	12		
Disagree (2)	42	18	41	13		
Neither Agree not Disagree (3)	19	10	28	13		
Agree (4)	12	2	14	3		
Strongly Agree (5)	2	2	9	3		
	2.18 (105)	1.98 (53)	2.45 (121)	2.36 (44)	2.24	323
					<i>answered question</i>	323
					<i>skipped question</i>	5

Appendix E.1

Table E.1.11.1

Political Party - Question 11						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
11.1: Replace human security guards if able to assume friend from foe, spot an intrusion, alert proper authorities, but take no further action						
Strongly Disagree (1)	7	4	5	4		
Disagree (2)	18	11	18	5		
Neither Agree not Disagree (3)	17	8	19	12		
Agree (4)	51	18	65	21		
Strongly Agree (5)	13	11	14	2		
	3.42 (106)	3.40 (52)	3.54 (121)	3.27 (44)		
11.2: Accompany human security guards but not have the ability to operate autonomously (i.e. without the permission of a human security guard)						
Strongly Disagree (1)	1	1	6	1		
Disagree (2)	13	9	15	6		
Neither Agree not Disagree (3)	27	5	29	16		
Agree (4)	49	27	56	17		
Strongly Agree (5)	16	10	15	3		
	3.62 (106)	3.69 (52)	3.49 (121)	3.35 (43)		
11.3: Operate without human control, but should be supervised by human security guards						
Strongly Disagree (1)	5	4	9	1		
Disagree (2)	16	9	24	6		
Neither Agree not Disagree (3)	21	11	26	17		
Agree (4)	53	24	55	14		
Strongly Agree (5)	11	4	7	6		
	3.46 (106)	3.29 (52)	3.22 (121)	3.41 (44)		
11.4: Be able to defend themselves without using lethal force if necessary against intruders assuming it can recognize friend from foe						
Strongly Disagree (1)	5	1	6	2		
Disagree (2)	13	3	18	1		
Neither Agree not Disagree (3)	13	4	20	12		
Agree (4)	56	34	57	26		
Strongly Agree (5)	19	9	20	3		
	3.67 (106)	3.92 (51)	3.55 (121)	3.61 (44)		
11.5: Only be used in conjunction with human security guards						
Strongly Disagree (1)	2	1	5	0		
Disagree (2)	12	9	18	4		
Neither Agree not Disagree (3)	31	11	32	21		
Agree (4)	47	21	56	17		
Strongly Agree (5)	12	10	9	2		
	3.53 (104)	3.58 (52)	3.38 (120)	3.39 (44)		

Appendix E.1

Table E.1.11.2

Political Party - Question 11						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Defense: Robot security guards should...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
11.6: Be allowed to hold stationary guard positions, but only be allowed to use lethal force to defend a territory if granted permission by a human soldier						
Strongly Disagree (1)	4	3	12	3		
Disagree (2)	12	9	11	4		
Neither Agree not Disagree (3)	18	6	23	11		
Agree (4)	55	29	55	21		
Strongly Agree (5)	15	5	19	5		
	3.63 (104)	3.46 (52)	3.48 (120)	3.48 (44)	3.53	320
11.7: Be used to hold stationary guard positions and use lethal force if necessary without the permission of a human						
Strongly Disagree (1)	38	15	30	10		
Disagree (2)	41	22	61	9		
Neither Agree not Disagree (3)	14	8	16	19		
Agree (4)	8	6	10	6		
Strongly Agree (5)	4	1	4	0		
	2.04 (105)	2.15 (52)	2.15 (121)	2.48 (44)	2.16	322
					<i>answered question</i>	323
					<i>skipped question</i>	5

Appendix E.1

Table E.1.12

Political Party - Question 12						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Reconnaissance: Robots should...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
12.1: Accompany a platoon as they explore territory						
Strongly Disagree (1)	0	3	1	0		
Disagree (2)	0	1	2	2		
Neither Agree not Disagree (3)	12	2	14	8		
Agree (4)	67	29	71	27		
Strongly Agree (5)	26	17	33	7		
	4.13 (105)	4.08 (52)	4.10 (121)	3.89 (44)	4.08	322
12.2: Explore territory without human control						
Strongly Disagree (1)	2	4	3	1		
Disagree (2)	12	11	15	3		
Neither Agree not Disagree (3)	14	4	21	10		
Agree (4)	54	16	61	23		
Strongly Agree (5)	23	17	21	7		
	3.80 (105)	3.60 (52)	3.68 (121)	3.73 (44)	3.71	322
12.3: Be able to defend themselves without using lethal force against attackers if necessary						
Strongly Disagree (1)	4	4	7	1		
Disagree (2)	13	3	13	1		
Neither Agree not Disagree (3)	18	6	23	11		
Agree (4)	52	26	57	24		
Strongly Agree (5)	18	12	20	7		
	3.64 (105)	3.76 (51)	3.58 (120)	3.80 (44)	3.66	320
					<i>answered question</i>	322
					<i>skipped question</i>	6

Appendix E.1

Table E.1.13

Political Party - Question 13						
Please answer the following questions by selecting the number on the scale that best corresponds to your response. Robots and Bombs: Robots with the ability to handle (i.e. find and disengage) bombs should...						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
13.1: Be under the constant surveillance of a human soldier						
Strongly Disagree (1)	4	2	4	0		
Disagree (2)	16	15	22	6		
Neither Agree not Disagree (3)	23	9	29	14		
Agree (4)	49	17	42	19		
Strongly Agree (5)	13	8	24	5		
	3.49 (105)	3.27 (51)	3.50 (121)	3.52 (44)	3.46	321
13.2: Be allowed to find bombs, but only be allowed to proceed with disengage the bomb with the permission of a human						
Strongly Disagree (1)	2	2	4	0		
Disagree (2)	9	11	13	4		
Neither Agree not Disagree (3)	17	8	19	14		
Agree (4)	56	22	69	22		
Strongly Agree (5)	21	8	16	4		
	3.81 (105)	3.45 (51)	3.66 (121)	3.59 (44)	3.67	321
13.3: Be allowed to set down, find and disengage explosives without direct human control						
Strongly Disagree (1)	5	6	7	3		
Disagree (2)	37	14	40	5		
Neither Agree not Disagree (3)	28	12	25	16		
Agree (4)	19	14	33	17		
Strongly Agree (5)	16	4	16	3		
	3.04 (105)	2.92 (50)	3.09 (121)	3.27 (44)	3.07	320
					<i>answered question</i>	321
					<i>skipped question</i>	7

Appendix E.2

Table E.2.1

Political Party - Question 18						
Are you?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Male	60	31	78	29	60.6%	198
Female	47	21	42	14	37.9%	124
Would rather not say	1	0	2	2	1.5%	5
<i>answered question</i>						327
<i>skipped question</i>						1

Table E.2.2

Political Party - Question 19						
What is your age?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Under 18	2	1	2	2	2.1%	7
18-24	94	44	97	34	82.0%	269
25-34	5	4	11	7	8.2%	27
35-44	1	1	5	0	2.1%	7
45-54	2	3	6	1	3.7%	12
55-64	2	0	1	0	0.9%	3
65 or older	1	0	0	0	0.3%	1
Would rather not say	1	0	0	1	0.6%	2
<i>answered question</i>						328
<i>skipped question</i>						0

Table E.2.3

Political Party - Question 20						
What is the highest level of education you have completed?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Less than high school	1	0	0	0	0.3%	1
High School/ Vocational School	14	11	14	9	14.7%	48
Some College	75	31	80	26	64.8%	212
Associate's Degree	0	0	1	0	0.3%	1
Bachelor's Degree	11	7	13	7	11.6%	38
Master's Degree	5	7	13	3	8.6%	28
Doctoral Degree	5	0	5	1	3.4%	11
Professional Degree	0	0	0	0	0.0%	0
Would rather not say	0	0	0	1	0.3%	1
<i>answered question</i>						327
<i>skipped question</i>						1

Appendix E.2

Table E.2.4

Political Party - Question 23						
What is the classification of the company you are employed by?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Public Sector	6	9	15	3	10.7%	33
Private Sector	14	11	23	7	17.9%	55
Not-for-Profit	6	0	10	1	5.5%	17
Don't Know	4	6	2	6	5.9%	18
Other	4	3	8	2	5.5%	17
Not Employed	61	21	53	21	50.8%	156
Would rather not say	6	0	3	2	3.6%	11
<i>answered question</i>						307
<i>skipped question</i>						21

Table E.2.5

Political Party - Question 25						
Do you consider yourself?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Democrat	108	0	0	0	32.9%	108
Republican	0	53	0	0	16.2%	53
Independent	0	0	122	0	37.2%	122
Other	0	0	0	45	13.7%	45
<i>answered question</i>						328
<i>skipped question</i>						0

Table E.2.6

Political Party - Question 26						
What is your experience, if any, with the military?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Active Duty	1	1	3	0	1.5%	5
Retired	0	2	1	0	0.9%	3
Reserve	0	0	0	0	0.0%	0
ROTC	4	7	4	1	4.9%	16
Other	11	6	9	5	9.6%	31
None	91	37	104	37	83.0%	269
<i>answered question</i>						324
<i>skipped question</i>						4

Appendix E.2

Table E.2.7

Political Party - Question 27						
How would you rate your familiarity and knowledge of...?						
Answer Options	Do you consider yourself?				Rating Average	Response Count
	Democrat	Republican	Independent	Other		
Military						
Very unfamiliar and knowledgeable	8	1	4	4		
Somewhat unfamiliar and knowledgeable	26	7	21	6		
Neither familiar or unfamiliar	29	10	37	12		
Somewhat familiar and knowledgeable	34	19	44	18		
Very familiar and knowledgeable	9	16	13	3		
	3.09 (106)	3.79 (53)	3.34 (119)	3.23 (43)	3.32	321
Robotics						
Very unfamiliar and knowledgeable	12	2	6	6		
Somewhat unfamiliar and knowledgeable	17	12	21	2		
Neither familiar or unfamiliar	22	19	27	10		
Somewhat familiar and knowledgeable	41	14	50	17		
Very familiar and knowledgeable	12	6	15	7		
	3.23 (104)	3.19 (53)	3.39 (119)	3.40 (42)	3.31	318
					<i>answered question</i>	323
					<i>skipped question</i>	5

Table E.2.8

Political Party - Question 28						
What is your experience, if any, with robotics?						
Answer Options	Do you consider yourself?				Response Frequency	Response Count
	Democrat	Republican	Independent	Other		
Robotics related major	24	10	19	6	18.4%	59
FIRST	26	10	24	13	22.7%	73
Job related to robotics	6	3	10	8	8.4%	27
Teaching position	3	0	5	1	2.8%	9
Other	26	13	45	14	30.5%	98
None	60	29	54	14	48.9%	157
					<i>answered question</i>	321
					<i>skipped question</i>	7

Appendix F

Worcester Polytechnic Institute
Interactive Qualifying Project
The Impact of Robots on Select Military Operations
Professor David Brown
Daniel Duffty and Audra Sosny

Question 1:

Informed Consent Agreement for Participation in a Research Study

Title of Study: The Impact of Robots on Select Military Operations

Introduction: The purpose of this study is to analyze society's opinions and attitudes about the use of robots by the military. The study will focus on four major military operations: surveillance, reconnaissance, bomb disposal, and defense.

Record keeping and confidentiality:
The information that you provide in this study will be both anonymous and confidential.

Your participation in this research is voluntary.
You may decide to stop participating in the research at any time without penalty or loss of benefits to which you may otherwise be entitled. You need not answer every question.

Time required to complete:
You will complete a questionnaire that will last no more than 15 minutes.

For more information about this study, contact:
Daniel Duffty: [dduffty@gmail.com](mailto:dduffy@gmail.com)
Audra Sosny: asosny@gmail.com

This study has been approved by the Worcester Polytechnic Institute Institutional Review Board. For questions or concerns related to this approval, contact: Professor Kent Rissmiller, IRB Chair, Tel. 508-831-5019, Email: kjr@wpi.edu

By continuing below, you acknowledge that you have been informed about and consent to be a participant in the study described above.

Appendix F

Instructions: Please complete the following short-answer questions truthfully. If you are not comfortable completing a question, please indicate or leave blank.

1. *What do you believe are potential advantages of robots used in the military?*
2. *What do you believe are potential disadvantages of robots used in the military?*
3. *How do you think the military can use robots in the future?*
4. *Do you have any additional comments related to the use of robots with select military operations?*

Instructions: Please answer the following demographic questions. If you would rather not respond to a question, you may leave it blank.

1. *Are you?* Male Female Would rather not say
2. *What is your age?*
Under 18 18-24 25-34 35-44 45-54 55-64 65 or older Would rather not say
3. *What is the highest level of education you have completed?*
Less than high school High School/ Vocational School Some College
Associate's Degree Bachelor's Degree Master's Degree
Doctoral Degree Professional Degree Would rather not say
4. *What is was your degree in your major?* _____
5. *What is your primary occupation (If you are a full-time student, please indicate that you are a student)?*

6. *What is the classification of the company are employed by?*
Public Sector Private Section Not-for-Profit Other _____
Don't Know Not Employer, Would rather not say

Appendix G

Interview Questions

Primary Investigator: Professor David Brown

Student Investigators: Daniel Duffty
Audra Sosny

Undergraduate Project: IQP

Project Title: Impact of Robots on Select Military Operations

1. Describe your occupation (If a student, what is your major area of study?)
2. What do you believe are potential advantages of robots used in the military?
3. What do you believe are potential disadvantages of robots used in the military?
4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?
5. In what fields do you find robots most useful in the military now?
6. We are interested in your insight regarding robots in the following fields:
 - Surveillance
 - Security
 - Automated Defense Platforms
 - Reconnaissance
 - Bomb disposal
7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?
8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots? In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?
9. Do you have any additional comments regarding robots and their use in the military?
10. Do you mind if your name is associated with your answers?

Appendix H

Appendix H.1: Professor William A. Baller, Humanities and Arts

Thursday, December 11, 2008 at 11:00 AM

Verbally explained Informed Consent Agreement – understood and agreed.

1. Describe your occupation (If a student, what is your major area of study?).

I'm a college instructor at WPI, I teach mostly courses on European history and global history, focusing on the 20th century

2. What do you believe are potential advantages of robots used in the military?

The main one from a military point of view would be that it saves and protects American lives. When America does go to war, that will facilitate that and increase the chances that the American military will win wars.

3. What do you believe are potential disadvantages of robots used in the military?

I think one is the cost. Robots are very expensive, I can imagine, and it's certainly commendable to save American lives, but I do think that robots might be expensive to taxpayers, and that money might be used for other things. It also might make America going to war more likely, because the travesty of soldiers killed or wounded, but robots are more expendable, so I think it would increase the likelihood that America would go to war. I understand there are robots in the war in Iraq or Afghanistan, I know the predator missiles seem to be robotic to me, but I've also read a source that says robots are already waging war, I suspect it's a robotic mobile gun machine, or a machine gun, and while I think it's commendable that Americans not be killed, in the past, especially World War 2, men of all classes did fight in war, that may well be a good war, but before America went to war late, and that was not a preemptive war, then American realized that if America went to war, so men or boys would be killed. Using robots and predator drones will save American lives, but those opposing America will die, will be hideously wounded, and I do think it means use of robots and robotic type of weapons mean that Americans would be more willing to go to war in general.

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

Both, I think ultimately the goal is to take humans out of the battlefield and rely more on high tech weapons and robots so Americans aren't killed. I know right now they have robotic supplements to help find Americans that are killed or wounded, of course carrying supplies to the battlefield. But I think that the ultimate goal is to completely replace humans on the battlefield and have robots doing as much fighting as possible.

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Looking far into the future, you don't expect to see human soldiers on ground, just robots?

Not sure how far in the future, aviation is there right now, robotic drone missiles that are being used, they may be effective in a place like Afghanistan, but they've killed a number of civilians, and relations with Afghanistan are very bad because of that. I suspect there will always be some humans in the battlefield, but I feel the goal is to get as many men off the battlefield as possible, because Americans don't want to see their loved ones getting killed and dragged in the dirt of whatever. I think that is a way of minimizing ... in the war, but I suspect that the military high-tech planners actually, the more they replace humans with robots, that will further their goal.

5. In what fields do you find robots most useful in the military now?

Again, I'm not expert on robots, but I think if you consider the drone missiles, the predator missiles, for surveillance they're pretty effective. But again, there's a lot of criticism of the use of predator missiles in Afghanistan and Pakistan due to they have killed a number of civilians, and America has apologized for that, but it's very clear more and more the way the war is going that if they have robots on the battlefield, humans make mistakes too, but I think it's more likely as humans are replaced and fighting more and more from a distance and there's less face to face contact.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

That's just huge, the military's doing it, the CIA is doing it, there's a lot of that going on now and I suspect that it will increase with 9-11 fears.

Security

It's how you define security, we call the American Defense Department, I'm an army veteran, but the American department call itself the department of defense, not the department of aggression, so it depends how you define security, but I think that the military and high-tech contracts will always argue, correctly or not, that this is always about defense, it's not about aggression.

We're trying to define security as more of base security, so patrolling robots, all that.

I suspect that that's a big part of the drive for mobile robots, to surveillance and for security, my impression now is that no one in the military or defense contractors are saying 'we're spending too much money on robots,' more and more of the pentagon budget, more and more of the <various examples>, no one in the military's saying 'cut our budgets,' and I suspect they want more and more of that money for robots.

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Automated Defense Platforms

I've heard that they're using automatic robots that are sort of like land-based gunships that have machine guns to go after the enemy. Would you say that's defensive, it may well be, but I suspect it will also be offensive to go after alleged terrorists or the Taliban or whatever, but like I said I'm a veteran myself, and anything is invariably defensive, not offensive.

Reconnaissance

Just tremendously, like I said, I'd be interested to see the military budget, but I think no one is saying we need less robots for all kind of purposes like sensors or surveillance.

Tremendous use of pilotless planes are robotic, I suspect, I think that's just going to grow; I mean no one in the military says cut our budgets. But I suspect that they're going to pick defensive systems that they're going to use that they're going to use more money for robots and perhaps less for destroyers or submarines or land-based forces.

