Fear the Robots!

A Study on the Perceived Future of Robotics in Modern Society

An Interactive Qualifying Project Report

Submitted to the faculty of

Worcester Polytechnic Institute

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

By

James Castro

with the assistance of : Thomas Conwell, Timothy Sharood, Nathanael Vander Els

Project Advisor: *Professor John M. Wilkes*

Abstract

This study is an extension of two previous Worcester Polytechnic Institute studies on the perceived future of robotics. The first was to compare WPI to other colleges. This study is a longitudinal look at the perceptions of WPI students that participated in an STS class focused on emergent robotic technologies. We used their final reflection papers to ascertain what the students expect of robotics, whether it ought to change, if they changed positions and if they came to any consensus.

Contents

Introduction

This second study focuses on understanding perceptions of the future of robotics among aspiring technologists and the effects of becoming more informed about the policy debates surrounding robotics. The focus is on their emerging opinions about appropriate regulatory policies as they learn more about what is going on, and is likely to happen soon. We worked with a group of students taking a Science, Technology and Society class on emergent technology taught by a sociologist and surveyed the participants early and late in the class. We also worked with them to develop a mock congressional committee hearing to better understand our government's decision making process. In addition, we analyzed a set of papers written by the students at the end of the class in which they reflected on the process by which their views evolved. They were asked to note which things they felt influenced their views the most, especially reading a book and participating in a role playing debate. This gave us an adequate longitudinal data set both quantitative and qualitative, to ascertain how their opinions changed over a period of about 2 months.

While we were working on this study it became evident that we would not be able to complete the project if we continued to try to collect data. Hence, we recruited another teammate, James Castro, who would attempt to fill in the gap of missing second wave questionnaire date from about half the class. As a backup plan, he would also try to predict how the students felt during the middle part of our surveying by looking at what they said about the process of change they went through when reporting at the end of the class in their reflection papers.

Since the last thing the students did was role play members of Congress, that meant introducing, amending and voting on bills was on their minds as they wrote up their reflections. Hence, the comments are what they thought the policies and institutions in the area should be, as they reported on how optimistic they were that the positive outcomes and more promising technologies would indeed be the ones developed.

To try to fill in the missing data on the process of opinion development, James sought help from the students whose data was missing. If they answered later, after the reflection paper and another month or two had passed, he could not just say their views were the same as they were at the time the rest of the class filled out the questionnaire for the second time The lack of cooperation from those students after repeated contacts made him turn to another data gathering and estimation strategy. He decided to approach our report's findings in a different manner. His final effort to contact those students took the form of organizing a campus wide debate about the perceived future of robotics sponsored by WPI's Student Pugwash chapter. Here was a chance for a class reunion and an opportunity to shine before a peer audience. Class members would be the most prepared people at this event. Unfortunately the publicity did not pass SGA review in time to reach the general student body and only the members of the class received invitations. However, graduate students got the message and one person (a robotics graduate student) showed up for the presentation and debate. This one person found the results surprising and was actively participating and genuinely interested in the topic.

Thus, it is clear that Student Pugwash should try again to gather a general audience to debate this topic. The study and the issues it raises are at least of great interest to those involved in the field of robotics. However, for James, the window of opportunity to gather the data he wanted from the missing class members had closed. He had to decide between completing the study by reanalyzing existing data in greater depth or ending by designing a new improved study to be carried out in the future. He teamed up with a member of our team to do the former, and then something happened to encourage him to do the latter as well.

The one gap James know he could plug involved reanalyzing existing reflective essay data to specify and verify the qualitative claims made in our paper. He will do a content analysis of our data using new constructed quantitative variable data derived from classifying the positions taken in the essays along a few dimensions of theoretical interest. These new variables would reflect the qualitative comments made within the reflection papers and quantify them for statistical correlation analysis. At the very least they will make it easier to talk about the frequency distributions of the positions taken. This is a matter the prior qualitative analysis left vague unless there was an overwhelming consensus in the class. It will also make it easier to describe how a student's position changes as new information is presented to them if we know whether they are joining or dissenting from the majority position. However, the key to the study is to be able to correlate data from the initial questionnaire with the data from the final reflective essay papers.

The results of this study will shed light on how future opinions and policies on robotics might shape emergent robotic technology. This study's main focus was the effect of relevant learning and peer discussion on changes in perception and opinion. While the answer would seem to be that change in response to information is likely, there is substantial social theory about selective perception that suggests one retains primarily the information that is consistent with one's views, and tends to dismiss, miss or forget the discrepant information. Thus, learning more and having to defend one's position against critics does not necessarily lead to a change of opinion.

With such massive developments being made in the field and such huge fiscal commitments to continued military development, it is prudent to consider at least the most likely results of our actions. Has the US generally (and the Department of Defense in particular) eagerly rushed headlong into a new technical era without considering the consequences of our decisions? This study was created to look at where people think we are and where they think we are going, especially those currently studying in the field of robotics.