Bomb Disposal

Well, yeah, I think you see that now with the threat of IEDs, and I guess they have been pretty effective, but like I said, I suspect that there's tremendous impetuous in the military saying we need more robots to destroy these bombs before they kill Americans or Humvees or tanks or whatever, so I think in all those areas is more and more of a drumbeat now for more money

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

Well, until the Bush administration, I believe the law said you cannot assassinate foreign leaders, or other soldiers, I think that's been unofficially amended. But even before and after World War 2, I believe the position was you cannot assassinate leaders, but very clearly a place like Pakistan, Afghanistan, and now we're in the Middle East, predator missiles or drones are being used to assassinate people we consider enemies. I'm not sure what the Geneva Convention says, but during World War 2 and afterwards, I'm not sure what statute said it, but it was illegal for Americans to assassinate other people, and I'm not sure that's an informal agreement or whatever, but Bush has allowed assassinating enemies.

<Clarification of assassination: killing enemies in a un-battlefield situation>

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

As a taxpayer, I'd just assume have the cost be kept as reasonable as possible. But I suspect that they will try to mass-produce as many as they can. As I said, I don't remember anyone in the military saying we need fewer robots or cut our robotic budget; I suspect they want a lot more money for all kinds of robots.

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Would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

As a taxpayer, if they're going to use more robots, I'd assume they use the cheapest ones possible, so whether American based or not I don't really care, but I think traditionally the American military has shown they prefer using Lockheed and Grommet and they don't want to use foreign planes, they want ... from Lockheed and other American makers. From me as a taxpayer, it doesn't make any difference to me.

9. Do you have any additional comments regarding robots and their use in the military?

I think it's a very important issue and I think the moral issues should be examined very careful and they are incredibly expensive, and the military budget is going to be cut, it's clear that Obama is going to cut the military budget. I think they need to be examined much more carefully for all kinds of reasons.

10. Do you mind if your name is associated with your answers?

No.

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Appendix H.2: MSG Serafin M. Cascalheira, Military Science

Wednesday, December 10, 2008 at 11:00 AM

Verbally explained the Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?).

I am the Senior Militant Instructor at WPI for the ROTC program. Which, we as a whole school, WPI as a whole school, service most of the school within the consortium - Holy Cross, Assumption Clark, the standard schools, none of the medical schools. We also service Fitchburg and UMass Lowell. My job as a Senior Militant Instructor is to be an adviser to the commander and also teach the cadets the basics to advance level operations, how to become an effective leader/ manager, not only of the troops/ people, but time also. My job is kind of an overall overseer and be the professors of military sciences' right-hand man, or right-hand person I should say.

Do you have any experience in the military with robots?

No, robotic experience beside the EOD units, we've used the robots to go out and identify IEDs, or explosives. But, me personally, no. I've seen it but I've never played with robots.

2. What do you believe are potential advantages of robots used in the military?

That's a very broad question. I think like anything, technology wise, I think it could give us some distinctive advantages. We should be careful though, I don't think, but maybe later on, it's very hard to replicate the human brain. But I think it definitely has a lot of advantages in the operational type stuff like I do, which is combat operations. I think just the rovers they use, the UAVs, is basically a robot – it's definitely an advantage.

3. What do you believe are potential disadvantages of robots used in the military?

Trying to think that it can replace the human brain. That I think is maybe a disadvantage. As long as we don't break that barrier, I think we'll be fine. You see with computers every day, the computer is only as smart as the person operating it. I think that there are definitely advantages. In any type of robotics I guess, you can include robotic arms, legs, and stuff like that, I think being careful to not violate ethical issues would be my biggest concern. I've been in the military for 24 years now and I came in when there was no computers or there was a computer and it was a big blue screen or green screen looking thing. Now we tie ourselves to all these electronics, it's like we can't function without email, we can't function without our computer - but before we did okay. Don't get me wrong, there's definitely a great advantage to technology, information is instantaneous. But I think what happens to us, is we get so much information that we're only able to process so much of it at once. We have so much overwhelming information to us and that's what happens on the battlefield. You've so much happening to you, you have to use the basic functions - it's just a reaction, it's not a thought process. You can't think about it, you've got to react. So, I guess in that

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aspect if a robot does that reaction for you, let's say a robotics weapons system would be great for an attack. How is it identified? That's probably an issue - how you identify if it's a really threat or not? There's definitely advantages, I just think that sometimes we become overwhelmed with the amount of information that's given to us out there. In certain cases, especially in the military, it's not one of those things that you can think about you have to react to it, hopefully you react to it correctly or something bad happens to you. It's like flying a helicopter like the Colonel does or when you're under attack, you just have to react – it's like breathing or walking, if you have to think about it, it's a problem - if that makes any sense.

So if I understand you correctly, you don't think that robots can make that reaction fast enough?

I have not seen it yet. Again, I think we have to be careful when we try to replicate expertise because there are so many variables. You just have to start with a base ground. Can the robot, will the robot be able to say to himself, or herself, or itself, "If this happens, I do this. But if this happens, what do I do now?" There are so many different situations. One of the things I tell the cadets or the students all the time, "You have to start with a base knowledge, and from that point on with that base you react to whatever the situation is." Can a robot do that? I'm sure to a certain degree they can do that. Can they do that as well as humans? Sometimes they probably can and I think some other times they probably can't. They process the information faster, they're stronger - they're not... to injury, so generally speaking. But I think we have to be careful, when we get to that level, especially in the military. We have robotic things doing operations right now, but in the military, you have to rely on that robot to protect or save human lives. It's not a structured environment; it's a very changing and very fluid environment. Can provide great benefits? I believe they can provide great benefits, I really do...they're able to see, detect, and react to things quicker than a human can, but can they correlate and fluidly change from situation to situation without malfunctioning. Maybe in the future, I don't know that, but from what I've seen up to this point, it's a pretty hard task.

So your concern is the programming limitations of making sure you include every possible....

It's impossible to do that. I believe it's like infinite, what's infinite? It's never ending. It's pretty impossible to replicate a situation that's never happened yet.

So keep a soldier in the loop?

That's right. Always keep a unit at hand. Could you go with less soldiers? Maybe, I don't know...with all the technology they have can do a lot more than they did back in World War II and Korea. We're a lot more advanced, so we can do a lot with less soldiers but we cannot forget the human hands that actually put that into application.

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4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

I touched on that a little bit. It can provide some advantages in early warning, defense, reconnaissance, and probably information gathering. We talked about the UAVs, bomb detecting, early warning devices. I mean, they can definitely provide those advantages...I mean, like I said, I think remote controlled robotic weapons...that can probably provide an advantage...I know since I've been in the military we've slowly progressed where everybody is communicating, everybody is equipped with the same type of equipment, everybody's got data in front of them. When it comes down to the actual task they're reacting to in action or reaction, you don't think about all of the things you have. You aren't thinking about talking, you're thinking about surviving or humanistic and survival ...trying to defend a friend, a partner, or whatever the case may be. Maybe generations down the road, can they adapt to it? My daughter texts, has a computer at 14, 15, 12, I never did that. Can we adapt to it? Yeah, we probably could, as long as we keep a basic platform, is what I'm trying to say. What I told my son years ago is, I use this analogy a lot, "Just because you read a book on how to make a rocket ship, doesn't mean you can build a rocket ship." In the army, just because we have to use robots, it's coming to be a long process, just like everything else...out since the early 90's...as the situation changes...One of the greatest things out there...is there a future? I'd like to think there will be a future...We've gotten so far up to this point, that we can go even further, I'd like to think so. To ask me where the future of the army and robots is, I don't know. Will robots replace humans? Eventually...we have to be careful though, what we ask for, because there might be an underlying theory that we've got to be careful how far we want to push that.

Once it's done, it can't be undone. We repeat history, and you look back in history and look at what's happening in America...some changes are great changes, we were idiots in the old days...but how much further do you want to go? When do you stop? When is enough, enough?...I think that's what I'm afraid of when it comes to technology...Just because you thought of it and you built it, doesn't mean...

5. In what fields do you find robots most useful in the military now, or in the future?

Already answered in previous question.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Definitely could be an advantage...Could definitely...We have stuff in the market right now, we have stuff now that the sky's the limit as far as seeing, hearing, smelling, detecting...

Security

Already answered in previous question.

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Automated Defense Platforms

Some advantages, I can think of some disadvantages. In a controlled environment, it's easier to control. We can never replicate the actual effect. Like right now, I guarantee you, that some of the systems are slowly being replaced because it's not doing exactly what it's supposed to do...what we thought of, what we wanted to do with the program...An automated platform has some advantages, but again, I don't care what you do, how you do it,...unless it's in the actual environment, it's a big difference. Again, I'm not against robots, but we have to be careful how far we push that. I don't think that it can ever replace human thought...can it replace human...it probably can do that, I'm sure.

Reconnaissance

Same thing, same concept. I think what we also need to, I'll give you an example, again, my opinion, something detecting from 20, 30,000 feet by a robot or aerial drone is pretty good. Can we actually replicate the actual human intelligence of that? I don't know. That's what happened to us in Iraq. We had the per se...I just do what I'm told. The information we were getting, by suspected forces... We didn't have enough human intelligence, again in my opinion...we don't know what we really know, some of that stuff we'll never know... We might miss that human factor, that intent of what is really happening. Definitely a great benefit in many cases...see what they don't see, so that's definitely a great advantage – both reconnaissance and surveillance.

Bomb disposal

If you can use robots, that's definitely the way to go. I know a few people who have died from that...there's just not enough of them out there...Again, human control but it's a robot doing the work – that would be the way of the future – human control but a robot is actually doing the work...A tool, a great tool – that would be the best way to put it.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

Not that I know of, no.

Do you have any predictions about where that might be headed? What regulations might be established in the future?

I don't know, I'll be honest with you, I don't know. What I thought, our country is in chaos right now, just the financial aspect of it...I have hope, just like everybody else has hope...as rough as it gets, it's still the best thing going. You don't see people pouring into all these other countries, people still want to come here...self-responsibility and some ethical values to a certain degree because when you start developing stuff like that, you've got to add some type of morality to it because what you may want to do, the next person who comes along may use it to cause harm instead of some kind of good...The future is open, so it's kind of hard to tell...robots, or robotic type pieces of equipment, proves to be very beneficial in

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many instances, especially what's killing most of our soldiers right now...robotic arms and legs now, I mean that's, that's pretty impressive...In the military, like I said, UAVs...explosive guys that use those robots to detect...phenomenal pieces of equipment...If our focus is in that direction...along the way of this project, you're probably going to figure out...this isn't quite the way I envisioned it to be. I don't know what else to tell you.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

I would say multiple operations, a base platform that you can add stuff to make it function for...going up stairs...having multiple kits to adjust to your mission because no one mission is ever the same...A multi-functional platform with kits, like you said, would be very beneficial...more cost effective too, you don't have to sit there and...you just plug and play kind of like a Mr. Potato Head, not like the Transformers...plug and play type of thing would be more beneficial than...

In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

I don't know. I think whoever has the best technology; it seems to be us a majority of time...seems to be that way at least, the perception out there. But if somebody else has something out that's a little bit better...to me, in the military is weaponry. There are other countries who build...generally thinking we have something that's fairly equal, maybe not quite as good, but fairly equal...you might want to consider it, but again, it depends what it's for...I buy American, I drive American, I try, I have a Toyota also, my wife drives a Toyota...

9. Do you have any additional comments regarding robots and their use in the military?

Nope, don't think so.

10. Do you mind if your name is associated with your answers?

No, as long as it reflects my personal opinion and as long as you don't add anything.

Appendix H

Appendix H.3: Professor Eben C. Cobb, Mechanical Engineering

Monday, December 1, 2008 at 10:00 AM

Verbally explained the Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?).

I am currently a professor of mechanical engineering at Worcester Polytechnic Institute.

What classes do you teach?

I teach introduction to computer aided design, statics, dynamics, kinematics, dynamics of machines, machine design, advanced mechanical electronics, some of the robotics courses.

2. What do you believe are potential advantages of robots used in the military?

Well, that is a hard question to answer; but the main thing would be to avoid casualties, injury, or death of the military personnel.

3. What do you believe are potential disadvantages of robots used in the military?

It is, well, it's possible that, as with all tools, they could be misused. Such as use for, all tools can be used incorrectly, used for things that they're not meant to, and particularly autonomous robots. Once they're sent on their way, there may not be any way to control them and they may have unintended consequences, so that, that could be a problem.

So take like a gun, you give it to a police officer it's a good thing, you give it to a terrorist, it's a dangerous thing. Same idea except it...

It's worse that unless you can, a robot is harder to kill than a terrorist. And the robot, depending upon the quality of the programming that is done, may not be able to distinguish between friend or foe. And once it acquires a target, I mean there are all kinds of science fiction movies with robots going berserk, and that is a very real danger. So that could be a problem. Not to say it can't be overcome but it could be danger and there has to be some way to...

Do you fear the initial programming or somebody hacking into it?

Well, both. My initial fearing is particularly seeing what I have seen both in school and in industry is in the time constraints that are given to people to try and come up with a product, they don't always take the full time that they need to fully understand what they're trying to program and they run into problems and that propagates down and down the system. So thus, most of the military robotic systems, now I guess we should also define robotics systems, but the autonomous robotics systems do not have weapons on them; the ones in the military now do not have weapons on them. If they're human controlled, that is tele-

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operated, that's a different story. But the autonomous robots that are available for the military right now do not have weapons on them, for just that reason - they're not comfortable yet that they won't go berserk and start...

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

Oh, I think that it's very important; again, I don't think you'll ever do away with military personnel. But as tools, there are some articles recently about exoskeletons, which are partially robotic. And that, I think that holds great promise. Just the idea of wearing an earth mover rather than some weapons, all that is possible as well, that one of the man limitations of personnel is that they can't fly, you can't carry really heavy loads and things like that, which as the weapons get bigger and stronger...

So correct me if I'm mistaken but you think that they're going to be a supplement instead of a replacement to the soldiers?

Yes. There may be things like piloted, remotely piloted aircraft that is the pilot physically is not in the aircraft. But I think the C3PO type robot is not going to exist. The pilot is going to exist, just not in the aircraft.

5. In what fields do you find robots most useful in the military now, or in the future?

Well, classic military conundrum - amateurs talk tactics, professionals talk logistics. Moving equipment, moving supplies, moving ammunition and what else - that's where in a highly dangerous environment, that's what you want to do. So, I think that's where the robots will initially they'll make their impact and that will continue. I mean, it's possible in the future they'll replace military personnel on the battlefield - soldiers or robotic tanks and things like that, but I doubt that's where they're going to go initially. Initially there will be things like surveillance, detection. What they have now, they'll be better at it - detecting roadside bombs, removing bombs, investigating, which also can be used for other things, like earthquakes. Carrying things, just being able to send out 20 vehicles with all the supplies you need and push a button and they go and you don't need to have anybody watching them - that is a tremendous advantage to have. Aircraft that you can send off somewhere - aircraft loaded with 200 tons of food and water and whatever, and I send them off and let them go and I don't have to worry about them because they're off and doing their thing. That's what I think is going to be...so I don't see it in the weapons, although that it possible. I think right now the most will be in the logistics of moving supplies, moving equipment because that takes a lot of time and a lot of effort to do.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Yea, that, I think that there is a lot going on there. I know that there is a student who came back from Iraq that is at WPI who is now a biochemistry or chemistry student who found a

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way; he's probably in one of those WPI magazines, who found a way to based on some kind of light reflection to detect roadside bombs. So that's a nice thing to send out, disposable, useable, expendable things to go out and check on. Also would be good for, also one of the really important things is to check for contaminated water, check for...in earthquakes, in volcanoes, fire fighting, all those kind of things. So that sort of surveillance of finding and identifying a problem, that is going to be a big thing where they're going to move on there because that's all a very dangerous thing to do. Where's the fire? Going into a building where there has been a chemical spill and sending a robot and not endangering anybody - so that has both military and civilian applications, so I think that's what's going to be a primary thrust of what's going to be happening in the next few years.

Security

That makes all kinds of sense - even simple things of crossing a light beam and an alarm goes off - but yea, like that kind of patrolling, so I'm a lot of places have mobile and non-mobile security systems, that's possible.

Automated Defense Platforms

Like I said, that gets now into arming autonomous robots where if the programming and the set-up and everything is not very carefully controlled then how do you turn it off? You'd have to destroy it yourself and then it's a race between are you going to be killed versus kill it - the classic science fiction movie. I would bet, I would predict that a human-controlled, where a human could control multiple weapons - if you're equipped with canons, machine guns, whatever - which would not be possible by an individual, by one individual, but through a robotics system could control, that I see as possible. That I think and like I said as far as seeing the predator's role, that I think is possible, so it would be the same kind of remotely operated, where operator would sit in a console, sort of like the training modules, but have control over multiple weapons systems, that I see as very possible and very do-able

Reconnaissance

Yep, that we talked about, where's the fire? Where's the people. What's really interesting is you can now find there are people doing mouse-sized or insect-sized autonomous robots - that would be great if I as a military commander could send a swarm, or a nest of bees to the opposing force that would look like bees and spread them out. That is, on the battlefield, that is the most important thing, is information. I don't know if you're heard this - "command, control, communication, and information", or intelligence - and everything is done to increase that cycle. If you can think faster than your enemy is, if you gain information or process that information more quickly, yeah, and a lot of robotics systems have that, so the surveillance, reconnaissance, that would be definitely do-able, particularly if this can be done covertly, without the other side knowing what you're doing.

* He is quoting Napoleon here

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Well, if you have enough of an advantage covertness isn't really an issue...

No, that's true but given you don't know whether you have that advantage or not so I think the covert reconnaissance, like I said sending something that's the size of a bee, there would really have to be some serious detecting and then of course on the other hand you'd have to have something to detect all of these things – that goes back to the security.

Bomb disposal

They're already doing that and that like I said that has big applications because then you can go back to firefighting, you can go back to search the rescue - the same kind of techniques that are necessary for bomb disposal are also necessary for pulling people out of earthquake-damaged buildings, or out of a chemical spills or a plant where there's toxic chemicals. So the same kind of methodology, the same operations needed for bomb disposal or bomb detecting, like roadside bomb detecting, are the same things you need to do that is required to pull people in catastrophe situations.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

You mean that exist in our government now?

Our government...International law?

I'm sure that there can be things that would apply in U.S. law and in international law, the application of appropriate force. For example, it's not okay to use an atomic bomb to attack 3 people. That's overkill, there's no point to that and a case could be made for attacking large populations as well. So I'm sure that a lot of law could be applied to that again. Again, looking at it as a tool.

So, you think the same law and can applied to humans and robots?

Yes, because it's a tool. If you think of it in that way, then I think that all of the laws, the Geneva conventions, would apply to that too. If you can use a robot, I would make a bet that somebody could argue, even though there's not a specific law, but that you could probably argue that you could not have an autonomous robot go do interrogations because again just like having a weapon on it, it could go nuts and its programming might send it down a path that you don't want, which would be illegal under the Geneva conventions. So I think that the existing laws probably would be applicable to that as they are to military now without much modification.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

Well, more effective is the module. The military is particularly involved with, because it makes sense – of ok, I have a vehicle, whatever it is, has wheels, has tracks, aircraft,

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whatever -but I can put a cannon on it, I can put a tank of water on it, I can use it to carry ammunition, I can have anti-aircraft guns on it - it makes things simpler. Like the classic thing is, why have 20 different kinds of ammunition - one or two is all, because in the heat of combat you don't want to, well these bullets don't fit, those bullets. The Russians in particular after World War II, redesigned all of weapons - the AK47 takes NATO standard ammunition so if they ever ran out of their own ammunition they could use captured ammunition. So that kind of thinking pervades the military. So I would bet this modular - you have a platform and you pull off this piece on and put that piece on it - that it makes perfect sense from the military way of thinking, because that's what they want to do - it makes life simpler. Fewer repair parts, I may have more of them, but if one thing is damaged or destroyed, I can take the usable parts from it and fix a few others. So that kind of philosophy of having enough stuff lying around that is all similar and can be interchanged - that's a classic military concept, and so sure I think that's how it will be rather than, now I'm sure there are certain special things you can imagine, very very large equipment, like in my mind the transporter that carries the space shuttle...okay, there's only one of them, there's only a need for one of them, it's very expensive. Otherwise I think there'll be modular that can be interchanged with various parts because it makes sense again from the supply point of view that I don't have to buy all these kinds of different pieces. I can buy two of these and two of these and two of these and everything works. That's, like I said, a classic military concept.

9. Do you have any additional comments regarding robots and their use in the military?

I, well me, personally, I don't have any, it does not bother me. Again, the rules of war, the Geneva Conventions and so on. I should mention this, you didn't ask, I was in the military, in the army, in Germany watching the Russians during the Cold War, so I know a lot of what was going on. The protection against chemicals, biological is a constant danger. So these robots and right now the roadside bombs that they're finding, the ambushes, being able to set-up a remote surveillance thing is something very interesting. I don't particularly see the autonomous, automated soldier with its own weapons platform. I see the sort of like the games where one person, one human can control multiple thing, like one human is controlling ten aircraft or ten tanks. That I think is going to happen. The piles and piles and piles of autonomous robotic soldiers, I think the ethical problems with that and the all be bad science fiction movies. You Particularly I'm bothered with engineering. Boy, we can't even get valves to open things for your car. If you can't get that programming straight, don't put any guns on these things, and I know because I pay attention to this that the few experiments the robot has done turned out badly with the weapons systems, the autonomous weapons systems, and I agree. So I see more of them being used as tools, being able to enhance people's ability, but not, never going to replace people. As I said, to me it's a tool - how it's used, that is covered under the current laws. People always can abuse things. I don't have a problem personally with it, like I said because I'd rather send out, like I said an expendable robot rather than a human life, because everybody wins in that situation.

10. Do you mind if your name is associated with your answers?

Nope, I'm happy to, happy help

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Appendix H.5: Major Robert G. Davis, Military Science

Wednesday, December 10, 2008 at 10:30 AM

Verbally explained the Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?) What classes do you teach?

Here at WPI I am the Commandant of Cadets, so I'm actually in charge of all the Cadets to make sure that they get all of their military type training, military specific training. I also have a course that I teach to juniors that's about three hours a week.

What is the name of the course that you teach?

...300, it's a leadership course.

Do you have any experience in the military with robotics?

Not a lot, I've seen them, I've seen the robots, some of them. I guess it depends how you define a robot - we use a lot of technology, a lot of computers. A lot of our robots are kind of shaped like airplanes, UAVs, others are shaped like little R2D2s that do for bomb disposal. It depends how you define a robot, nothing like on Battle Star Galactica, the Terminator Chronicles, whatever it is.

For your reference, we're defining a robot for the use of robot as basically anything that can automatically control some type of process, action – it's a very broad definition so it can apply to pretty much anything that you'd like it to apply to.

2. What do you believe are potential advantages of robots used in the military?

We're definitely going to move into a place where we're going to use more and more of these things – economic reasons, political reasons, social reasons; they're all good reasons to use these things. You put a pilot inside an airplane, there's just so many limits to how many Gs he can take. You're end up putting a lot of more weight on the plane because there's all these safety mechanisms that have to go on there – you have to worry about him ejecting. You got to pay this guy, year after year after year to ride around in this thing. There's always a danger one gets killed - it's a big political risk. We lose a UAV, the public doesn't care. Every time somebody dies in Iraq, it's on the nightly news. It's kind of a hit that we take, and it makes modern warfare more difficult in the age of YouTube where everything gets recorded and sent around the world immediately. I think it's inevitable that we're going to move to more of these – every single indicator that I see says that we're going to move to more and more of these.

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3. What do you believe are potential disadvantages of robots used in the military?

We've done studies in the past. We have these big missile fields out in the Mid-West, mostly in the Mid-West, the frozen part of America where we have nuclear warheads underground and at various adversaries throughout the world. There's been talk at times that these should be controlled centrally somewhere and a machine should maybe run some of these. Instead, we insist on having people down there close to the missile. I think anytime anything is that important, no human is going to want to advocate that kind of responsibility. They're going to want to add that emotional component in it where a machine doesn't have that emotional component – it's just another failsafe we're going to add. Think of Asimov's Three, "You don't want to make anything you can't unmake." We want to stay in control and we want to find where these points, where possible problematic areas are and make sure that humans stay in those areas to make intelligent decisions. You don't want to wind anything up and set it out there, you want to remain in control at all times.

So, you wouldn't support an automated defense platform as you're describing?

No, I don't think very few people in the military would and I don't think the American people would. But from a logical point instead of the President carrying around a football of codes, then it runs down a system, and all these lieutenants are going to turn keys, seems like it would be more efficient if the President just had a computer and could just go "Boom." It's a logical thing to do, war is an emotional thing, and if you're talking about exterminating continents, it becomes even more emotional

4. What are your thoughts on the future of robots in the military?

Right now, we've got UAVs, unmanned aerial vehicles that we basically fly around like video games. You'll have a UAV flying around in Afghanistan, that guy might be in Florida flying that UAV around, gathering information. Occasionally, the weather will fly one into a mountain or get shutdown. It's a shame, but nobody's dying. I see definitely more and more of that happening. I see some of this stuff getting more automated.

Automated in what sense?

Maybe you've got a larger aircraft, with a lot of smaller aircraft in it and this guy loses his UAV, he pushes a button over here and he takes another one. Maybe we turn these things into fighters now, it's almost like, like I said you've got a guy in Florida, it's like playing a video game only real stuff is getting blown up on the other side of the world. I see more and more of that happening. I see even some of our cargo maybe getting delivered by these things. Just more and more. I think a line between what the human does and what the computer does what start to get blurred a bit. The way we now fly troops around is very much like an airline. We're a service and it's colder on the aircraft, other than that, it's the same thing. They don't lose your bags, that's another good thing, because everybody puts their own bag in the back, so it's very much like an airline. In the future, I'm not convinced that it's going to be that way. I think it's very possible where you have some guy someplace else flying that thing and then parts of the aircraft will be almost automatic. We have more

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sophisticated aircraft, which I think I can talk about but I'm not sure, so I won't talk about the specifics, that can actually take off, bomb, land on the road. Nothing but a disk entered into a machine and no human on board at all. We still insist because of our history, we insist that a human being be aboard that aircraft. We still do a lot of things. We still wear scarves, the guys that wear flight suits still wear scarves. There's nobody opening the canopy anymore and letting the scarf flutter in the back because we fly around way too fast for that, but we still have that as part of our culture. Some of it is just going to be the Generals now retiring, maybe a couple of generations of that before we fully embrace that idea.

5. In what fields do you find robots most useful in the military now, or in the future?

Discussed later in the interview

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Advantages - I guess you can shape this thing any way you want to shape it. Some of these little craft we come up with are really small, and that's just the stuff I know about, there's probably stuff even smaller. An advantage is size, it gives you flexibility. I don't think there's any substitute for human intelligence, but it can certainly supplement that. The fact that if we're building these things in bulk, the cost will be low - I'd much rather lose a small machine than a person, politically it's better. If Al Qaeda captures my machines, they can keep it. If Al Qaeda captures a person, I've got to deal with them and we've got to get them back, and there's a whole political component to that as well. A lot of advantages, a lot of disadvantages. The biggest problem we've got is trying to keep up with the technology. You've got people in Japan and kids inventing stuff in their basements. We're trying to incorporate as best as we can, but we've got this big, bulky culture. It takes us 14 years to do an acquisitions project, that's the whole thing. We've got to re-design ourselves to be able to incorporate faster all these changes because if we don't the enemy will.

So when you say re-design ourselves you're saying a cultural change, ethics possibly...

Cultural change, ethics. The ethics part is something we really haven't touched. We're so far from being able to logically sit down and look at the ethics of this thing. I don't even think we're ready to begin the discussion. We've got to re-design ourselves as an institution to be able to go out, find these areas, find these bits of technology. Sometimes it's only going to be parts of technologies only that we want and not other parts and be able to incorporate those things quickly and adapt them for our uses. We're not doing a very good job at that.

Security

Already discussed in previous question

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Automated Defense Platforms

There are probably far more advantages than disadvantages if you look at it dispassionately and logically, but I don't think we're ready to do that. We're just too nervous to do that, some of that is a warranted caution, and some of that is just us not being able to embrace the future. By the time you get enough rank to make a decision, you've been around a while; you've seen things one-way and it's hard to change your mind. Again, it goes back to that cultural change, that kind of ... shift we've got to make. We're just not there yet.

Reconnaissance

Pretty much what I said before, applies I think. It's pretty much the same (as surveillance).

Bomb disposal

These things do a really excellent job at bomb disposal. I've actually seen them through binoculars at work in Iraq, it's pretty amazing stuff. I got to tell you, I'd much rather have that thing go do it than a poor kid doing it. They're a little slower than a human would be, but it sure is a lot safer. I've heard of a few of those things going off and those things have dealt with them. But for the most part it's really efficient and good. We're getting better and better at that.

Can you comment on maybe what is limiting the speed of the robots right now?

I just think that it's caution. We teach people cordon off the area, get everybody out of the way and you take your time because we don't want anybody to get hurt. But sometimes we purposely will take that thing out in the field and keep them ready, you know. The ones that we're encountering now are roadside bombs in Iraq, and to some extent Afghanistan, are homemade, so they're garbage, a lot of them are just really temperamental anyway, and sometimes you'll just pick it up. A lot of times we'll move it out in the field, set another bomb beside it, get out of the way, and it will just blow up itself. I think a lot of it's just caution and a lot of it's I can do things with my hand, but if I've got a joystick or I've programmed a machine to do something, it's going to be more clunky and artificially done. You can't improve on the human design right away, although they do some things better than we do.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

I think the biggest problem is just people just refusing to embrace the future fast enough.

So not really anything official, more of the culture?

Yea, I'm not aware of anything, which is strange.

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So as there really isn't much developed right now, what would you predict might be some laws regulating the use of robots as far as design, use, purpose, etc.?

I would think you would always want to have a person in control of the machine. You'd always want to have a person that guides the evolution of the machine. You'd want a person that can control the machine if necessary. I guess at some point there's some task that only humans are going to be able to do; robots aren't going to be replacing them. When I say ever, I mean the foreseeable future, because I don't know what's going to happen in 500 years. Then you're going to have other tasks that machines are always do better than us. Then you're going to have some tasks where humans and machines are going to be in some type of competition because both have areas within the process that they're a little better at. Those areas, that's really where it's going to hit the fan because we're going to have to see who wins out. My guess is that in the short-term, it's going to be humans every time.

Would you mind just commenting on what tasks you're referring to do humans can always do, that robots can always do...?

We could be at war with China for instance - logically it makes sense to blow-up Chinese dams because you can kill millions of people and destroy massive amounts of infrastructure with a just few missiles to blow up these dams. The bad part about that is you're killing millions of people. The human would make the decision not to do that because it's immoral. I'm not sure a machine would grasp the difference. If my mission is to kill people, why aren't I doing that? (As a robot). From a logical point of view, it's logical that we do that, but I don't think a human would make that decision. I think any kind of moral decision-making needs to be done by human beings.

From what I understand, you cannot program ethics directly into a fully automated robot?

I don't believe so. I think it's too complex and it's not logical, it's not always a logical thing. We can't program ethics in certain humans; some of them just don't seem to get it. We don't even agree upon what it is. You and I, I'm sure, have differences in some areas if we sit and talked about it, about what's ethical and what's not. I think it needs to be human beings making all these decisions. Robots are always going to do a repetitive task better than humans. You're going to get pretty much the same result every time if you program a robot to do the same result. Humans, if you ever bought an American car, you'll find that every once in a while the human doesn't connect part A and part B right and you get a lemon car. The robots rarely make that same mistake. Where it gets difficult is these tasks that aren't a black and white thing where these things have exact cut-offs, there's gray areas in-between. That's really where the problem is. How do we balance a process where the robot does part and a human does part? We've got to blow those distinctions. This isn't a robot task, or a human task, this is a robot-human task.

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8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

I want to use whatever works the best. I really don't care about that kind of theoretical argument. I guess if we can buy off the-shelf it's cheaper, we can get it quicker. If the civilians are using it too, the police are using it, and firemen are using it, and maybe we can buy off-the-shelf and get the stuff quicker. Have shorter supply lines, that'd probably be better overall, but I want whatever is going to save the lives of the people I'm fighting with and save the lives of as many of the enemy as possible. I don't want to go out and kill a bunch of the enemy; I want to kill the minimum number and then get them to turn around and follow our policies that the government wants them to do. Whatever does that is what I want to do.

Would you prefer using a robot that has been built and developed by a foreign country or one that has been built and developed in-land?

That really depends. Theoretically, I would like everything built in America because we control it. But if it's made in Canada, that's fine with me. I want to make sure that I can keep buying parts, make sure I can keep buying the robots I need. I wouldn't want to buy them from China or Russia because I don't know if they're always going to stand by us when we need their help and support, or even France for that matter. Theoretically, buying American is better.

9. Do you have any additional comments regarding robots and their use in the military?

Nope, you covered everything.

10. Do you mind if your name is associated with your answers?

No, I don't mind.

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Appendix H.6: Professor Michael A. Gennert, Computer Science

Friday, December 5, 2008 at 1:00 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

I'm an associate professor of computer science and department head of computer science and director of robotics engineering. I teach introduction to programming and design, discrete mathematics, computer vision, computer processing, artificial intelligence.

2. What do you believe are potential advantages of robots used in the military?

Potential advantages are they can go to places too dangerous for human being. Right now, they are used a lot in IED Detection and Disposal, and UXO, which is unexploded ordinance, same thing, same kind of problem, only less well hidden typically. They usually get blown up, and that's fine because the human being didn't get blown up. Used for some surveillance tasks also; throw a robot into a room and let it do reconnaissance or surveillance of the room. Again, it keeps people out of harms way. I've seen an example of a weaponized robot which is actually fairly scary, and I've heard the claim made, by Rod Brooks formally of IRobot, that the weaponized robot lets the robot shoot second, which is a big advantage too. Imagine a human encountering a potential threat, the human has a chance to wait and he might get shot, and he might not survive the encounter, whereas the robot can wait and be the second one to shoot if it comes down to that. So, there's that argument.

3. What do you believe are potential disadvantages of robots used in the military?

Weaponized robots have the disadvantage of potentially taking actions we don't want them to take, so that's why they're not weaponized much yet today. They distance people from each other, and it makes warfare seem more... like a game, less harmful. Like it's easier to drop a bomb from an airplane than to shoot someone in the eye that you can see. Robots just sort of increase that. They also have the drawback that it doesn't let the person interact with the society they're trying to govern or secure. A great advantage of people is that they can hand out candy, help build infrastructure, befriend the population they're among, robots don't do that yet.

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

The future is enormous because robots get cheaper and more capable, and people get more expensive over time and not much more capable. Certainly there's a big advantage of deploying more robots, you can have more force in place. I think that pressure will just increase to have more robots. I think the issue of having robots commanding weapons is going to be very hard to deal with and I don't see us replacing soldiers any time soon. But, lots of tasks could be automated, for example, convoys could be autonomous, so you have

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perhaps a driver of the lead vehicle and the other vehicles just follow, and you get more people out of harms way that way. More tasks around ships and airplanes can be automated, so you have less airmen, airwomen, and people in the navy who are loading ordinance onto planes, loading guns, dealing with material, it would be good to get those people out of harms way. And with machines that might be possible.

5. In what fields do you find robots most useful in the military now?

Right now, most useful is for IED detection and disposal, and its surveillance. Then there's the whole UAV, Unmanned Aerial Vehicles, like the Predator and Global Hawk, so there's sort of a hybrid between autonomy and teleoperation. They fly by themselves fairly well, but someone is always monitoring them, and if they do launch a weapon, that's always under human control. Humans happen to be back at Nellis Airforce Base in Nevada, which gets to the earlier question of distancing people from people on the ground. These people commute into this base, watch the screen for a while, press buttons, blow people up, get back in their cars, and go home; it's all so antiseptic, and that's not healthy.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Very useful, robots can go various places humans can't go or can't go safely, robots can be hidden, they can be very small; you could leave a robot somewhere and have it surveillance for hours, days, years and not get tired potentially. And it's well hidden, do a good job, out of harms way. A real good thing.