In order to encourage the students to really consider multiple facets of this problem we integrated this study into a social science class on technology in modern society. In this class students were assigned relevant contemporary reading and participated in a mock congressional hearing designed to spark debate and encourage critical consideration of our current policies. In this endeavor we found that we were largely successful in that students who answered both the initial survey at the outset of the class and the final survey toward the end of the class had changed, often strengthened but rarely just maintained their initial opinions. Additionally, the students submitted a paper reflecting on the process where we found many of them described considering problems they had not thought of before and viewpoints they were unfamiliar with and they often noted that this affected their final opinions. Meanwhile in James's extension study he should be able to specify the flow of positions and see if there is a trend toward consensus, or whether that breaks down as people learn more.

He also proposes a parallel study of another population from the public schools, since it would not be as select and elite as the college populations of WPI and Clark U. For various reasons he proposes that it be of a relatively young audience with difference data collection procedures. He gives up the longitudinal dimension that distinguishes this study to be able to

see what the distribution is in another group more representative of the general population due to his conviction that the general public will be a factor in the future robotics debate.
At least one needs to know if the elite college student populations most likely to participate in a high level policy debate are in sync with currents in the general population or not.

One of the issues we ran into with this study was the fact that this is a continuously ongoing controversy. Even the book Wired for War which is only a few years old feels dated at times and it is hard to keep a consistent bead on the actual level of technology available to the D.o.D... vs. the known projects and perceived technology level. Still with these problems being considered right now it is the best time to encourage related education and to find out what students believe is likely the most probable robotics outcome for the future- at least the part of they have immediate knowledge of. Our unique positions as teaching assistants allowed us to interview and educate people who will be entering this debate in the real world in the next few years, while James's position in WPI's Student Pugwash club potentially allowed him access to such a unique new set of students for his parallel study to assess the generality of our findings. Even though our conclusions focus on finding consensus, James had the liberty to explore many other areas of interest that could yield interesting information hidden within our data. This sort of connection between and integration of different kinds of data sources is all too rare in social research, which tends to use only one data gathering technique and is not usually longitudinal in nature. This makes this class study as elaborated by Brauckmann's prior work and James's proposed parallel study in interesting research strategy. As it shapes the class discussion it will be invaluable to the students studying in robotics at WPI who will take this course for credit and later the general public as these results are reported at national meetings in social science.

The results of this study will reveal whether there is a consensus amongst the elite of students aspiring to enter the field of robotics as well as other student peers who could have a say in the robotics debate to play out in the next generation. While these findings are crucial they do not answer two important questions; how does the general public feel about the future of robotics? How can one make this kind of study more generalized to be able to answer the prior comparative elite vs. general public question? James will address this in his proposed future studies section.

Chapter I: Overview

Robotics, or the idea of robots as automated servants, has been a part of our culture for a considerable time. As technological capabilities in this field have improved exponentially, we have become more able to produce robots that can be either beneficial to society or become the means to rip it apart. The use of drones in warfare has become a primary mode of operations and taken man against machine warfare to a new level. The operations are so remote from the theater of operations that the soldiers are no longer at risk. Only the machines and their maintenance crews are in the theater of operations. The effects of these drone strikes are getting all too close to home as influential Congressmen have decided that domestic activities like those were are conducting approach would be unacceptable. The UN is also looking at what is going on with concern and talking about War Crimes Tribunals as a possibility. We wanted to examine what the next generation thinks of the problems we are facing today and ones we could possibly face in the future.

Between 2008 and 2012 there were 147 documented drone strikes, with a total of 894 persons killed and an additional 211 people injured. The ethics debate about the social implications of our increasingly "robotic" society was drawn to the center of public attention by the debate about the emerging man-machine relationship in the war on terror. Robotics has begun to enter every portion of our lives from farming, to manufacturing, and cleaning, and it has been particularly important in the theater of war.

It is no secret that the direction of technology is affected by its funding. Funding from the defense sector going to companies like the Defense Advanced Research Projects Agency (D.A.R.P.A.) has given a characteristic direction to the research and development of robotics. We sought to understand the current generation's perception of the direction of robotics and their opinions on the best possible course forward. We will assess the perceived future of robotics, from the uses seen in the military to private sector applications. Additionally we will assess the perceived value of this course and its effects on the ethical understanding and maturity of thought the students developed during the process. The data from this study will be compared to the previous data sets of several populations of students in order to assess the validity of the finding's representation of the greater population. We will also suggest points of interest for future research, and the direction this course is capable of taking to ensure that the students graduating from WPI have a sober and balanced understanding of the implications of creating robotic weapons and the ethics involved in their proper deployment and use.

In the media we see a polarizing debate facing the development and expansion of weapons research. The United States military budget is more than double that of the rest of the world combined and many question the need for such extravagant spending in such an unsustainable way. The Research and Development budget in 2011 for the US Department of Defense (D.o.D...) was $79.1 billion. This included $1.9 billion for continued development of the Predator and Reaper Unmanned Aerial Systems, the usual system for tactical strikes, and the same equipment used for the previously mentioned drone strikes. There are those in our government who would increase this budget every year, and there are those who believe that we need to lower military spending in favor of other activities and other kinds of robotic applications.