Reconnaissance

A little trickier, obviously surveillance implies you can stay in one spot. Reconnaissance you have to move around a little bit. Same logic applies, you can have a robot on a mission for a long time ... out of harms way. Those tend to be teleoperated rather than autonomous, but I think there's a real big need for those.

Security

Yeah, patrolling perimeters for example, they do have those devices now. In security, though, they may have interaction with people, when you encounter either people who are there innocuously or who are threats and that takes more judgment, and people aren't as good at dealing with robots as they are dealing with people. Again, if worst comes to worst, you lose your robot not a human, or worst comes to worst you can make a situation worse because you don't have a person on the ground to allay suspicion, calm down somebody, or reason with someone who can be reasoned with. So you have drawbacks and advantages to that.

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What sort of force do you think would be appropriate?

Certainly non-lethal force. This way in the worst case, no irreparable harm is done. Even then you have to be really careful because what's nonlethal to most adults might be lethal to a child, and even a rubber bullet has been known to kill a person. Nonlethal force isn't always nonlethal, it turns out.

Automated Defense Platforms

Now you're getting to a more complicated area. The greater the operator control, the greater the benefit and the less the risk. On the other hand it puts more humans in harms way, potentially,

<This ends the face-to-face part of the interview; the following is his responses to our questions in an email.>

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

No, although that doesn't mean that they don't exist.

8. Would you prefer that the military use custom specified robots or > standard off-the-shelf robots? In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

Custom vs. Off-the-shelf: Either, as long as it meets their requirements. Note that for mission-critical applications, off-the-shelf devices are highly unlikely to meet the military's extensive and exacting list of requirements.

US vs. foreign-produced: Would be highly concerned about sensitive technology in the hand of certain foreign nations. Also, concerned about possibility of foreign robots deliberately failing during operations.

9. Do you have any additional comments regarding robots and their use in the military?

For robotics weapons, the question can be distilled down to "What are the rules of engagement?" Right now, no one knows and most people in the military are unwilling to take responsibility for this. I have heard that Special Ops, which is inherently a riskier profession, is an exception and is more amenable to deploying robots. Let me also make the observation that we (grudgingly) accept casualties from friendly fire as part of the cost of war. We seem much more reluctant to accept the same from friendly robots. Rightly so.

10. Do you mind if your name is associated with your answers?

No.

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Appendix H.7: Professor Janice Gobert, Social Science & Policy Studies

Thursday, December 4, 2008 at 2:30 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

I'm a professor of learning sciences with a background in cognitive psychology and artificial intelligence, that's sort of the two fields that cognitive science draws on. I know some current issues in robotics, but I've never worked for the military and I've never had any personal relationships with any robots.

What kind of classes do you teach?

I teach intro psych, cognitive psych, I just did a course on learning environments for science education

2. What do you believe are potential advantages of robots used in the military?

I'm not sure what's within their scope, and within their goal of using robots, I think offloading the information offloading the now-paths, maybe testing out land-mines and things like that. I think if you can save human lives using robots that's always critical. If there's a way we can sort of use robots to send them out to test various areas and sensors and things like that, that would be an excellent use of robots.

3. What do you believe are potential disadvantages of robots used in the military?

I don't know that I can think of any disadvantages per se. The disadvantages are a little more difficult to phrase my answer, so I'm going to open it up a little bit. You can program an expert system or a robot to react in certain ways, but the kinds of knowledge that have to be formalized to do that are difficult and complicated, and so, I think, not that human reasoning is completely without error, there's human error, there's a lot of complexity in getting a robot to think and behave in the way that a human might. So I think that to start with I could see a plan of action that would be pretty realizable for robots in the use of the military but I think in the long run, the degree to which they can take over more and more complex tasks is an empirical question, and certainly a very complex one.

4. What are your thoughts on the future of robots in the military? Where do you see the technology headed?

Well I think, getting back to the most useful technique, I think of using robots where the risk of loss of human life is too great. If we can offload these kinds of tasks to robots, things like going down into areas where you're trying to access where there are enemies, troops, etc. That would be key - that would be ideal, actually.

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Are you expecting them to replace soldiers, or simply act as a supplement to them?

A supplement and a tool, yes.

Could you be more specific?

I can imagine a scenario in which, and you know my knowledge of what the military does is somewhat limited, but I can imagine, I've heard of lots of cases in Afghanistan and such, where someone's been driving over an area and a bomb has blown up the car, I have a friend whose cousin was hurt that way, he could have been killed, thankfully he wasn't and he wasn't crippled thankfully, but hit entire body has shrapnel in it basically because they drove over an area that had a bomb. So, if you had less, I mean robots are not going to be able to drive any time soon, but if you could have only one driver, or you could send them over those paths ahead, that would be a potentially very useful thing to do.

5. In what fields do you find robots most useful in the military now?

It would make sense to me that they would be used that way to test things out. That would make sense, because an area where they're more easily programmed for the information and knowledge directions they need, the operators are able to work and take into account, and the human life risk is great, so therefore when you evaluate those two things, hand in hand, it seems like that would be an area in which we should invest, and it's realizable, I mean it's an attainable goal and it saves human lives and that is a win-win.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Well they're probably very good at detecting any movement at all; I mean they're probably as good as humans maybe even better than humans, so surveillance is definitely an area that could be used.

Security

Yup, absolutely

Automated Defense Platforms

Not sure

Reconnaissance

I guess it would depend on the nature of [the] Intel; again some things are more obtainable than others.

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Bomb disposal

No additional comments

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

No, and I can't foresee any either. I know the human subject is ... really well, I've started an IRB at the company I used to work for and governed it for a few years, so I really can't see any ethical issues in doing so in the development or use of robots.

In regards to the rules of war...

Well, I don't know we haven't really addressed whether robots themselves would really have weapons. I suppose I could imagine a scenario in which you have bombs hooked up to a robot, you know, going into an area and blowing it up. Here's an interesting one, say you strap a bunch of bombs on a robot and send it into enemy territory, my question: is the robot capable of differentiating civilians from ... That becomes, and again, that's a really hard thing to imagine, say if you don't want to kill women and children, do you just go by the long hair rule, well not all women have long hair... I think there's some ill-defined properties there that become difficult to encode in order to make the system fool-proof.

You have concerns of the more automated identification and one such issue that's being brought up is how to incorporate a robot with the chain of command?

I think that, in that case, if I understand you correctly, it would probably be a bad idea to have a robot draft with weapon, because also they could end up in enemy hands, and then they would get weapons. That's another reason why not to do it.

If there is a scenario where a robot is automated in some way to perform a task and it mis-performs that task or a person is killed that shouldn't be killed, how would this relate to liability, who's responsible?

Then it's the people who govern the rules of the robots, right? ... I guess, to be cautious, if we use the robot exclusively without weapons to start with, and so they're only on determining boundaries, safety issues versus not, etc. Definitely in factories, going out specifically if you now you've got a whole set of land mines or whatever, and you want to detonate those, because right after you're going to cross with your soldiers, then you can explicitly have that goal. It seems to me there's some clear ways to proceed that make sense that are programmable that are useful that save human lives. And that as we learn more and more and as technology increases, we can make more complex use of robots. But I think we should move cautiously beyond the point of them seeking out Intel, safety borders etc.

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8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

I guess you'd have to decide based on the task. I think [that decision] is up to the military, also because the design is a really extensive component and the sensors and things are a very extensive component so I guess you have to decide based on the task of the robot what kind of sensors and equipment they may or may not need to equip every robot with every type of device, because again, they're not intelligent operators themselves, unless what you have is another use I just thought of, if you have something with a video camera that's logging in real time, streaming in real time and then you're going to make a decision how to proceed, you're the human actor proceeding with the robot, then you have robots with those features and you're going to use them for that purpose.

It depends on what and maybe where the mission is being performed?

Yeah, where and how

In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

Well I don't know, that's kind of a hard question. In some respects it makes sense to keep that development in the US. It makes sense to keep that development only in companies that we're allies with, but that changes too. I think to be prudent, and I always like to err on the side of caution on things such as this, that it makes sense to have American designed, built, systems...

9. Do you have any additional comments regarding robots and their use in the military?

No.

10. Do you mind if your name is associated with your answers?

No.

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Appendix H.8: Major Jeffery Hilt, Military Science

Friday, December 5, 2008 at 9:00 AM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

My name is Major Jeff Hilt. I am a field artillery officer. However, I am now an acquisitions professional of the acquisitions core in the Army. My job and experience with robotics has been with in combat with unmanned aerial vehicles, UAVs, and then at a job working as a capabilities manager for...and unmanned systems at Fort Knox for computer combat systems. We helped developed tactics...We also developed the design with capabilities...that go along with robotics for a...force. I did that job for a little over two years.

What was your major area of study while completing your officer training?

I am a graduate of the University of Southern Mississippi. I was history major. However, I've also attended the Field Artillery Officer Basic Course, Field Artillery Officer Advanced Course...Acquisitions Basic Course, Elite Contracting Course, and a number of Advanced Acquisition University courses online for acquisitions.

2. What do you believe are potential advantages of robots used in the military?

Force protection. When I say force protection, I refer to when we put a robot in harm's way as opposed to a soldier. It basically makes it an extension of the soldier where it could be anything from taking casualties to becoming captured themselves.

3. What do you believe are potential disadvantages of robots used in the military?

You become dependent on them and you depend on technology and not on the unique senses that a human being has. You cannot depend on technology; the technology of a robot is an inanimate object no matter how good artificial intelligence becomes it's nowhere near where it needs to be. It doesn't have a gut feeling, it doesn't have senses, and it can't sense if something is wrong. There's no gray areas, it's either black or white, and that could lead to a lot of potential problems.

So you're major concern is the loss of expertise.

I'd say more lack of situational awareness. The world is not black and white. There are many gray areas involved. You don't know when to shoot or not to shoot. Just because the rules of engagement say you can shoot, doesn't mean that you should or you have to. That's what I mean by that.

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4. What are your thoughts on the future of robots in the military? Where do you see the robot development headed?

It's heading down a great road. From my experience in development and seeing them implemented in combat, robots save lives. Instead of now using an individual to go diffuse a bomb, you can use a robot to do that. If a bomb goes off or it's set off intentionally I can buy another robot, I can't buy another father of a child, an uncle, or someone's son or daughter. It's moving forward at a rapid pace. There's DARPA, I'm not sure what DARPA stands for off the top of my head. There's a lot of research going into robotics using not only combat platforms with weapons, sensor platforms, communications platforms, relays, using a robot for supplies, called a Mule and preventing casualties...logistics. I see soldiers using robots in the future in combat operations.

Are you expecting robots to be a replacement or simply act as supplement? That can be in general or in certain operations yes and in others no.

You're never going to replace a soldier. You can only use a robot to supplement them. They will be a combat multiplier. You can't replace a human being. You utilize them in certain operations, but you just can't replace them.

5. In what fields do you find robots most useful in the military now?

Right now for explosive ordinance, IOD, roadside bombs, checking out areas to see if they're booby-trapped, things like that where there is a greater than average chance of the soldier being blown to pieces or severely injured, you can send a robot in. Also, for exploring small areas like caves in Afghanistan, covert operations mainly.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Those are a great. We don't have enough of them for surveillance. Again, a robot that is smaller and has a lot better senses when it comes to seeing or hearing than a human. You can do that without endangering a human. Those are a great advantage and I look forward to those.

Security

Security, they can be a supplement but they cannot replace. Again, you don't want people to start depending upon technology because there are gray areas. You do something initially to supplement the human in the loop, the man in the loop and the person in the loop...again, that's getting a little like artificial back in the 80's, RoboCop, things like that. There is no such thing as artificial intelligence, at least not now.

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Automated Defense Platforms

Again, there's got to be a fine line with that...The obvious, called...it's a defense platform, it's got...and there's different ways that you can activate the thing. You can either put a man in the loop or you can make it completely automated, but if you automate it and something steps inside the sentry range, it's going to get blown up – it may be a cow, it may be a small child, it may be something else. That's something that is heading down a very slippery slope.

So if I understand you correctly, you're saying that the soldier always needs to be the decision maker for this type of operation.

Yes, that is correct.

Reconnaissance

Same thing with surveillance as with reconnaissance – You can put them out in fights, if they get blown up, I can buy more parts, I can't buy another person. You can mount a number of things on there - radio intercept, vision recording. Remember, a human once they see something they have only their memory to go back. With a robot if they have a camera on there, you can go back and you can analyze that data and send it back. It gives more personnel the opportunity to analyze what's out there. It's a great thing and we should continue to move forward with it.

Bomb disposal

Do more, do more. Again, as technology increases, the enemy is not dumb. If I can put robot in there to do something that's got the manual capability to disable a device, if they both get blown up, oh well, it's just a robot, not a person.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

There's a lot talk, we have a lot of internal guidelines for the use of robotics. We are mandated to have a person in the loop because again, there are no gray areas with a robot – garbage in, garbage out...It's going to do what you tell it to do, there's no take back.

Do you know the name of that regulation?

There's no law or regulation, it's more a standard operating procedure...I'm basing most of this on, that is a tenet of robotics operations - that there will always be a man in the loop.

What do you think might interfere with the development or robots, if anything?

Lack of technical maturation to make it do things that you want it do it. There are a lot of technical issues, along with bandwidth. If you want to operate these things remotely, we

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don't have the bandwidth available to do so - the government has sold a lot of bandwidth back to commercial assets, so we're limited to what we can utilize. Those are the two main things right there...

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

I'd go with the module approach because we have limited access, money mainly. No situation is ever going to be the same. So it's not really cost effective or...performance to do that...having a module or kit to get the best of everything you possibly can, slap on package on, take another one off, that's the best way to go.

In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

I'd have to go with U.S. based companies. We are limited by law that we cannot use anything that's produced from a foreign country...flash drives were built in Germany, but we can't use them because you need an import-export license, an NBA, I don't remember the acronym off the top of my head. We're bound by law to use only U.S. parts.

I can find out for you and get back to you. I can't remember off the top of my head, I'm taking my notes and I will found out what law is later...I have a friend in the Pentagon, he's all over that.

9. Do you have any additional comments regarding robots and their use in the military?

You cannot be over-dependent upon technology. People think technologies should win wars, but the boots on the ground are going to win wars. You can have all the robots and missiles that you want, but somebody has got to operate the robot, somebody has got to be able to analyze...and based upon information the operator receives, he can then in turn make an informed decision whether to ignore the situation or actively act upon by means of machine guns, rockets, or call for some other...platform. But technology is not a replacement for machinery. You're not going to...this isn't Star Wars...Well, you still need the...to go in there and put boots on the ground and assess the situation...itself.

10. Do you mind if your name is associated with your answers?

Not a problem.

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Appendix H.9: Lt Colonel Terrance Leary, Air Force and Aerospace

Thursday, December 4, 2008 at 1:30 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?) What classes do you teach?

I am a commander of the Air Force ROTC Detachment, which is one of the commissioning sources where a student can participate in a civilian college and at the same time pursue a commission when they graduate as an officer of the United States Air Force. So I'm in charge of running that program for the students in the consortium and taking care of the cadre that help around that program.

Do you have any experience with robots in the military?

Limited. I mean my definition of robot, I took the survey, it's probably, you know there were a couple that you went through when taking the survey - to me a robot that can be anything that helps or facilitates automation. So my background is program management engineering and the acquisitions system of buying and selling and upgrading the weapons systems. Like the helmet over there is a fighter pilot helmet that allows you to, without turning the plane, to look over there and fire a missile. The goggles are night-vision goggles, and in some sense the helmet is a little bit of a robot, an automated system, where as the goggles really aren't, they just enable you to see at nighttime type of thing. I'm familiar with unmanned air vehicles and the Air Force's use of those. But no personal first-hand experience other than developing things related to helmets systems if considered some form of automation.

2. What do you believe are potential advantages of robots used in the military?

I mean I think the big advantage is to keep from putting human life at risk where a robot or an automated piece of equipment can do the job. And then the other one would be efficiencies and speed. So, typically, you're going to pursue one of those things, or possibly a combination of all of the above. You're either going to try to limit risk to life; you're going to do it for speed's sake, or you're going to do it for efficiency's sake.

3. What do you believe are potential disadvantages of robots used in the military?

Well, I'm in large favor of it. I mean the disadvantages would be cost. And in constraint, poor economic times, that we seem like we're in for a while now anyway and with reducing budgets and increasing costs for manpower and personnel, it can come to a point where you can't really can't afford all of the automation and robotics that you might want and they tend to be very expensive materials and if you're using it to save human life and destroying them, then it's costing to replace them. I think the other possible big negative would be to lose the, the loss of knowledge, the loss of corporate knowledge where you become reliant on the

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robot to do something that man or woman used to be able to do. And you kind of lose that expertise. So those are probably to two big ones that I can think of off the top of my head.

4. What are your thoughts on the future of robots in the military?

I think they're going to impact every facet of every branch of the military, I mean I prefer to talk mostly to the Air Force because that's my expertise. You know, I've been in 22 years, going on 23 and you know the whole idea of an unmanned air vehicles is to you know, tackle air speed in pilot-run, pilot-centric air force even when the first unmanned air vehicles, like Patterson when they were fielding predator and global hawk initially, and there is a lot of resistance. Some of the community, that this is just a toy, and you always need a pilot, you need the decision maker. But being with a science and engineering background, I've never had that misconception. I think there are some old attitudes that need to change but I think that it's rapidly progressed in the last, let's say since 2003 timeframe, so the last 6 years, 5, 6 years. I think that we've just on the beginning of a huge up-slope and maybe an erythematic or exponential growth of the use of technology and robotics and automation.

Air force focus:

Yeah, I think that the unmanned air vehicle is here the stay. The Air Force is in the process of actually creating, the UAV is probably, when you think robot in the air force the two places that we use them the most, where our personal would physically use them would be security forces, explosive ordinance disposal, which is very similar to what the Army would use it for and different types of unmanned air vehicles, which the army uses as well for tactical intelligence but the air force has ones that fly higher, and loiter longer, for long term surveillance and reconnaissance. I mean, you can call a satellite a robot if you want, and we've been using those for years. The Air Force, like I said, I think, they're eventually going to, they've gone from a little bit of resistance to having a UAV, to even having a UAV, to arming a UAV, to allowing UAV's to fire arms and kill people, let alone collect intelligence. In the works are unmanned combat air vehicles that can actually fight air-to-air dogfights, recognizing that the limiting factor in air-to-air engagements right now is the pilot. The human in the loop is the one that can't put up with faster, higher, speed, turns, sharper turns, so the pilot becomes the limiting factor. There are contracts out there in several stages of development for unmanned bombers, unmanned air-to-air dogfight aircraft. But you know, I think the Air Force and really part of the survey, it's probably one of your questions, but where you draw the line to me is the decision maker always needs to be a human element. If it's a decision, take off, turn right, turn left, that can but automated but if it's a life-death decision, to me that's where the human always has to be in the loop. And I think that's where the Air Force community is kind of slowly starting to become comfortable with the UAVs to help fire missiles and that type of stuff. Okay, there's a pilot and weapons controller there at the console, they're collecting the intelligence as it's collected and they're making decisions. The robot/ UAV/ satellite, whether is a laser on a plane, a laser on a satellite, even if it were a ballistic missile launch and the air borne laser had the ability to protect that and fire it's laser, that needs to be a human decision to me because it could be an aircraft. If there's a mistake somebody needs to be held accountable, somebody needs to be blamed. That's part of the military's responsibility, that's why we're given the

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responsibilities that we are and the human in the loop, not the robot in the loop, is the one that's ultimately responsible.

Are you expecting them to replace soldiers, or simply act as a supplement to them?

I think the more, you know, UAV is a perfect example. There are rare instances where they want to try to disarm something and reverse intelligence and find out who the source came from, but most times they just want to not kill anybody. So I think that's clearly an area where human life is at risk to handle that material and clearly you want to replace, do as much as you can except by specific case-by-case exceptions replace the person with the robot. I think the majority of the Air Force uses though, relative to satellite and aircraft, will always be a supplemental and in some sense, like I said, it could be an airborne laser, a satellite laser, on an aircraft doing a defense mission that's automated. You still need a person manning a console 24/7, as long as that asset is deployed, that can confirm its decision and prove it. We man our missile silos, we're not going to leave a laser, just like we're not going to leave a nuclear weapon with a computer that's going to make the decision, we're not going to let it make the final execution order. I don't see the military really ever getting to the point where they're comfortable that a machine makes the execution order. In that sense it will always just supplement and require less man power.

So just following the chain of command?

Right

5. In what fields do you find robots most useful in the military now, or in the future?

Well, clearly security forces, and not just EOD – security forces, perimeter defense, base defense, those areas, Intel surveillance and reconnaissance. And like I said, with the UAVs, so strike-missions, interdictions, suppression of enemy air defenses behind enemy lines is a perfect example of where a stealth bomber UAV of something like that. You could make a plane that could penetrate people's air defenses without putting a human at risk and attack their service to air missiles, so when that when the planes do fly in to drop bombs, they're not at risk. Right now we use the B-2 and the F-22, which are a 2 billion dollar aircraft and a 100 million dollar aircraft. We only have 21 B-2s, the stealth bomber, and we use them to do those jobs and you could build a robot much cheaper to do that and not need the man, but maybe have the man at the console. But what I was going to tell you before is that they've created a career field in the air force, called the UAV. Basically, they've been taking pilots and making them fly the UAVs. They're looking at changing that because in the Army enlisted can fly, only pilot and ward officers can fly helicopters and planes, but their UAVs their enlisted troops and non-rated people that haven't been through pilot training can fly them. In the Air Force, up until this year, only rated pilots, who have been through pilot training, UPT, were allowed to fly. We're moving away from that. We're doing an experiment this year and next of putting some non-rated people and putting them through some training of how to fly UAVs. And then they're going to make a decision in the next year on whether or not that's going to become a career field. My prediction is that it will become a career field and officers that haven't been through undergraduate pilot training,

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UPT, will be allowed to fly UAVs. Eventually I would not be surprised if within the next 5 years enlisted troops are allowed to fly UAVs. Doesn't mean they will have the authority to fire the missile, they'll do the flying, and there will still be somebody on duty, or on watch, whether it's one officer for 5 UAVs at a console that is responsible for making that executive decisions when ammunitions of life is at risk.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Surveillance, to us, the difference between reconnaissance and surveillances is reconnaissance is when you actively go out and try to collect specific intelligence; you have some reason to believe there is something available. Surveillance is a passive activity that's always on. It's a satellite or a UAV that's put in an area, or it's an electronic signals collector. To me, surveillance can be completely automated. You don't need, whereas reconnaissance would be you're going into a specific area to collect intelligence and you might have a hell-fire missile on there where you need a man in the loop still if you want to act on that intelligence at the time. I mean, you can have a robot query somebody or set off an alarm say we think we have actionable surveillance intelligence gathered and get a decision maker quickly to do some analysis and decide if they want to act on that surveillance information.

Security

I think it's a huge enabler and a force-reduction tool for security forces. Like I said, in ordinance disposal, when you go to try take the man out of the loop, make it the reverse - the robot is the standard, but the man is the exception. Of course, that man is probably operating the robot, but that's fine. In security forces the goal would be to reduce the number of men by making them key enablers by sensing the detecting the man-power still has to be there.

Automated Defense Platforms

I don't have a whole lot out there that comes directly to mind. Again, it's like the air-borne laser that I was talking about. Even if that's a defensive mechanism, it can still put other people's lives at risk. So to that extent, there still has to be a decision maker in the loop there.

Reconnaissance

Already covered in interview

Bomb disposal

Already covered in interview

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7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

No, I mean, there might be something in the rules of engagement that would. Every time we're in a theater, when we're at war, we establish something called the rules of engagements, and those rules of engagements within a theater, whether that be Eastern Europe, or the European theater where Iraq and Afghanistan are. Or Cent Com, Central Command, where Afghanistan and Iraq are, those rules of engagement might prohibit any machine from acting without a human, or responsible human decision maker. But I'm not aware of anything specific.

Do you have any predictions about where that might be headed? What regulations might be established in the future?

No, I think that comes with the military fields' capability by weapons system. I think with each weapons system they write kind of the rules of engagement for the use and deployment of that weapons system. So it would be in like technical, publications, and instructions relative to the use of that weapons system. So every time something automated comes along, it's looked at on a case by case basis, not a generic. Now, you know, the more and more we automate, more automated driven vehicles and automated aircraft, I think I believe they would be forced to come up with something generic. Actually, acquisitions is the manufacture of things, it's one of the first places robotics was ever put into use. I'll talk about that as specific military capability because we manage that, but we contract it out to Boeing and Lockheed Martin of the world, but that's a huge area of use, whether it's an F-22 assembly line, just like a Toyota assembly line. We build fewer of them when we're talking aircraft, than if we're talking like M-16 rifles or bombs where we're cranking out thousands, but automation is definitely a part of the business and engineering of program management.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

Always off-the-shelf for affordability if it can be adapted to the mission.

So more kind of like having a module that you can add different kits to?

Or programs and whatever, yea. You said preference, so do I believe that most of them, that's a battle that you fight most of the time, even between services. We have a predator and a global hawk that can already do this, why do you need a UAV in the Army that, I forgot what they call theirs, a Sky Knight or something like that, it's very close to the global hawk in capability. Well it doesn't do everything we want; we don't want it in your control. So from a logistics standpoint and cost standpoint, clearly the preference is an off-the-shelf robot that can be adapted. In the political realm and the military chain of command, my guess is that unless forced upon the military they'll go down unique robots.

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In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

I'm a free market person, so whoever does the best, cheapest job, or whoever does the best job cheapest.

9. Do you have any additional comments regarding robots and their use in the military?

Nope

10. Do you mind if your name is associated with your answers?

No, anything we talk about is strictly my opinion, personal opinion, not an official Air Force position.

Appendix H

Appendix H.10: Professor William R. Michalson, Electrical and Computer Engineering

Monday, December 1, 2008 at 11:00 AM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?) What classes do you teach?

College professor in the electrical and computer department also affiliated with the computer science department and robotics. I teach primarily in the areas of computer engineering, I also will be teaching robotics.

2. What do you believe are potential advantages of robots used in the military?

That's a huge question. The obvious goal of robots in the military is really probably two-fold; one enhanced force protection and also force multiplier.

3. What do you believe are potential disadvantages of robots used in the military?

Well, a couple of big risks associated with robots. One is the military has historically really required a man to be in the decision-making role. So if a trigger is going to be pulled, if a missile is going to be launched, as long as I've been working in the military and in history, the basic rule has been it's gonna be a human finger pushing that button to make sure that any such decision went through command channels. One of the big reluctances I've seen in the military relative to robots is the disparity between having the decision-making become automated and making sure that the command chain is being followed. So, that certainly is a huge risk. Other risks, of course, are the potential for misinformation. Of course, we tend to hold machines to much higher standards than we hold people. So, the risk of misinformation... I think the cost of a robot making a mistake is going to be perceived as being much higher than the cost of a human making exactly the same mistake. I think that there's going to be a disconnect that we have to reconcile. In fact, there's a great example. There's an upcoming movie, that's being advertised for a movie, I pay so much advertising that I can't remember what it's actually advertising. But, there's this scene where they have this robotic car driving itself going out to fetch pizza for some secret island. If you look carefully, you see the steering wheel just jostling back and forth at a high rate of speed. Well, that's kind of emblematic of the way we use computers because nobody drives that way, nobody makes course corrections that quickly and that rapidly. In terms of real driving, generally it's a much smoother motion. But we see the example in a vehicle and we're trying to keep the car perfectly in the center of the road. Well, one of the reasons is because the risks of making a mistake with a machine are greater than that of a person.

I think the other issue with robots in the military, and I recently attended a conference where they said that typically it takes between 2 and 4 soldiers currently to operate a single robot - that defeats the force multiplier. Yes, you keep those 2 to 4 soldiers safer, but it actually costs you man-power to deal with robots. I think there are issues and risks associated with that. I know the military wants to push to where robots are actually working members of a

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team and are basically in just team members. But I think the two big risks are working against that currently.

4. What are your thoughts on the future of robots in the military?

I think the most obvious, early deployments and the things that we've seen are deployments with sensors, communications, surveillance applications. I think those are some of places where you get the most payback because that way you can sense your environment and you can gain intelligence without having to risk people. Of course, we've been doing that not with technically robotic vehicles; we've been doing that since the early '70s. But I think that robots will ...

Are you expecting them to replace soldiers, or simply act as a supplement to them?

I would expect that they'll always be supplemental. I don't think that you'll ever have robots in control of a tactical situation.

5. In what fields do you find robots most useful in the military now, or in the future?

Right now, it seems to be primarily surveillance, sensory, things of that nature.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

It's an obvious, early, there's some low hanging fruit there.

Security

I think there's certainly an application there. I think the manpower issue is probably going to be a problem because why not just deploy sensors in my environment rather than having them mobile. Do I buy anything, of putting robots in that application except having more things to watch?

Automated Defense Platforms

Well that, I mean, that is an interesting question. Is the phalanx gun, are robotic systems, patriot missile system, robotics systems?

Under the definition we're using, yes they are

They're already deployed. If the definition includes things that once released track, intercept, a target. Once they're deployed, if they're especially autonomous to the party, then we've been doing that for a long time.

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But you think that it should be somebody pressing the trigger?

Right now somebody in an aircraft deploys the sea-sparrow. Once they deploy the sea-sparrow, the sea sparrow takes over and either hits or misses. But it does the target tracking and the intercept. We've done that for a long time, in guided missiles. That has been considered internationally acceptable for a long time. The automatic deployment is where you run into a problem. If a robot is making the decision to fire, that has tended to be trouble.

Do you think they're ever going to get around that or is that going to be permanent in your mind?

I think that is really an international rules of conduct issue. I don't see that changing any time in the near future. I kind of hope it doesn't change. Robots are machines and I spent a career trying to develop fault tolerant systems and have been reasonably successfully in building some systems that absolutely, positively, work when they have to. But there's still that low probability chance that it's going to make a wrong decision. And people can make a wrong decision as well, but who's going to get prosecuted if a robot makes a bad decision? Our legal system does not currently have any mechanism to hold a robot accountable. What does that mean in a legal sense? I think that those are the issues that ...

Reconnaissance

Already gone there, I think reconnaissance and surveillance tend to lump together

Bomb disposal

That is certainly an area where robotics have been used successfully and will continue to be used successfully. Primarily tele-robotics, not autonomous robotics, which is a distinction, again, it's that decision-making issue. But certainly tele-robotics has been used in application for a long time.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military? Besides the international code of conduct...

I am sure that there are a plethora of military specifications that could be applied to robots. As to anything specifically targeted to robots, I'm not sure. But I would expect that the construction of robots is going to fall into the normal military specifications for electronic systems. I would think the differences would be in terms of the rules of engagement and in terms of how robots are used in a situation. I'm sure there's guidelines, military guidelines associated with the use of robots, but I don't know of any of them.

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8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots? In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

Probably both depending upon the application. I know over the years, particularly in the early '80s there's been a tremendous move to commercial off the shelf systems. Primarily because of the outrage of \$1,000 hammers and \$10,000 coffee pots. But I think that there are some applications that the one-size fits all solution simply does not work properly for?

Can you think of anything off the top of your head?

Most real-time systems. There's a great urge in the electronics community today to sit down with your favorite software package, rapidly prototype something that works very well on the desk top, and in a one-see and two-see environment can be shown to solve the problem you need to solve. But many times the solutions are not scaleable to real working environments. It's at that point you need to make a transition to say well, we've proved the concept used rapid prototyping techniques. Maybe if we only have to do it once that's good enough, but if we need to deploy something in large numbers or have a large number of users be able to deal with it or incorporate it in a variety of different vehicles or weapons platforms, ultimately there comes a time when you need the customization. Although we have been shying away from that quite a bit lately. I do know in the homeland security businesses, there have been a lot of, particularly mesh-network solutions that work very well when you're dealing with 4 or 5 security officers, but when you're dealing with 4 or 5 hundred they fail miserably. Object recognition is another great thing when you're dealing with surveillance applications. You're dealing with unknown object detection and are trying to identify objects or identify faces. Facial recognition works great if the subset of faces that you're looking for is small enough. if your base is 100 faces you can be pretty accurate identifying 1 face from another...if your base is 1,000 you're not gonna be so accurate. There are still some things and this is why you kind of don't want the automatic targeting. Right because if I look at you and I look at [one of my colleagues] you have some features that are reasonably similar. If I have you both siding side by side, the differences are really obvious. If I have the two of you sitting 200 yards out, which one am I going to pick as the right one? It becomes much more difficult. then if I stick you in a crowd of 500 people, how am I going to guarantee that I'm going to pick you out accurately... humans still are very good at picking out those minute differences, machines have a tough time with it.

9. Do you have any additional comments regarding robots and their use in the military?

No, I think that this has been fairly comprehensive. Just the tip of an iceberg. It's a huge problem.

10. Do you mind if your name is associated with your answers?

Nope, and everything I say to the best of my recollection will be completely true.

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Appendix H.11: Professor Bradley A. Miller, Mechanical Engineering

Thursday, December 11, 2008 at 3:00 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

I'm the associate director of the robotics resource center, and I teach intro to Robotics

2. What do you believe are potential advantages of robots used in the military?

They would save lives, maybe do a better job.

3. What do you believe are potential disadvantages of robots used in the military?

They would turn the military into a bunch of video gamers, and they would have no concept of what they were actually doing. Nobody would be noticing the numbers of people who were killed... No one would ever even have to change their carpool to fight a war.

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

Initially, I would think they would act as a supplement, but in some cases they would out-and-out replace people. I would expect that the new F22 fighters are probably the last manned fighters and after that will be robotic. In that case, it's a pure replacement, at least for the pilot, if not for the rest of the crew. I would think that for other stuff it would be a supplement ... sophisticated it can actually do a better job of really operating all kinds of stuff.

Would you envision robots being 100% of the on-the-ground military force?

I don't know really...I suppose maybe it could happen, I mean that would be a logical conclusion, so maybe.

Do you think it would be technologically feasible?

Ultimately, sure, in 100 years, yeah.

5. In what fields do you find robots most useful in the military now?

Robots are being used now in the military for defusing and finding bombs, doing advanced surveillance of caves and villages and things like that, looking for snipers and looking for terrorists, search and rescue things. They're arming predators, which were once only a surveillance platform and now they're armed. This kind of thing is in the military today, this kind of thing. Kind of transport stuff, where you have robotic vehicles that are carrying

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supplies that follow troops, and they pretty much have that today or next week or something. That's what I see today. Lots of marine applications, lots of naval applications, cruise missiles are robots, a bunch of sensor inputs, a bunch of computations, and then drives the motors, and it happens to blow up at the end, and it doesn't mind, so that works.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Yeah, predators

Ground surveillance

Nobody surveillance the ground from the ground

Security

Absolutely, might as well be happening now

Automated Defense Platforms

Those exist now, for sure. They exist on ships for incoming missiles and things like that. Those have been around for years.

What degree of automation do you feel is appropriate?

I think it depends on the reliability of the system, but I expect you'd not want to be shooting down Korean airliners quite as often, so you'd want to make sure that you can correctly identify the target before shooting at it. It would depend on the accuracy of the system, how foolproof it really is.

Do you think it's going to get to the point where you don't need a human to double-check it?

I think it's going to get to the point where it will be as good as the human who might be double-checking it at some point, basically making the decision using the same data and making decisions the same way, but then humans make mistakes too. ... You would not want to have an aircraft carrier or some kind of ship get blown up 'because someone was kind of asleep at the switch. You want it to work.

Reconnaissance

...