Wired For War:

Wired for War by J. W. Singer is the first of several readings the students in the class completed. Wired for War was published in 2009 and became a best seller. When the book first came out it helped bring the conversation of the implications of robotic technology to the public eye. In the book Singer presents an argument that urges the reader to think about possible consequences of the robotics technology developed from 2000 to 2005 or so.

The book is separated into two parts. In the first part singer presents the reader with copious facts and statistics about the developing robotics industry. The statistics shed light on the pace of development in the robotics industry and the flow of research funding. However the examples Singer focuses on are robots developed for and funded by the military. The majority of the statistics are related to military applications and development and is less focused on the development of robots for commercial markets. He compares the funding of these two markets but does not directly examine commercial robots.

In part one Singer also introduced the reader to the idea of the 'closed loop' or a robot that can make decisions without human approval. The discussion in the book is centered on robots in control of weapons. This reflects the current generation of applications in which humans still pull the trigger on weapons carried by drones. The questions is whether the goal is or should be autonomous artificially intelligent robots, able to make decisions about when to engage and therefore, capable of weighing human life and death decisions with legal and moral implications. In short, this is a debate about who is accountable for such actions.

In the beginning of part two Singer discusses revolutionary paradigm shifts, which he refers to as "revolutions in military affairs (RMAs.)" In this chapter Singer predicts that the development of robotics will be an RMA. He proposes that the development of robotics will have far reaching effects on society. Singer likens the possible changes in society due to the development of robotics to the changes in society that came about with the advent of the automobile. The second part of the book centers on possible negative consequences of robotic technologies.

Literature Review and Research Strategy: *by Michael Brauckmann*

A robot is a machine built upon the "sense-think-act" paradigm—that is, they are man-made devices that sense their environment, process data, and respond based on what they've perceived (Singer, 67). The PackBots, which have been deployed in Afghanistan and Iraq, are far from the only robots out there. iRobot also makes the Roomba, small disk-shaped vacuum cleaner robot. Predator drones armed with missiles patrol foreign skies. Industrial robots tirelessly work on the production lines of factories across the globe. The field of robotics is developing extremely quickly.

In Wired for War P. W. Singer tells the story of this emerging technology and its impact on society. The vast majority of research in this field in the United States comes from military funding programs such as the defense advanced research project agency DARPA. According to Singer (2010), some 80% of what is spent in this country comes from defense dept. sources. Programs for developing a single robot frequently have budgets in excess of several million dollars. The first section of the book covers the current robotic technologies employed by US troops in Iraq and Afghanistan. From clearing improvised explosives and roadside bombs, to flying surveillance missions in Iraq, to taking out insurgents with Hellfire missiles; these early robotic warriors have paved the way for robotics in the military. Some of these robots are designed as scouts, made to go into places people don't want to. Others, Foster-Miller's SWORDS platform and the predator drone, are intended to hunt down and kill humans.

While the original PackBot and Talon platforms included robotic arms, Foster-Miller's SWORDS version of the Talon is a prototype designed to carry and fire weapons. Capable of carrying anything from an M-16 to a .50-caliber machine gun to a rocket launcher, the SWORDS robots are amazingly accurate (Singer 30). iRobot is also developing a shotgun-wielding version of their PackBot. Singer interviews the scientists and engineers developing these robots, as well as the soldiers who use them. Through these interviews the argument is made that these technologies are the building blocks to a much greater change in the way we fight wars. The possible developments that come from combining these technologies with things like communication networks and artificial intelligence sound like scenes from a movie, and indeed many of them draw their inspiration from science fiction.

In 1998, Vice Admiral Arthur Cebrowski predicted that the introduction of computers and near-instant communication would produce something he called "Network Centric Warfare." He predicted that this change would be a paradigm shift called a "revolution in military affairs," or RMA. "RMAs typically involve the introduction of a new technology or organization, which in turn creates a whole new model of fighting and winning wars. A new weapon is introduced that makes obsolete all the previous best weapons (Singer 2004)." Just as the introduction of guns made highly trained knights nearly worthless, Cebrowski predicted that near-instant communication would create a similar change in warfare. Unfortunately, network-centric warfare introduced a sort of information overload, proving Cebrowski wrong. Singer predicts that robotics will be the technology that actually revolutionizes military affairs, "perhaps even leading to the rise and fall of global powers (Singer 204)." This is especially likely to be the case if it is combined with the new communications infrastructure that massively increased the situational awareness of soldiers in the field and their commanders far from the front lines.