Bomb Disposal

They're doing that now, police departments do that now.

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7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

I think anything which interferes with the military is probably illegal. I'm not familiar with that.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

That's just a question of economy. You wouldn't want to compromise the quality. Then I guess it's just a question of price versus extra engineering to make the custom version, rather than using...but people always use ...

Would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

Sure, why not, yeah. It doesn't really matter

No concerns of sabotage?

You could easily check the design, there's not reason to believe that a US produced robot would not have some spy person who helped make it... You should be able to check this stuff; you should be able to find out. If you were going to buy fighters from some other country, you ought to know how they work, and what's inside, it's not like they're going to explode when they get to the other country's border. We seem to have enough trouble making our own stuff work, but I don't think it would be a whole lot worse.

9. Do you have any additional comments regarding robots and their use in the military?

My main comment about this is that the first time, much better, and the second time not as well, that Desert Storm was sold to the population of the United States by never showing somebody getting blown up. They showed pictures of smart bombs going down elevator shafts and they showed the luckiest man in the world driving across a bridge that was getting blown up right behind him as he drove across the bridge, but nobody ever died on TV. They would talk about smart bombs and they would talk about fighters and they would talk about how cool the technology was, but they never talked about 250,000 Red Brigade guys getting bombed to extinction in the middle of the desert, and that was to make it more palatable and less horrific. The more you do that, the more you disengage yourselves from the humans, who are really having the outcome of the war, then the easier it is to do it, to the point where, somebody far away says 'I'm going to blow up those guys 'cause they did something' and you press a button in Washington and then some city on the other side of the planet gets blown up, and nobody sees it except in a picture from a satellite, and nobody even has to fire the missile, it just happens automatically. I think it just makes it too easy, people should still be involved. There should be some kind of personal consequence. ...

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10. Do you mind if your name is associated with your answers?

No.

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Appendix H.12: Ms Ellen Purdy, Enterprise Director, Joint Ground Robotics

Tuesday October 14, 2008 at 2:00pm

Verbally explained Informed Consent Agreement – understood and agreed

1. What does your position entail? Enterprise Director, Joint Ground Robotics

“Basically I’ve got two major jobs one is what we call oversight and you keep an eye on what everybody else is doing. Looking at the department of defense we have many services that all operate on the ground, all use ground robotics for various activities and all invest in using robotics to meet needs. If it looks like one service is doing a project that the other service needs, you look at that so that you don’t repeat the work. Look for a common solution; look for who’s doing what. Where are we going to go in 25 years, what are the technologies that you’re not going to get out of the consumer products. Second piece is honest to goodness management. Manage several minds of funding and decide where that money is spent on – applied research and development to build key technologies that are going to go against applications. Look at joint solutions. We would say ok, how do we go about doing that and the office authorize the funding to execute the planning. We actually figure out program objective memorandum – budget across five years. How do you use POM to do robotics stuff over the next 5 years? Try new approaches. Use stuff from commercial sector that you can hop on without spending own money to do it. Constantly adjust. Office authorizes.”

2. Are there equivalent people in other areas of the military, such as the marines or the air force with a position similar to yours?

There are no equivalent people in other areas of the military. She works with any particular branch and her position is within the office of secretary of defense.

3. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

“I think they will almost always be a tool to be used by the service members. A couple things, there will be certain jobs that we won’t want service members to do and would rather have a service member to do – dull, boring dangerous, repetitive. But the way the department uses its personnel is that it’s not one person doing one job at a time, joke about 10% of other duties at a time. Never have a one for one, won’t work that way because one day a person might be a driver and the other day a person leading a patrol. Historically the concentrates on greater and greater areas of the world with the same people. 20 years ago in we were in 40 countries, now we’re in 120 countries. Discovered that we do better as the United States that we would with our partner nations. We train them; work with them, help build up ability to build national security. More partner nations more thinly spread personnel. Going to want robots to do a lot of tasking that we do today, but there will still be the same about of people. For instance, not really a robot but the type of technology you need for an autonomous system – convey of point a to point b, need a driver, person to load and unload the truck,

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somebody to provide security, somebody in case you run into mechanical failure. Number of people to simply move supplies from point a to point b is actually a lot of people. If trucks can drive themselves, then you can move more trucks with the same about of people. Don't need a person driving every single truck, used to take 20 people for a 12 truck."

Is this type of convoy system currently being used?

"Used now – not being used right now but is in testing and we're certainly heading there. There are all sorts of activities that are in development – built in prototype form, put in the hands of soldiers for a whole variety of different types of missions. Still the same thing that people have to do to be part of the task, but everybody multitasks these days. Forward operating bases, somebody has to pull sentry duty every night. If I can have a ground robot with different types of sensors and can react up to a certain level, I can have more people getting ready for the next day's activity. Haven't reduced people but the same people can do more because specific"

Where can we find more information about these developments?

"Developments – military and history channel. Entire piece on battlefield extraction assistant robot. Robot has the ability to go through complex environments. Specifically looking at inside buildings and can extract a wounded soldier. Run into being pinned down and wounded. Can send two people in to carry the dead weight of the soldier. Robot only put one person in risk. (Big dogs on YouTube). The reason that we're keen on that is because if you look at the terrain around the world we do a lot of operations by foot. If you look at the amount of weight soldiers have to carry, you're looking at packs in excess of 120 pounds. Trying to go through very dense jungles – can do that with a robot that you can't do with a vehicle. One of the things that the military engages in quite a bit, if you look at the realm, there has been tsunami – people get cut off because you simply can't get there. One person and a fleet of big dogs you can move a lot of supplies without a lot of people."

Sources for this?

Big dog and Google bear. Find a lot of stuff. Darpa urban challenge under a year ago. Joint robotics.com – sponsors website. Open public released information. www.robotictec consortium now under contract with DOD. Google robotics technology consortium

4. In what fields do you find robots most useful in the military at the moment?

"Right now the biggest use of the robots is in EOD. A little over 6,000 robots in Iraq and Afghanistan. Two missions they do the most are reconnaissance, look to see if there are people hiding in buildings and they investigate things on their own. If they confirm, robot can disarm IED. Doing the reconnaissance, you can see what's in front of you without a person is number one. Investigating things to determine yes or no if it's a bomb and then how to disarm. Cut detonation wire, variety of ways to prevent the bomb from going off. Or just blow the bomb in place – don't want to blow up because we learn how to build the bombs and learn how to counter them. If there's nothing to be learned there, the robot will

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lob an explosive and set the bomb off. Plenty of stories where the bomb did destroy the robots – blown to bits. Rather give up a \$300, 000 piece of equipment than a person.”

5. We are interested in your insight regarding robots in the following fields:

Surveillance

Security

Automated Defense Platforms

Reconnaissance

Bomb or EOD disposal

“Technically feasible and things that will be useful to the military. Variety no currently doing is sentry duties and protection duties. Most robots because of the power sources only do jobs that you can measure in hours. Soldiers need sleep, need to stop and sleep when we figure out how to get long term power to the robots in remote environments we can do missions that last for days and weeks and months. One thing robots will always be used for is reconnaissance, a lot of protection types of activities, a lot of logistic types of activities. What about driver-less forklifts? A lot of logistics and support types of activities. Robots that can do runway inspections. There are only certain places that can handle that weight. Training a lot of times is with real ammunition. Used to knowing when to release the weapons, somebody has to clean up the mess. If we can have machines clean up the mess so that the land can be used for something else is a very very attractive activity. One of the problems is land mines. If we have machines that can go in and diffuse landmines we can use the land for other activities. Millions of acres that right now can't be used because of the mines that have been put down. It's a pretty long list of things that we'll be able to do if we continue on our present course.”

List on website? Not right now...there's snippets...hopefully in December or January we're going to make the unmanned systems integrated roadmap...publicly available. A lot of information is captured in that roadmap

6. Are there any other fields that you feel we should be investigating or will be significant for robots in the military?

No, already answered above. We covered the most important areas.

7. Have you encountered any laws or rules, such as the Geneva Convention that currently affect or might affect the use of robots in the military?

“Yes and no, the United States had the policy that says that we subscribe to the law of armed conflict that has been on the book for a long time. Not everybody agrees with that law. Lots of descriptions on what is fair and not in war. Who doesn't pay attention – terrorists? In terms of being able to use robots for military tasks, we'll always have to build them so that they're in compliance with that law. We may never choose to do certain tasks with unmanned systems. If you look at the way that our system works, there are no requirements for the department of defense for armed robots that are autonomous. There are predator and

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raven, but they're piloted by people. Control is away from where the airframe is – been doing it for years. Patriot missile – autonomous system. Where the action occurs is somewhere where we are not. There are things that we will probably not do. The robot will not identify you as an enemy and fire a weapon. Not sure that we would ever ask for anything like that. I wouldn't be surprised if something like that came from a country other than the United States. Different countries will choose to follow different rules. It will be a long time before you really see an armed robot operating around in the United States. Need to solve how you spoof proof the robot? How do you prevent hacking into the control system and changing the software to go after friendlys? Until that technology is fool-proof we won't go down that road for a while."

- 8. Does the military use custom specified robots or standard off-the-shelf robots. In either case, is the US military likely to use foreign-produced robots, or only ones that have been developed by US companies?**

"Law in the books that says buy American. But when it comes to research and development, we go to wherever the source is. When you get to a certain point in technology that prevents us from doing business with other countries. There are certain things that we will and will not sell to the United States. Depends on the application and what the system is and does."

Have you always used custom specified robots?

"A little of both. In the beginning because the need was so great, we took what we could get, whatever the commercial sector had to offer even if it wasn't a really good fit. Now we're a lot smarter about what we can and shouldn't do, so we're starting to apply our changes that are very much driven by complete military concerns and not of interest to the consumer."

- 9. How much effort is being put into the development of robots on behalf of the military/government?**

A lot, already answered and applied above

- 10. Do you have any additional comments regarding robots and their use in the military?**

None at the moment

- 11. Do you mind if your name is associated with your answers?**

Perfectly fine

Can we contact you again?

If you think of other questions, just send me an email. Definitely get an answer back

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Will you complete the survey?

Absolutely will complete survey

Note: She seemed very interested in our project, specifically the data we plan to collect through the survey. Would like to explore the potential of submitting our work to her office and publishing the project.

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Appendix H.13: Professor Yiming Rong, Mechanical Engineering

Tuesday, December 2, 2008 at 10:45 AM

Verbally explained Informed Consent Agreement – understood and agreement

- 1. Describe your occupation (If a student, what is your major area of study?)**
- 2. What do you believe are potential advantages of robots used in the military?**

We have a narrow definition and a broad definition of a robot. Traditionally, from industrial applications we define the robot is a ... programmed handling devise ... Now, the definition goes broader and broader so anything we can construe to do some kind of a persistable function we can call a robot. The government today, in military applications we see a lot of potential for use and I think now the military people are using many robots already, so that any kind of special case that could be more dangerous in objective due to some kind of infection or many many examples.*

*Basic gist is that robots can go where people can't

- 3. What do you believe are potential disadvantages of robots used in the military?**

I do not see any significant disadvantages. That would require some kind of high-tech stuff and some kind of advancement. The benefits are really obvious.

- 4. What are your thoughts on the future of robots in the military?**

For me, I see them having future development in the space engineering area. In space, we need a lot of manipulators to ... up the thing with some kind of intelligence built in. Like the motor vehicles that you..., sometimes there could be military related applications. Another one could be under sea, those kinds of applications. If we do a lot of good automation ... could be combined with any kind of weapon, and that is very dangerous.

Are you expecting them to replace soldiers, or simply act as a supplement to them?

No, simply because of the use of human common sense to make a lot of decisions, and we have some sort of emotion deeply involved within those ... troops, and the politics...even more complicated. I think a robot is a very good tool you can use, and you have to know how to use it.

You would agree to disagree that you can't replace soldiers' expertise with a robot?

Some expertise, some kind of skills, for example aligning an object you must arrange before cutting, traditionally the soldier has to focus on that kind of thing. Now he can rely on some sort of artificial lighter vision, in the darker environment, a vision system can do very well.

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That part of expertise on a skill level, we may have some kind of tools we can use to extend the human's ability, but intellectually, I don't think we can rely too much on them. ...

5. In what fields do you find robots most useful in the military now?

I do not know much about that but I would like to see more preventable functions so we can use a robot to avoid any kind of defensive from happening. For example, we can detect any kind of dangerous situation no matter when if you use some kind of a low emission radar technology, so to protect our soldiers. ...

6. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

No

In the future, what kind of rules would you expect to see?

I would like to see laws to protect from misusing in a way to harm any kind of human being. But a weapon is a different story. We should make robots much more intelligent, but we should not give too much power to those kinds of intelligent machines, we have to rely on people to make those kinds of decisions. And that kind of thing, we should have laws to regulate that.

So more regulation on something like an autonomous robot you're much more supportive of needing some type of human interaction or control.

Right, certain functions that you know would have to use a human operator to trigger.

The robot shouldn't make the final decision

Right

7. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

I think the military may need both. For some more mature kinds of technology, you can use mass production to produce more or broader use. For some kind of specific things and for more immature product you may have more customizations.

Would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

For military applications we may have more robots developed in the nation. But cannot prevent all the ... for high volume products, that kind of standard product. That's a tough thing. Currently I'm dealing with weapons that are being produced overseas too.

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Do you think the production of robots would eventually be outsourced?

Maybe for the low end products. I think it is very important for the US to keep the high-end products produced inland. That's very important because we need to keep that kind of power here.

8. Do you have any additional comments regarding robots and their use in the military?

Actually I'd like to see more robotics to be regular, more recent activities in the army, navy, because a lot of ... technologies have been developed from military applications.

9. Do you mind if your name is associated with your answers?

Sure. I'm a professor of mechanical engineering and in charge of the manufacturing engineering program, and I'm teaching about industrial robot in the senior level. I also have supervised many robotics related MQPs.

What MQPs have you advised that are related to robots? The titles?

I don't remember the titles. Several students came to me and they had their own idea to make some sort of automated type of robotic assistance that they would like to develop and we finished on last year and another ... in the Mechanical Engineering department. This year we have another one ongoing with... students, 2 of them are robotics engineering majors, and one is a manufacturing engineering major.

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Appendix H.14: Professor John Sanbonmatsu, Humanities & Arts

Tuesday, December 2, 2008 at 11:00 AM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?) What classes do you teach?

I teach philosophy and my area of expertise is pretty much social and political philosophy. I also teach ethics... I teach other courses here but that's kind of my main interest. I'm interested in questions having to do with power and culture and questions of violence and the military, those things have always interested me ...

2. What do you believe are potential advantages of robots used in the military?

None. I can see a myriad of military advantages, but one first has to accept the premise that war is a good thing, and that killing people more efficiently is a better thing, so it's hard for me to see how introducing robots to the battlefield... I can see how it's going to revolutionize warfare, but as an ethical philosopher and political thinker I'm more interested in thinking about ways to end warfare rather than ways of making it more efficient, especially for the stronger power. Because basically the technology is going to be dominated by those who already dominate the world, so it's just going to increase their power over other nations and peoples and certainly I don't think that's good either.

3. What do you believe are potential disadvantages of robots used in the military?

One thing as I just said is it's likely to exacerbate the existing military, political, economic, and social inequalities between and among peoples and states. It's going to further degrade the human subject or individual by #1 reducing the latitude for human agency and autonomy, secondly by giving the choices of killing or not killing over to a machine, which is really one of the ultimate degradations of human dignity that one could think of. We already do this to animals through mechanized agriculture through slaughterhouses, and now it's like Nazism, it's the same kind of principle, that humans are less important than things and I'm going to give you an example of the first concern, the US downed an Irani airbus in the 1980s, I think it was 1987, Flight 755, during the Persian Gulf War. USS Vincende was on patrol and, they saw a blip on the radar screen, and supposedly, if they are to be believed, they couldn't tell if it was a missile or a fighter or whatever, so the point being here they had very little time to make that decision, a matter of seconds, and they decided to fire a missile and not risk an attack and they killed three or four hundred innocent civilians, so the more we empower the machines, the more we disempower ourselves.

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How would it change your opinion if the definition of robot we are using for this report would not only include an automated soldier but would also include things like a remote control vehicle? Given that, would you change any of your answers.

Again, suppose it is Aug. 30th 1939, the day before the Third Reich invaded Poland, and you were to say “well Professor would you be in favor of sending automated control of our convoys for the Reich to make it more efficient to quash Poland?” I would say “no, because I am against the third Reich’s invasion and I don’t think they should have this machinery and equipment anyway” and that would basically be my opinion here. If you look at the uses of, specifically in our Pentagon, because the US military was the initial innovator for all computer science technology, initially for Univac and so forth for ballistic missiles on a trajectories and nuclear war planning and on up until the present it is the engine of growth for the whole industry, especially robotics. If you actually look at the deployment and use of American Military Power over the last century-century and a half it’s always used on the offensive, it’s never used for the defensive, except on a handful of occasions, and it’s used indiscriminately, this has been true for twentieth century and now the twenty first: most of the people we kill are civilians. It’s hard for me to see how powering the military behemoth with new, high tech weaponry will do anything other than worsen the situation.

4. In what fields do you find robots most useful (or least destructive)?

“Don’t we need to look at technology and our artifacts always in terms of the values we’re bringing to them and also their consequences for society? No technology is completely neutral, they all have social implications.”

5. We are interested in your insight regarding robots in the following fields:

Surveillance

Surveillance is a huge problem. This is another example of how human agency and will and existential choices and so forth are being ripped away from us by powerful elites who are employing these kinds of technologies. For example we’re all aware of the kinds of wire tapping that’s been going on by the United States but in China, which is brutal and autocratic regimes that we have in the world, American corporations have been flocking there to help them develop robotic and other kinds of surveillance technologies. In fact, they have some face and group recognition software that allows machines to alert the authorities when more than say two or three people congregate on a street corner. What I see... a writer who’s very interested in the stuff is Paul Verillio has written a lot about surveillance technologies and also Michelle Fupelle but I think that anything that increases the power of the state, the ability of the state to spy on its citizens is dangerous.

But used in a military environment where they could be protecting soldiers who are asleep form a night-time attack?

Sure, again, if they’re fascists do we want them to be protected? It depends on which soldiers and under which circumstances. I mean any kind of technological advantage that

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helps warfare, that helps soldiers to do their mission, is basically increasing the power of that force, right, whether it's directly or indirectly? Even medical technological advantages can help increase the potency. I don't think we can separate our the question you've asked from the political and social realities on the ground like who's using these surveillance technologies and to do what? If it's to invade more countries, why is that a good thing?

Security

IN terms of security, if you think about the terrorist threat for example, it's hard to see how any kind of technology can be used in any kind of ways you've described in terms of either augmenting military force or increasing surveillance of the citizenry.

Automated Defense Platforms

I had this experience: I was at the museum of science, and I was at their robotics exhibit, and I was competing against a robot doing this puzzle/pattern recognition thing and of course the thing beat me hands down, but what was kind of scary to me was how quickly the thing moved. It was moving so quickly that it was almost invisible to the naked eye. It seems to me that this is what the Pentagon wants, are fully automated battle platforms that will completely dominate and outgun any more human being. Now I don't believe there is a realistic scenario that these things will take over humanity, but if you look at the way we have used force indiscriminately throughout all of our wars and are still doing it in Afghanistan and Iraq, this killing thousands- tens of thousands of civilians. You can just imagine what a nightmare: These things are going to go into people's homes, they're going to butcher everybody inside and they'll do it in the blink of an eye and they'll be nothing anyone can do to protect themselves. So I think it's a very bad idea all around. The only social utility it has is to increase power or the powerful.

Reconnaissance

In theory, one can imagine peace-time uses for that kind of technology like Google Earth and satellite reconnaissance but again, it's enabling the military to do its job, we have to ask what the job is and do we want it to do the job of killing and controlling people better.

Bomb disposal

I think that's a very good use for it, and also I would say search and rescue. Unfortunately right now we use a lot of dogs who end up being poisoned in the course of their training, they're made to sniff out all sorts of toxics and then they die of cancer. If we could use robots in the wake of an earthquake, say, to listen or go into dangerous areas, that's great. But again, the technology has to be led into an ethical vision. It has to be a sense of what our priorities are as human beings who are in control of these artifacts and what it is we want to achieve with them. If our goal is to dominate the world we should just keep on doing what we're doing, I mean the Air Force has militarized outer space and wants to put up semi-automatic battle stations up there. If you want to continue to see the third world bullied and so forth then go for it, otherwise. There are some scientists who just refuse to work on

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robotics because of the military and that aspect of it. I think that's a conscientious decision and every scientist or potential scientist has to make that choice, one is never innocent of the uses to which ones technologies are put. ... Oppenheimer, the scientists who worked on the Manhattan Project, a lot of them may have felt the need to do what they did, but then some later regretted it, especially after Japan wasn't given a demonstration trial of the weapon. That's the other aspect of it. ... (Slight aside of about a song about Verner von Braun and his rockets that relates to accountability) I just make the ... and I can wipe my hands of it. But actually if all the scientists said "hey, we think these wars we keep getting into are ruining our national reputation, killing lots of innocent people, we're not going to participate, then the whole thing would come to a crashing halt. So the consent in the technical aspect is the consent in the political aspect.

6. Are you aware of any laws, regulations, code of ethics, morals, anything that might interfere or govern the use of robots in the military?

No, unfortunately there aren't any. That's the damnest thing, like so may of our technologies. I met this scientist once who was working in nanotechnology and I said "what about these people who say this stuff might develop into these potentially lethal, self-reproducing machines." And he didn't say it wasn't possible, he just said "well, we have to be careful with what we're doing" Basically there aren't regulations because capitalism and the state are running everything, and military and capitalism are providing incentives in the structure for these discoveries and there's no democratic accountability. So there's no law as far as I know on any book anywhere that says a robot can't kill a human being or be programmed to kill a human being. Otherwise, we wouldn't have predator drones making these kinds of kill decisions. I'm not sure how that mechanism works, but basically I don't think there are any. Should there be? Of course there should but rules governing warfare are not terribly effective, right? There are the Geneva Conventions and look the United States has completely disregarded them and has tortured people, throwing them in jail for years without charge, setting up secret torture camps throughout the world, this is happening today still, it's still going on. So if we can't even have effective laws, and actually these are well recognized laws that the United States has signed on to International Human Rights laws and wars having to govern force and most people disregard them, so there's no reason to think that even if we had a law with different codes and conduct and all that, I mean look at what are soldiers actually do on the ground, like any soldiers anywhere: they commit atrocities, they rape people, they murder them, they torture people, I mean that is war, and anything that amplifies that, you could say is evil, in my opinion. Unless one wants to make the case for just war, but the problem is once you've created them you can't put them back into the bottle.

Clearly there is something restriction governing our use of force...

That has nothing to do with law or code of ethics that has to do with the fact that it would be politically suicidal, I mean the United States considered using nuclear weapons in Korea and in Vietnam, I mean actively considered it. The United States still, during the presidential campaign, Hillary Clinton attacked Barack Obama, and now she's Secretary of State, Hillary Clinton attacked Barack Obama for saying that the United States shouldn't contemplate the first use of nuclear weapons in Iran. So that still goes on. The United States is the only

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country ever to use Nuclear Weapons on a civilian population, and that has never said it wouldn't do it again. So the only reason we don't do it, the only reason we didn't use them in Vietnam is because they weren't shown to be militarily effective.

So you think them looking purely towards their own gain which is governing their use of whatever methods they have?

Well the Prussian military strategist Von Clausewitz said "war is the continuation of politics by other means." And that is still the case. In other words, the only reason we have instruments of war is because there's desires for power, domination, and control and occasionally defense but whatever, I mean we don't have a Department of Defense; we have a Department of War. I think it was Herbert Marcuzza the philosopher who pointed out that once that decision was made to re-dub the department of war, which is what it was during World War 2, the department of defense, the game as over. So now we spend, you know, 400, 600 billion dollars a year on so-called defense and it's all offense, there's no defense. You can't even defend against terrorists, really; look at the 9-11 attacks, what are you going to do? Scramble some planes against 19 guys with box cutters? It makes no sense, so we have this huge juggernaut of destruction polluting the earth, killing innocent people, enriching the rich and making the poor poorer, and the question I think is how to stop it, it's not how to make it go smoother.

7. Do you have any additional comments regarding robots and their use in the military?

<He appreciates us for doing the project>

Appendix H

Appendix H.15: Professor Ruth L. Smith, Humanities & Arts

Tuesday, December 2, 2008 at 3:00 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?) What classes do you teach?

I teach in the religion and philosophy part of the humanities and arts department and I also teach in rhetoric and rhetorical theory communications and I also teach courses like... right now I'm teaching the problem of evil and I teach religion and culture and rhetorical theory and introduction to philosophy and religion

2. What do you believe are potential advantages of robots used in the military?

This is not something I've studied, presumably robots could be used to prevent human beings from being the combatant, but whether that is an advantage or not, I don't know. There is also concern that it shields the damage people do because even though someone might sit in Colorado and anguish over what they are telling a robot to do in Afghanistan, they're not actually having to ...

3. What do you believe are potential disadvantages of robots used in the military?

Well not having to confront what you're doing and therefore not developing a certain kind of consciousness or self-consciousness. I mean robots can go awry like anything else, so they do not necessarily solve the problem of being specific of ... a target, they may be aimed at knocking a target but may be damaging ... That issue may never be eliminated. But that issue of not having a direct link with the damage that's being done.

Just for clarification, the definition of robot we are using for this report would not only include an automated soldier but would also include things like a remote control vehicle. Given that, would you change any of your answers.

Well if it were a remote controlled vehicle, I'm thinking about a story I heard of a vehicle that was carrying a huge piece of equipment, maybe a generator, and there were a lot of concern that they wouldn't make it, but it could have been blown up whether it was a robotic vehicle or a human driven vehicle. I suppose if it were robotic, those humans driving it wouldn't have been jeopardized, but it wouldn't have meant the vehicle itself ...

4. What are your thoughts on the future of robots in the military?

Well again, it's a very complicated question and the military is already doing all sorts of robotic or robotically driven operations, so I don't really have an educated way of answering that. Again, the question is would robotic operations replace human ones and what would

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that resolve? I realize that could protect lives and could perhaps keep people from harm and could perhaps carry out certain operations, but the conflict is going to find some avenue, I think, that will put humans to humans, as we saw over the weekend in Mumbai, because it's humans to humans that conflict announces itself, and that would be chosen by anyone wanting to make whatever point they were trying to make. So if you don't have humans driving the vehicle out in the desert, you can find them somewhere else.

So you're saying whoever they are, the offensive person is going to try and find humans on the other end?

I think so, yes. It's not to say that they wouldn't do other kinds of damage just as people always have in war, try to do other kinds of damage, but it's the human target that prompts or allows one group to make a point.

5. We are interested in your insight regarding robots in the following fields:

Surveillance (description)

Well there's the line isn't it. It isn't by prohibiting surveillance it won't happen, it already does. There's millions of cameras around Worcester. I did think that citizens ought to be more involved in some distinction and not only military who are always trying to give citizens a secure feeling that the best decisions are being made. Whether the military would ever mount surveillance, I can't imagine they wouldn't, that's what surveillance was designed to circumvent. I can see that surveillance of an area hard to protect by robotic means would have an advantage. Surveillance to that advantage would have to be confined to that advantage. I'm not someone who argues that if you have one kind it's inevitably a slippery slope, life is full of making distinctions, I just think those distinctions need to be made more rigorously and with a mind to civic rights rather than everything coming in some sense under the military.

Security (description)

Some people have talked about that as part of whatever it means to guard a border and I can see hypothetically that a robot could send information, but I'm not persuaded that it could intelligently guard. Even I ... that it could ever ask enough questions that it could really make a determination of danger. You would immediately say "well humans don't do that very well either."

How far do you think they should be allowed to go? Should they be able to walk around and alert a human if they see something odd? Should they be able to subdue?

I think they should be allowed to alert a human, but I don't think they should be able to subdue. If they can't do that, than someone may just take out the robot, but they'll do that anyway, so the robot will become part of combat. I don't see that it circumvents the problem of the human advantage.

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Reconnaissance, so scouting missions:

So in other words, planes that are simply robotic

Planes that are robotic or just little ground vehicles that go out, map the terrain, etc.

Again, if there is surveillance for reasonable purposes, I'm not going to have an objection. I'm not going to pretend there's not going to be surveillance anyway. But if the surveillance, if the *kind* of surveillance the ... becomes very generalized. There was a time in which the question of wire tapping entered in and rules were made that blocked it except in certain occasions. I think well if it can't be done but it was.

Bomb disposal

That's very tempting in which one can say "well what could be the harm? How does that have any negatives or ...?" I think there are uses now, aren't there of robotic operations to just ... Again, I don't know enough about it to really speak well, but that seems to me one of the most constructive uses, because that explosive is going to damage ...

6. Are you aware of any laws, regulations, code of ethics, morals, anything that might interfere or govern the use of robots in the military?

I don't. I don't know what it would mean to put robotic operations under the Geneva Conventions, for instance. And I don't know what it would mean to put robotic operations under other kinds of accords that have come in in some way as appendages to those because often people go back to very early what were just war prohibitions against any use of force in relation to a noncombatant and in relation to ... one has to respond defensively rather than offensively. I don't know the extent to which robotic operations can be programmed to do that. So could the robot tell the difference between a child and a soldier carrying a weapon? Or a child and a soldier not carrying a traditional weapon that some of them have. I don't know the extent to which differentiation would be possible but I imagine that in that kind of conversation could have some kind of mediation between robotic operations and both some of the oldest of codes about either inhibiting or prohibiting war action or continuing to develop them.

There's a science fiction, Asimov, and his Three Laws of Robotics... do you think those kinds of things should enter into programming or use?

I don't know, yes they should enter into use, but those are written on the top of all kinds of ancient code. They're not, in a sense, novel, they add the robot men as something that can do damage and something that can also be harmed. I don't know that not harming a robot can ever be considered as a rule of combat. Could one robot be programmed not to harm another? In that sense, one is, I think, playing with fantasy. But to program robots not to harm humans would ... in a way like earlier, that if a robot were doing surveillance someplace but were not programmed to shoot, or whatever the action would be. That is putting the robot under a code that human beings are also, one way or another bound by.

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So you think robots should be bound to similar things that humans are bound to?

Yes. Because robots are a ... of human control, and so it is humans decisions. Robots are billions and billions and billions of human decisions.

7. Would you care if the military use custom built robots or standard off-the-shelf robots?

How well does the military make things would be the question. I don't know how to answer that, I don't know if it's good at it. And I mean good at making something behave the way it should behave. But what the military doesn't control it's still responsible for, and this might sound a little far fetched but analogously the military in the current war has hired lots of private groups to do things that the military used to do, and that hasn't worked out so well. I would think that this would have to come under the same kind of scrutiny of... Is the military, and again one would have to say at best, in control of the wartime codes and is in control of the wartime codes under it ... stuff out to Halliburton well that didn't turn out so well and the private security groups that it hired turned out not so well, so I would have the same hesitations here. The military is responsible for what it hires and what it hires out. In a way robotic operation is a way of kind of hiring out.

8. Do you have any additional comments regarding robots and their use in the military?

I don't. As you said there are many operations and many of them are already in play, so how one could ever retreat with even those and code them for the kinds of war time both cautions and prohibitions that have been of an international point of order, and not in a trivial sense but in a deeper sense.

9. Do you mind if your name is associated with your answers?

No, but I don't consider that I am an expert in any ways. I have questions, but ...

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Appendix H.16: Professor Kenneth A. Stafford, Mechanical Engineering

Wednesday, December 10, 2008 at 3:00 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

I am a retired Air Force officer that has now been at WPI for 10 years. I teach courses in Mechanical Engineering initially, but then have been part of the Robotics Engineering Course. Currently, I teach the Freshman Introduction to Robotics course as well as sophomore and junior level courses.

2. What do you believe are potential advantages of robots used in the military?

A couple things that come to mind, from a humanistic point of view, there is less danger to taking lives out of the risk equation when it comes to unknown areas where you could have a disastrous loss of life. There's also, from an engineering point of view, it means you could have incredibly more capable weapons, limitations for human survival limit aviation assets to certain G-loadings, adds a huge tear weight for life support systems, whether they be under water, in the air, or on the land. There's lots of things that can be changed.

3. What do you believe are potential disadvantages of robots used in the military?

Clearly there is this ethical dilemma about whether or not robots should be able to use deadly force. Humans can instantly go from a surveillance to deadly force scenario based on the rules of engagement that they know and judgment. Essentially, I believe every decision that humans make can be put into algorithmic form, but there's always those decisions that you always have to wonder how someone made that decision, that's what you may not have thought of when you programmed your robot. You know, the classic cases, of at the last minute "it doesn't feel right" so you don't do something, is not going to be easily obtainable through a robot. From the threshold for lowering the threshold of involvement, which could be a case of using the robot-it's too dangerous to put a man in but you won't bother with it, o, the robot can go in there. That could lower some thresholds of violent action. It definitely has a potential of violent interaction which could be prevented by human intervention.

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

Well the expectation based on what the DOD has said they're going to do is to put more and more mobile assets, unmanned, into the area. I suspect that it will replace a lot of missions: Surveillance missions, hazardous locations conditions-for example, it's only after a known areas of unexploded devices, potential chemical problems, ... problems all of those are areas in which you have a high probability will be contaminated, and you can just send in the robot. It'll replace those. It should augment some other fields, but since my background is in the Air Force, I believe that the current development of fighter aircraft, for example, are

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probably going to be the last aircraft that we'll see that will be designed around manned constraints.

5. In what fields do you find robots most useful in the military now?

Well, defensive robots, we have these already. The Patriot missile system can be purely robotic, if it wanted to be. The navy has a system on their ships which is totally robotic, the Air Force has long had weapons which are release and ... they seek their own target, and that's a robot. I would think that... I have friends associated with ground surveillance robots that are put places where we would usually have to put an eyes-on and track movements and relay all sorts of information without having to have a Special Forces type person there. Those are immediate and continuing uses, I suspect in the next few years we will see an increased involvement in utility robots in hazardous situations, whether it be something like the Big Dog or the existing Packbot, those sorts of things, or even the Black Eye's new demolition and retrieval robot. I think we'll see, appropriately, a lot more of those in use. Eventually, I see major weapons systems converting over.

6. We are interested in your insight regarding robots in the following fields:

Surveillance

Yeah, a natural for robotic... they don't require any sustenance, they sit there for hours, days, weeks, and just idle away without having to have support. If you think there's going to be some potential in an area, ground surveillance is always the most important stuff for us to locate, it's the most dangerous, and my business in the Air Force Special Forces was often involved supporting ground surveillance, and I could see a large benefit to having something that... out there that you can leave, let go and forget about after and only retrieve that information every so often. Huge Opportunity.

Security

Security can be a complex in several ways, and I feel security robots is a field that would be useful, and maybe have some unexpected missions. You don't have to have deadly force to be adequate security. Sentry, for example, if you can convince the enemy that you have deadly force, or if you can convince the enemy that they're compromised. So many areas, so much security stuff is totally... the mission has been totally compromised not if the person coming in has been eliminated but rather if that person has been illuminated. And so, all the security ... has to do is to detect, he doesn't have to shut down, he just has to detect it. I feel that would be really good for surveillance, yeah.

Automated Defense Platforms

Well, they're here. For appropriate application, it looks appropriate if there is a human interaction conformation switch, because frankly, most of the assets where they would be used, be it Patriot Missile or ... I can't remember the name of the system they have in the navy... you can't use them arbitrarily, you have to sure you have a real threat. Patriot

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missiles, there's only so much armor when you're firing that much lead at a time. And so I think that you go full on automatic because you're under heightened risk, but otherwise you'd want to have some sort of human intervention.