Singer however looks beyond the RMA. He sees robotics causing a cascade of interdependent and complicated changes in society more generally. The social implications of these technologies and the changes they bring about are far reaching, and unforeseen effects may be even greater than the predicted outcomes. Singer cites Futurist Ray Kurzweil, whose company focuses on predicting trends in technology to "catch the train at the right moment." Kurzweil believes that we are on the verge of such technological breakthroughs that they will change all the rules in an event he calls the Singularity (Singer 2004). Singer, and Kurzweil, are not alone in their belief that robotics is bringing about the Singularity which will turn the system we know upside down. Bill Joy is the cofounder of Sun Microsystems and author of a short article entitled "Why the Future does not need us", in which he explains why he is uneasy about the danger we face in the 21 century (Joy). Joy's anxiety started when he read a preprint of Kurzweil's book The Age of Spiritual Machines, a story of a utopian future where man becomes one with robotics gaining near immortality. But Joy did not see this as a likely path of the technology Kurzweil described; instead he saw a future in which mankind made itself all but obsolete. Joy urges us to consider the consequence of allowing more and more decisions to be made for us by machines. He warns that no hostile takeover or willing surrendering of control will be needed. The technical system will simply become more and more complex until no human will be able to make intelligent decisions and we will become so dependent on the machines that flipping the power switch would be tantamount to suicide. (Joy) Joy compares robotics along with genetic engineering and nanotechnology to Pandora's Box and warns that we have nearly opened it, and what comes out will never be put back in a box. In his words:

"We are being propelled into this new century with no plan, no control, and no brakes. Have we already gone too far down the path to alter course? I don't believe so, but we aren't trying yet, and the last chance to assert control - the fail-safe point - is rapidly approaching" (Joy).

Another author Kevin Kelly writes in his book What Technology Wants that something entirely new has emerged which he calls the technium. He finds technology analogues to a biological organism evolving as much by internal processes as by human choice. He claims it is "whispering to itself" becoming increasingly autonomous and has "wants" and urges and a direction in which it wants to go. Kelly claims this technium has become "as great a force in our world as nature" and it would be unreasonable to expect it to obey us. Rather than even attempt to control it he guides us to learn what it wants, and where it will go, to listen to it, and decide how to "optimize technologies blessings while minimizing the costs". The increasing trend toward autonomy is evident in his work and commented upon extensively. Von Neumann, the inventor of the first useful computer, whose architecture is still prominent in many microprocessors, noted that technology was a process of increasing "structure, organization information, and control." Kelly called it "a vital force that throws us forward or pushes against us."

This study was inspired by Singer's book Wired for War and his concerns and warning about the current trends in the field of robotics. One of the four scenarios is drawn loosely from his description of our projected ahead. When confronted with Ideas like those expressed by Joy and Kelly, Singers warning may even come across as a moderate voice. The shape of the future lies in the balance of the policies, social changes, and decisions made in the present. We can consider the lessons of the scientists working on the atomic bomb

"The danger that things will move to fast, and in a way in which the process can take on a life of its own. We can as they did create insurmountable problems in no time flat. We must do more thinking up front if we are not to by similarly surprised and shocked by the consequences of our inventions." (Singer 2004)

Even Bill Joy in his pessimistic view of the future and near certainty that we were creating a dystopian future believed that this was the moment to take a stand.

"Have we already gone too far down the path to alter course? I don't believe so, but we aren't trying yet, and the last chance to assert control - the fail-safe point - is rapidly approaching… If we could agree, as a species, what we wanted, where we were headed, and why, then we would make our future much less dangerous - then we might understand what we can and should relinquish. I believe that we all wish our course could be determined by our collective values, ethics, and morals. If we had gained more collective wisdom over the past few thousand years, then a dialogue to this end would be more practical, and the incredible powers we are about to unleash would not be nearly so troubling." (Joy 9)

It may not be possible to predict the course of technology and, even if it is possible, controlling what that direction will be might still prove to be an insurmountable problem. However, if no attempt is made then we are certainly left to whims and urges of Kelly's technium whatever they may be. It is the author's opinion that it would be foolish not to make every effort to understand and direct the path of these technologies. If we make it our goal to understand where this technology is taking us and to shape our socio-technical policies so as to guide it in a favorable direction then that at least improves the odds that the future will be the result of our deliberations rather than technological inertia. *Wired for War* gives the reader an idea of the changes to come and raises many important questions about robotics and human nature itself that must be answered. Surely, then, it is a good idea to take a look at what futures are possible and ask how people perceive them.

To this end, we developed our four scenarios, each outlining a different possible future for the field of robotics. Each scenario varies in that the institution driving technology has different goals and ambitions which lead to a different path of development. Hence, responses will reveal the perceived effect of the institutional goals and mindset. Singer seems concerned that the US Military has ill-advisedly crossed an ethical line in the man-machine relationship, and will one day regret having done so when the USA is no longer the technology leader in their field. It's just a matter of time before the USA's current military capabilities are widely available to other nations and hostile political groups. According to Singer, it is possible to be short sighted and act in this way because the military avoids looking at the ethical implications of the technologies they work with. As Michael Goldblatt, DARPA's defense sciences office director, puts it "You can't let the fear of the future inhibit exploring the future." In the words of another DARPA program manager, "That [considering ethics] is above my pay grade." Hence, we thought to incorporate an ethical dimension into our scenarios.