Reconnaissance

We're in a new information kind of warfare were classical reconnaissance, which includes satellites and aviation assets, those remain pretty secure from human operated high-altitude ... is still fairly secure, we don't lose a lot on that. And I know that there's a lot of advantage in having a robotic asset doing the same thing. We don't have the possibility of continuous platforms available, whether they be robotic or not robotic. The satellites are only robotic in that they're remote control robotic. It depends upon the risk, during certain other conflicts, Vietnam, when we used to have high speed, low altitude reconnaissance flights, very risky missions, but today we've heard that barely anyone has even gone to that. It's not really a high-risk mission anymore, but I don't know if we totally appropriate for robotics to do that. If we ever have to revert to some sort of high speed-low level reconnaissance, or even some micro-asset that can hover and that would be good, but right now we're not too bad on reconnaissance.

What do you think about ground reconnaissance?

Ground reconnaissance, well that's what we were talking about earlier. That's a huge and inexpensive application of robotics. A network or a swarm of ground robots that could give you I-Pod sized or ... that can connect to each other and detect acoustics or RAF rocket would be incredibly useful. And again, has the big advantage of having no support system required for it, deploy via the ground or via the air, and just sit there... until they're turned on. Certainly, no robots that have no deadly capabilities should have any objection to anybody, at least that I can see.

Bomb Disposal

Yeah, natural. I mean in my definition of robot, it may not be exactly what I define as a robot, but just because bomb disposal is really just remote control to the most part, where as opposed to, when you asked me about robots, I define a robot as having sensors and processing power such that it can make decisions based upon it's environment and all of that, and most bomb-disposal robots we have are really just camera operated, remote control devices which are just an extension of a human operator, as opposed to being independent operators.

Conceivably in the future, they could ...

They could, they could be sniffers and this kind of stuff, and so yeah, that's just ..., the three D's of robots, right? Too dirty, too dull, or too dangerous, that's what you use robots for, so in DOD we're talking about things that are too dangerous. Too dull might be what having a forward asset that spends six months waiting for a train to go by and all of a sudden sees it and has to wake up.

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7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

There is the whole Papal declaration in the mid-80s, known as the Just Conflict, a Catholic proclamation that talks about just wars. It talks about discrimination and it talks about combatants versus noncombatants. It's controversial, but I would assume that a lot of people, especially Christians with that kind of understanding, would compare any kind of robotic, ethical use to those kind of constraints. Can it truly be discriminatory, can it distinguish not only between friend and foe, but combatant versus noncombatant, and understand when a combatant becomes a surrenderer, can it understand the differences? These would be questions that a lot of people would ask. In the nature of the business I was involved in, in psychological operations, we would always rather have 1000 people walk over voluntarily, than have to eliminate them where they stand. As I'm not sure a robot would be as persuasive in doing that sort of action. So there could be some legitimate questions about deadly force with them, in terms of both some pragmatic things and also some religious views on just wars.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

When Desert Storm first started, I was still in the Air Force, and GPS's were incredibly rare, and in fact the military was trying to procure GPS's but it was incredibly slow to procure, because to get them customized for a military environment was an incredibly long, slow, expensive procurement process. Thousands of handheld GPS's were sent from the sporting goods stores directly to the military, incredibly useful. They could be found on airplanes, they could be found on Jeep drivers, ... so I guess I'm trying to... some military missions will require custom built, but I think we make a mistake by assuming that every application needs to be custom built for the military environment. It changes the economics of the situation, I think; if you have a robot that's \$50,000, would you have as many, or as useful, as one that is \$5,000 that was more expendable, perhaps? There's certainly places you can't scrimp on the cost of military equipment, but that you want to have gold-plated military robots when you can have a nearly as useful, at one tenth the cost, which is generally my experience with military procurement.

Would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

We are a world economy. I don't think you'll find anything that's solely by US companies anymore. I have no problem with using the equipment that is available. I don't think anybody can buy an American built car, just like you can't really buy a Japanese built car anymore, so I think it's antiquated enough that we should hold on to born, bred...

Do concerns for industrial sabotage or anything...

The information that we have is always held. In a previous occupation that I had, I was involved with a night vision goggle, released to foreign countries, and one reason Desert

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Storm went as well as it did is because no one else had the generation 3 night vision technology that we had. The Russians had generation 2 and sold it to anybody, but those were the old Moon-scoops. As opposed to really, nearly no star illumination, and certainly not the 25% moon that the early ones required. So there is a technological advantage that always exists for a nation that has an enabling technology, but that's very transitory in nature, because it always gets to the other side eventually. So we wouldn't be selling our stuff to the other side, but we would be buying it from other people. From a pragmatic view, if we develop something which is unique and uniquely capable, then we certainly preserve it for some period of time.

But if someone else has something that we want...

If they're open market then we buy it.
(Reverse engineering... not really relevant to a robotics discussion)

9. Do you have any additional comments regarding robots and their use in the military?

I guess the only thing I would say is that this topic is kind of like discussing "what do you think the role of consumer robotics is?" In that the comments, informed people understand it's not whether we should do this but will we continue doing this? Twenty years ago, I went to what they called an Associate Pilot Program, in which it was an interesting choice of name in order to not turn off people who thought it was a robot, but it really was. It was a system that you put inside an existing fighter that did everything for the entire fighter mission, but you flew with a real pilot there, and the pilot could override these machines if they wanted to. I flew these on simulation missions, and the bottom line is "Oh my gosh, 22 years ago, they could do all thing things people said 'couldn't be done, have to have humans.'" They could react to changes in the configuration, they could make decisions based upon a new target of opportunity, they could work instantly and correctly on degraded systems which work during a flight. Everything we fired at this thing in terms of systems degradation, in terms of weather, in terms of totally inaccurate intelligence which makes the mission profile, these things would make the correct decisions quicker than the human could. In the whole scheme of things, maybe 5% of missions would have been improved by having the human override something, and that was 22 years ago. So, you know, they are there now. Fighter aircraft, since the F16, which has been around for about 25 years, have really been incapable of flight without a computer onboard because they're unstable aircraft, and no one can actually fly them. The two cars we have in my driveway have no connection between the throttle and the engine anymore. It's all drive by wire, and with that ... program engaged, which is a normal thing for these cars, you only turn... it looks at your input and decides what it thinks you wanted to do, and it makes corrections to the throttle and the brakes and stuff like that. So, they're there. And I think at this point it's too late to say 'no robots in the military' because my gosh we've had them, we're just talking about incrementing them up, and I think it's a great idea. I've seen a video of this kind of thing, where two countries decide to declare war and they send their two best robots in battle and they do battle in some place nobody cares about and 'yup, you won, that's it.' Why lay the whole country to waste and all the future generations with death or psychological stress to deal with when you could do the same thing with ... robots. That's my personal opinion.

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10. Do you mind if your name is associated with your answers?

No.

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Appendix H.17: Professor Gretar Tryggvason, Mechanical Engineering

Friday, December 12, 2008 at 2:30 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

I'm a professor of Mechanical Engineering and the department head of mechanical engineering. Usually I teach a graduate course in computational fluid mechanics, and occasionally I teach courses in thermodynamics, fluid dynamics...

2. What do you believe are potential advantages of robots used in the military?

Well they obviously reduce the risk of injuries of people ... in the operation. They potentially have surveillance applications, where it would be difficult to do in any other way, and maybe they give a way to provide security to people.

3. What do you believe are potential disadvantages of robots used in the military?

If there's no lives in danger it could sort of encourage recklessness. It could obviously encourage other unauthorized intrusions and breaches of privacy and things like that.

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

We are already seeing replacements of pilots by drones or manned airplanes by drones, so I think it's almost inconceivable that you won't see replacement of soldiers by robots in harm's way.

Do you think there would be no soldiers on the ground, or some soldiers and a vast majority of robots?

I think if the military thinks it can reduce casualties by using robots, I think there would be enormous pressure to remove soldiers altogether from the battlefield. I anticipate, though that that would be difficult for the immediate future, but the pressure will, I think, to have autonomous convoys and things like that.

5. In what fields do you find robots most useful in the military now?

They currently are used for surveillance, I think in the future they will be used increasingly for logistics, bomb diffusion, probably search and rescue, and I think eventually in combat operations.

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6. We are interested in your insight regarding robots in the following fields:

Surveillance

That's almost a given. You're going to have robots that can be anywhere observing anything without people.

Reconnaissance

It's pretty much the same thing.

Security

I think you're going to see an increase in that, there are going to be some issues with an armed security robot, but my guess is the temptation to put a gun on a robot is just going to be irresistible, no matter what the logistics or the moral objections are to that. We're already arming the drones, in spite of best intentions not to.

Automated Defense Platforms

That I think is very likely to happen eventually, completely automated is going to take a little longer than sort of semi-automated.

So you think for a while it will be human: press a button, and the turret does the rest?

Right. Just sort of seeing something and shooting is going to take a little while. Although, there have been a number of times where humans have made mistakes and shot things where they shouldn't have shot at, so maybe the robots will turn out to be even better at that.

Bomb Disposal

That's another one that is almost given, that's an obvious application.

Do you think they're going to be cheap little robots-you throw at the bomb and they both blowup or more expensive-disarm the bomb safely- models?

I think we will have both in the beginning, I can't say which one will survive.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

I'm not an expert in this, but my understanding in this is sort of, in principle you're not supposed to shoot at anything that moves without some sort of due process of identifying targets and things like that, and I think that obviously can be an issue. Obviously we do shoot at everything that moves, but if you completely automate that, it seems like it would

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have some sort of implications. I can imagine that there are some details, but I don't really know the specifics of that.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

I would assume that the military will eventually have to use mass-produced robots, but they might be mass produced for the military.

In either case, would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

I don't particularly care, I mean we use weapons, we use the Israeli Uzi, so I think, if we find solutions that are better made by foreign companies we're going to go with those, we already do in some cases. I think it would be irresponsible to ... a high level skills and know how developed in this country, but if they find something better that's made somewhere else, I think they're going to do that.

9. Do you have any additional comments regarding robots and their use in the military?

They're going to transform warfare, hopefully for the better.

10. Do you mind if your name is associated with your answers?

No I don't mind.

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Appendix H.18: Professor John M. Wilkes, Social Science & Policy Studies

Friday, December 12, 2008 at 2:00 PM

Verbally explained Informed Consent Agreement – understood and agreed

1. Describe your occupation (If a student, what is your major area of study?)

I'm a sociologist, and I teach courses that are mostly in the Society and Technology interface, I consider myself a specialist in the field of Science-Society-Technology Studies. An example of a course I might teach would be introduction to psychosociology of science or the society and technology course.

2. What do you believe are potential advantages of robots used in the military?

Well, the advantages are that they allow people to avoid bodily harm in dealing with things like land mines and other devices which are questionable ethics in warfare anyways, particularly in a dirty, low-budget war where there people are not directly engaging in each other but laying booby traps, and laying numbers of explosive devices, there are considerable advantage to using robots, but the other substantial advantage that I see is in surveillance applications, spotter planes are always a pretty risky business, so that's another area where I feel it's appropriate to bring in either satellites or robot planes.

3. What do you believe are potential disadvantages of robots used in the military?

There are lots of specifics, but the basic problem is that it takes us to the risk of a barbaric kind of warfare of man against machine, and some of the writers who have depicted citizen armies battling machines that are controlled by a few members of the elite, have presented this as something that we really want to think hard about, cause we don't want to get back to the situation we were in in the middle ages, where the elite had armor and no one else did. A small elite could act with impunity against the interests of even that vast majority and get away with it. So we want to be cautious about how far you get with man-machine warfare where one side does not have to put itself at risk, and can therefore win for all the wrong reasons.

4. What are your thoughts on the future of robots in the military? Are you expecting them to replace soldiers, or simply act as a supplement to them?

The science fiction that I've read on the subject seems to lean towards the idea that soldiers would be replaced, but I see it as a new sort of man-machine interface, which the side who has very substantial resources can enhance capabilities of a relatively small force. I want to be cautious, but basically I still think of a battlefield where human actors are contestants, the question is will the human actors be present and at risk, and if neither side is present and at risk then it is essentially a gladiatorial match, and I'm fine with that. If one side has to put itself at risk and the other is not, then we're getting out of warfare as an extension of

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diplomacy and into warfare as indiscriminate slaughter. Weapons of mass destruction take this to the extreme

5. In what fields do you find robots most useful in the military now?

I was reasonable impressed by their use for reconnoitering, for overall surveillance, I was unhappy to find that the robotic unmanned planes were being fitted with missiles, and I do find myself making a difference between something that is operated remotely and something that is autonomous... but on the ground, given the number of triggering mechanisms and claymore mines and the extent to which the battlefield is an increasingly inhuman place anyways, having more inhuman devices clear away seems to me appropriate and ethically non-problematic. I get into trouble where we have hunter-seeker devices which are looking for the warm body and are not capable of showing mercy if it turns out to be a noncombatant or somebody who was mistaken

6. We are interested in your insight regarding robots in the following fields:

Surveillance

I suspect we are going to see smaller and smaller devices that ultimately mimic birds and insects going into all kinds of places, and I expect this is going to enhance surveillance capabilities. Certainly, we're already under surveillance from space. Basically I see this as an area that's going to be part of an arms race

Security

I think we're going to end up with more of a man-machine relationship where you have humans who have access to robotic eyes and sensors, but I don't think this is an area that's going to be turned over completely to robots, although I do see a considerable enhancement, which is kind of like automation, fewer people able to patrol a larger area because of all their enhanced sensors and communication

Automated Defense Platforms

If it's designed for threats that appear too quickly for human reaction time to deal with. Now when you're dealing with things that have such short response times that we're beyond the response time of human organization, or even the individual human, then I think you're really left with few alternatives to try to automate your response, however much you try to have some human judgment or mercy in the loop. But in ship-to-ship, exoset missiles, cruise missiles, things of that nature, you really are talking about machine versus machine protection and defense, and I don't have much of a problem with that kind of an application. When you start getting into automated devices which are on a jeep platform patrolling a perimeter of an airfield, I'm worried about making those too autonomous, because there are just so many reasons why innocent bystanders, or people who have a legitimate reason to be there could get caught in the crossfire. Where the alarm has already been given, we know the intruder is there, whether the devices should have a nobody-is-supposed-to-be-there-

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therefore-they're-in-a-kill-zone-kill, that kind of logic is something we'd want to avoid. On the other hand when you talking about a reaction time of minute with an aircraft carrier at risk, then you're talking about an electronic duel in which the humans are just spectators. Personally I'd prefer we didn't deploy that kind of stuff, but once it's out there, defending does seem some kind of suitable use of a platform.

Reconnaissance

I see [recon and surveillance] raising similar issues, we're talking about the advance group that's trying to find out what's ahead, trying to find out which rooms or buildings are inhabited, I guess that's an area I expect to move ahead, but I fear that it will lead to an even greater extension of the tendencies of invading armies not to address defensive strongpoint, but instead just obliterate them.

Bomb Disposal

This I think is a fairly established direction that I'd expect to continue. An unexploded ordinance is, in my opinion, very similar to a mine, and I consider that to be one of the more legitimate uses.

7. Are you aware of any laws, regulations, code of ethics, etc. that may interfere with the use of robots by the military?

I'm going to respond on two levels. I think Asimov was on the right track when he had certain rules that applied to robots which were effectively protective of humankind, and to prevent them from taking over. Science fiction writers had a lot of fun where two of the rules would be in conflict, and the robot wouldn't know what to do, and would inadvertently put the human at risk. The idea that there should be a protocol along those lines is an interesting one, but I'm hoping we see the merger of two lines of activity. The first line of activity is the movement to non-lethal weapons. Once there is a group of effective non-lethal weapons and hesitation in their use, the fact that they are somewhat less effective than lethal weapons, does not cost you one of your own, and I'm hoping the movement to robotics will allow people to take the risk of hesitation long enough to deploy a new class of weapons which robots are allowed to employ because they're not lethal, and distinguish those from weapons that are only for humans, which are presumably going to bring some kind of judgment, some possibility of mercy, that only they can deploy. The US military has been slow to adopt and support the movement to nonlethal weapons, but the police have shown some interest, and the border patrol has also, and now the military is finding itself doing effectively what is police work and also finding that it's up against an enemy that wants to die when the military would actually like to see them survive for questioning. Under these circumstances I'd like to see a line of what are effectively instruments of coercion, but nonetheless non-lethal, which would allow us to use robotics to bring an element of humanity to conflicts and have people make their statements less by their acts and more by their rationales, which they would be capable of offering for their acts <Bin Laden stuff, not really relevant>. That allows for moderates coming from the same culture area to disagree with both the grounds and conclusions of his actions, and out of that there's some hope for

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political resolution of disputes, which doesn't exist if there are no survivors. And hence, really no reason to give up because you're not going to get to make a final statement, because when it's a fight to the death, there's no real chance of mercy; you end up losing a possibility of cultural and political significance to happen. So at any rate, I'm watching with interest at at least the possibility of robotics combined with nonlethal weaponry that turns into armed conflict into more political dialogue because more people are anticipating being captives of the other side, having to justify their actions, and eventually changing their minds.

8. Would you prefer that the military use custom specified robots or standard off-the-shelf robots?

As far as humanoid robots go, I have a preference that they not be mass-produced. It's too easy to have an army built up when you don't have that many people. For other types of robots, let me use an example from missile defense. When you're having an arms race, and defensive devices are so much more expensive than aggressive devices, it's possible for the aggressor to simply overwhelm the aggressor on the grounds of simply 'we can spend you to death.' For example, in terms of missile defense, we can probably deflect a small number, the numbers that might fall into the hands of terrorists, but say an attack from the Soviet Union. The same thing happens with mines, those are cheap. It seems we're going to have to find a way to deal with mines which is almost as cheap, or that survive long enough to deal with at least 10 mines

Would you prefer to use foreign-produced robots, or only ones that have been developed by US companies?

It's hard to answer that question. If the US government could get things built for foreign deployment that are illegal in the US, I'd be against it. If we're talking about just producing them more cheaply so there are enough to go around, and we're outfitting something like NATO, and they're already a cooperating group of nations, it's hard to see any objections.

9. Do you mind if your name is associated with your answers?

<Small objection>

<Compromise is that we let him know what we are quoting him on, and he lets us know if we may quote him>