The iRobot Corporation takes its name from Isaac Asimov's book I, Robot. Considering that iRobot is developing killer robots, this association is rather peculiar. Asimov was a science fiction writer and published a series of short stories known as I, Robot during the late 1940's. The book describes how, over the course of a lifetime, robotics begin as simple mechanics and develop into complex entities containing "positronic brains" somewhat more like the human brain than microcontrollers. In this alternate future, all robots follow the Laws of Robotics:

•A robot may not injure a human being, or through inaction, allow a human being to come to harm.

•A robot must obey the orders given to it by human beings except where such orders would conflict with the First Law.

•A robot must protect its own existence as long as such protection does not conflict with the First or Second Law

With these ethical laws in place, humanity thrives in the company of these intelligent machines. Robopsychologist Dr. Susan Calvin explains that strict adherence to these laws prevents robots from performing act or undertaking tasks that are immoral, dangerous, or generally undesirable.

iRobot's machines clearly violate all three of Asimov's laws. The military, in fact, "explicitly wants robots that can kill, won't take orders from just any human, and don't care about their own lives. So much for Laws One, Two, and Three (Singer 432.)" The people at iRobot, however, believe that Asimov would "think it's cool as hell (Singer 25)." In our scenarios each institution driving the development of robotics takes a different stance on robotic ethics. We chose to adopt Asimov's three laws as our basis of ethics thus every institution varies in its ability to accept Asimov's laws given its goals. By gathering people's perceptions of these scenarios, we hope to see if acceptance of Asimov's three laws reduces concern about ethical issues and stand as a guide for ethics in the field of robotics.

The design of this study is inspired by the Delphi study technique which traditionally includes a panel of experts in the field being assessed. Our study differs from this format in two basic ways, and there are precedents in the Technology Assessment and Public Understanding literatures. We have chosen to use a student sample instead of experts, and we chose to sample from aspiring experts both in and outside the field of robotics. It is the robotics majors who will stand in for our panel of experts. Previous research in the field of public perceptions of nuclear technology showed that the views of students could approximate the literate college educated portion of the US population called the attentive public. Another study in Aerospace innovation (Climis et al.) showed that student opinions were a rough approximation for expert opinions. This study included WPI students, WPI graduates and experts, and found that the technological breakthrough that 80% of experts found most likely about half of the students also found most likely. The other 50% of student tended to be a random scattering of other responses strengthening the overall patter of agreement with the experts. Hence the more attainable student sample is preferred. Moreover the scenarios are set in the timeline of the careers of current students so the technological developments discussed represent the contribution of the next generation to the field this makes current students a more appealing sample than current experts

As for the students outside the field of robotics (which includes other technical majors and non-technical majors) research on the telephone suggests that those affected by a technology may provide more accurate predictions than the engineers involved in the development of the technology. Similarly there will clearly be other voices, in the public debate over robotics and involved the process of making polices, which are not those of technical experts in the field.

Ellul describes a “Technological Mentality” which is employed by engineers and scientists. It is largely based on efficiency criteria and involves a narrowly focused preference for objective criteria and short term implications. While this mentality has certainly aided in the development of increasingly useful and efficient technologies, it results in short term thinking and can lead people to miss side effects with unintended consequences.

The non-technological members of society tend to think more long term, and more easily consider the effect of a technology outside of the domain of application it was designed for. These predictions are based on hunches, experiences, and judgments about what new capabilities the technology might provide. This subjective thinking is rarely convincing to the efficiency oriented expert engineers. None the less these predictions often prove accurate once a technology is developed and its unintended effects begin to trickle into society. For example, when the telephone and telecommunication equipment first became available most of the engineers working on it pictured a mass media communications system like today’s radio broadcasts. They claimed there would be phone lines fanning out from the opera halls so all the world could listen in. Obviously this was not the most substantial effect of the new technology, which was more suitable for point to point communication than broadcasts. However, at the time radio was being used for ship to shore communications and other point to point applications and was associated with this niche. The open niche was broadcasts and the telephone was caste into the open niche as a likely area of application.

Non experts are not likely to be distracted by such mindsets. They look at a new technology in terms of what it could help them with in the fields they know best. The firemen, pharmacists, doctors, hoteliers and even businessmen wanting to move production facilities to cheaper land outside the city but wanted to keep the office in the city center who most accurately predicted the social implications of the telephone.

Clearly it makes sense for one attempting to assess the future of a technology (despite the possibility of a singularity) to consider the voices of those outside the field that might better understand how the technology is likely to be applied in their own professions and fields.

(End of the section borrowed from the work of Michael Brauckmann)

Chapter II: Methodology

Robotics technology is rapidly expanding into every aspect of our lives, and if the pattern continues this technology will be entirely pervasive in the near future. Singer warns of a future filled with machines that rule our lives, removing humans from one job after another eventually making the population a burden on the system rather than its backbone. Singer also cautions us of a rather pessimistic scenario where our technology could exceed our own capabilities, intellectual as well as physical, and could even be our end as a noncompetitive species compared to our creations.

Though no-one can predict the future of technological advancement, we know the public debate starting in discussions around the water cooler and moving into the political arena will shape that future, in both terms of technical capability and safety regulation. Through this survey we sought to discover what people believe the direction of the technology is and whether the respondents from WPI believe the destination of that direction is wise or desirable.

This study was inspired by another study proceeding our own. The previous project sought to understand what the population of WPI and several other local colleges and Universities thought about the future of robotics. To achieve this the prior team presented several different scenarios to the participants and asked them to rate the scenarios on likelihood and desirability. We incorporated their questionnaire to make the information in our project investigating a small class, comparable to theirs. We could then at least compare their data to our first administration of the questionnaires and see if our class had roughly the same distribution on responses as those from WPI as a whole. The plan was then to periodically re-administer it to track change as people the class became more knowledgeable. We planned to compare the first time results to completion of the survey a second time (near the end of the class). Then they would describe their progress through the class including participation in the debate to their final reflections on the process preselected in an essay format.

In analyzing the data from this process we found a pattern emerging that showed the students becoming more concerned over time, and becoming determined to keep humans "in the loop" and hold them accountable. The resulting restrictions on robotic autonomy cut into the hopes of the military to reduce manpower requirements by increasing robotic capabilities. The mindset of the students and the military planners were at odds and this was likely to happen in the real world as well. From this we were able to extrapolate from this mini-mock debate to some of the likely controversies that were likely to emerge in the real debate over the next generation. At least they were likely to emerge in the technical elite population debate which WPI graduates were likely to be involved with, and probably the broader debate involving other professionals who would be affected, be they lawyers, doctors, businesspersons or politicians.

In analyzing the data from the process that unfolded in the 2 month class we found a pattern emerged showing a convergence in the prevailing opinion of the students. From this we have attempted to extrapolate to the concerns of the larger WPI student population in this ongoing and controversial debate. It is useful to know that the WPI students were not all that different in their distribution of opinions than the students from other colleges, but that is not to say that the Clark and WSU non-technical students did not have their own separate voice on key issues under study. The point is that the similarities in rating of relatively likelihood and concern were more impressive than the differences and revealed to outlines of an emerging debate about what to do when the most likely developments in a field and the least desirable ones under consideration and the consensus about this pattern goes well beyond the technically expert community. .

In the words of Brauckmann (2013),

> It is beyond the scope of this study to address whether the future of robotics is actually predictable. However, it is not difficult to answer some simpler questions with methodological implications in the field of technology assessment such as: How much consensus exists among students in different fields on the direction technology is going? And if there is strong consensus on some direction, how desirable is that future perceived to be? Consensus in perception may mean the technology is not entirely unpredictable. Common expectations can even become a self-fulfilling prophesy. Such a consensus poses a significant socio-political issue, whether or not it proves to be accurate, especially if it results in an attempt to control the direction of the field, or resist undesirable outcomes.

Hence a Longitudinal study was developed to compare the first set of data with the qualitative data from observing the debate as well as the individual reflection paper and second survey.

Four scenarios describing possible futures in the progression of robotics technology have been developed. Each one posits a different lead institution providing the bulk of the developmental funding for the field of robotics. Our questions about the perceived importance of institutional influence shaping the field are answered indirectly by examining changes in the perceptions of those likely to be affected in these ways.

The underlying question to be addressed is whether members of our class, and from that all students at WPI, are actively thinking about where the field of robotics is headed, and if those concerns are mitigated by the values prominent in the mindset of the institution leading the field. This ethics question was embedded in each of the four scenarios. By this we mean that references were directly or indirectly made to Asimov's laws in each case, and it was done in a parallel and integrated way that kept it from being obtrusive. Differing reactions to the scenarios imply that it really does matter what institution is playing the lead role. The respondents assess the likelihood, desirability, and ethical implications of four possible scenarios for the future of robotic technology. The reflection papers then prove that the students went through a stage of mental development where there views expanded with a better understanding of the issues and the different views and rationales.

Developing the Scenarios: *by Michael Brauckmann*

In order to determine students' perceptions of robotics technology being developed under different institutions four scenarios were created. Each scenario posits a different institution driving the development of robotics and each takes a different ethical stance on Isaac Asimov's 3 Laws of Robotics. Currently the vast majority of funding for research and development of robotics technology in the USA comes from the Department of Defense. In one scenario this trend was continued, in the other three scenarios another institution replaced the military as the lead robotics development avenue. Each institution has a different goal for the technology; to explore and take advantage of lunar resources, to aid in meeting a major global food and environmental crisis, to take advantage of eldercare opportunities in the commercial sector, and to gain an advantage on the battlefield.

Each scenario was designed to expand the current state of robotics technology for approximately 50 years, and to picture similarly advanced robotics systems. This time frame was chosen so that the scenario would represent the contribution of the current generation of students to the field at the end of their careers. Each scenario then represents a perceived future of robotics under the leadership of varying institutions trying to address different real world problems. Each scenario is designed to raise ethical questions about the direction of robotics technology and its social and technical implications. Differing views on these implications between scenarios will reveal the effect of the driving institution.

Although they come from works of fiction, Asimov's Three Laws are the best known statement in literature on the ethics of robotics and the need to keep the technology under control. We adopted Asimov's framework with care. Asimov wrote his laws before the first transistor was developed, the positronic brains he envisioned and our microprocessors share almost nothing in common. As one roboticist put it, "People ask me about whether or not our robots follow Asimov's laws. There is a simple reason [that they don't]. I can't build Asimov's laws into them (Singer 432)." Furthermore, the entire premise of Asimov's short stories is that the three laws do not entirely prevent robots from behaving in undesirable ways.

We have been very careful in adopting his framework in that it is the corporations in control of the development of robotics that are the ones following the ethical code not the robots per se. The institutions in control in each scenario vary in their willingness and ability to accept Asimov's laws, from complete acceptance in the lunar scenario to complete rejection in the military scenario with the others falling somewhere in between. At this point in our research there were concerns about the clarity, and readability of the scenarios as well as how long it would take respondents to read through all four of them. A pilot study was conducted in a single WPI class containing about 80% robotics majors in order to obtain initial responses to the scenarios. Feedback from this class allowed for critiques that were grounded in experience and set the stage for editorial adaptation of the stimulus and response items. Following this pilot study, the scenarios were also modified to avoid confusion and to shift attention to the social implications of the technology itself, downplaying the many feasibility concerns coming from the robotics majors about how such a thing might be implemented.

Developing the Survey: *by Michael Brauckmann*

A questionnaire was attached to each scenario in order to collect data on the direction and strength of participant reactions to the scenarios. In the end, the hope was to produce a rank order from most to least likely and most to least desirable, though ties were possible. The same Indicator questions were used on each scenario to enhance comparability between scenarios and make such a rank ordering possible. The questionnaire consists of five variable indicator items: one designed to assess the likelihood of a question; two to address the desirability of the scenario in general and as an economic and technical stimulus; three more to get at the severity of ethical issues raised by the technology. One of these ethics items was left open ended for the respondents to voice their concerns and the other picked up on the man machine relationship specifically to tie into the extensive literature regarding technological autonomy and control.

Each response is intended to reveal a different aspect of the participant's perceptions of a possible direction in which robotics could develop and gives one an idea of what they expect to see from the technology. The Study is simplified by treating the scenarios as alternatives, though in fact they are not mutually exclusive and in fact are likely to co-exist and interact. The four scenarios do not represent the only possibilities for robotics and the respondents' actual best prediction of what will really happen is not directly assessed. Instead, this is a search for consensus on the direction of the technology and whether the social implications associated with most likely directions are reassuring or disquieting.

It was decided to keep the number of differing response categories to a minimum to avoid confusion and improve the appearance of the survey. Each question was worded such that it could be answered on either a likelihood or desirability scale. Four response categories were chosen so that there would be no middle ground. Hence, participants would be encouraged to think about the question enough to choose a side. The two response scales used on the questionnaire are as follows:

Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely
Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable

At this point a walkthrough of the five items they were asked after each scenario is in order so that comments can be made about what variable the indicator is supposed to tap and what the logic was for addressing each key variable in this fashion.

The first question was "How likely is it that this scenario could come about?" This question was used to support a comparison of the four scenarios to reveal which scenario's application area (space, the seas, personal service or warfare) was perceived as the most probable direction of application and hence have funds for technological development in the field. It was important to allow for ties, so a forced rank ordering item was avoided. It is only of passing interest what the majority of the whole stratified sample considers to be most likely as the study is designed to be internally comparative. Each of the three strata, in the sample will first be considered separately in this regard. This study is designed to reveal the level of consensus between our three sample strata (robotics majors, other technical majors and non-technical (liberal arts) majors). Thus it is primarily the level of agreement within and between these groupings that is of interest. One wants to see if there is a significant consensus among these people with different academic backgrounds and literacy on the subject at hand. Then a comparison can be made with desirability to determine if the perceived most likely direction of the technology is also the most desirable. If the scenario came about, would the resulting technology be likely to spin-off many applications that significantly advance the field of robotics? This question was developed to determine the amount of influence the technology described in scenario would have in terms of stimulating robotics and possibly other related fields. High responses on this question are intended to indicate socio economic impact potential. However, on its face it also means that the participants see this as a promising direction of technology development that will spread outside the scope of the scenario. If a development is perceived as likely to spin-off and stimulate secondary effects on society and the economy it is especially interesting from the standpoint of the coming singularity argument. A "singularity" is a complex, interaction of explosive technological developments to the point that predicting where it is going and what effect it will have is likely to be impossible. While many spinoffs would not be enough by itself to support the notion of a coming singularity, as proposed in the literature and noted by Singer, many spin- off applications would be part of a singularity pattern. If a robotics advance is highly transferrable to other ends, it might usher in a dynamic and volatile period in which robotics technology could be involved in a technological revolution evocative of the singularity idea. So, perceived spinoff potential raises two questions of interest to this study. Is the technology particularly likely to get out of control and does it matter who funds the development of the technology in terms of provoking an upheaval one might call a singularity after which developments are unpredictable? One theoretical premise of this study is that it does matter which institution develops the technology and for what purpose. However, this is in principle an empirical question subject to testing. However, since the data being gathered here cannot directly address that question, it is for now a theoretical assumption, and will be tested only in the world of perceptions. I can only address the question of whether the sample believes that it matters which institution is in charge. I can also see if the respondents perceived the scenarios to have different likelihoods of generating spinoffs or not.

There are those who claim, with some justification, that technology will be applied to war whatever its initial area of development and application was. The opposite may also be true, in other words that military capabilities will soon be turned to other ends. For example, the internet was a DARPA project aimed at robust communications that could survive a nuclear war. Clearly that has not been its most significant application and it is increasingly considered a socially transformative communications medium. On the other hand, this could be an exceptional case. Most technology developed by the military is classified and subject to secrecy requirements that limit its spinoff potential, or at least delays it.

At this point we are not collecting data intended to (or in principle to be able to) resolve the questions of what the future will really be and whether it really matters what organizations fund and execute the initial development of a robotic capabilities. It is still interesting to find out if those affected believe it is important what the lead agent is and what their expectations about the future are. The perceptions of those in the field of robotics are clearly important and I would contend that the perceptions of their other technical and non-technical peers likely to be affected by these developments are also just as important. Note that we are asking only about the 50 year period which their careers will span, and they will be acting on these perceptions at least initially. If all four scenarios are considered to have massive and essentially equal potential for spinoff, the sample is saying that it does not matter who does what and why; robotic technology is intrinsically revolutionary and possibly uncontrollable i.e. they expect that the singularity is coming.

If the scenario came about, how desirable or undesirable would the resulting changes in the quality of life be? The change in quality of life is used as a general and non-specific indicator of the effect the technology change would have on the society it is introduced into. It was important to get beyond narrow efficiency and economic implications of robotics and get into disruption and displacement issues, if they concerned the respondent. A broader than economics intent had to be clear, hence "quality of life" for people. A desirable effect on the quality of life indicates that the technology improves society in some way or at least alleviates the social issue it was designed to address. Undesirable responses indicate the technology may create worse problems than it solves, upset the balance in the system, displace workers or even get out of control. The key is a perception that it does not seem likely to solve problems, or that in solving one problem it might have unintended consequences that were negative side-effects and create even worse problems. By comparing these responses across scenarios and across the three groups in our sample one can determine if a consensus exists on the scenarios most likely to have desirable outcomes and compare them to the perceived most likely scenarios. If the scenario came about, how desirable or undesirable would the resulting changes in the man machine relationship be?

Having two parts to the desirability question was an effort to separate out the major theme of dependency of people on machines and inversions in the man-machine control relationship from the many other questions risen by the movement of automation into a robotics phase (and the creation of artificial intelligence) that one could consider undesirable trends.

Having two questions which could easily be combined into a composite item was a modest recognition that this was a multidimensional variable. Similar to the quality of life question, this question is intended to measure the social desirability of the scenario. Whether it is dependence on machines to meet some basic need or the formation of a caretaker relationship, the way in which machines interact with humans is inevitably changed by the kind of advancements in robotics technology under discussion. Questions of subordination and autonomy are bound to come up and thus impact the man-machine relationship that we are accustomed to seeing.

From a man -machine partnership to explore and mine the moon under lunar surface conditions hazardous to humans, to reshaping the ecology of the seas to feed humans, to directly putting vulnerable humans under robotic care, the stakes are rising. In the end, creating machines designed to hunt, ambush and kill humans raises the ultimate question of who is in control here especially if there seems to be a trend from human in the loop to increasing autonomy in these killer bots. But all along the way to this "terminator" extreme, the man-machine relationship is one thing you want to watch, and the control issue it raises is the focus of Asimov's laws.

Whether the acceptability and rated desirability of the scenarios tracks with the degree to which the scenario violates these laws is one of the questions under study. Responses to this question will also be checked for consensus among robotics majors, other technical majors, and non-technical majors. It is not clear that WPI and Clark University students will see things the same way, as they did not in the case of nuclear power during the late 1970's. This is a matter where trust and confidence in the technology and the institutions creating and managing it become increasingly important to public acceptance.

The perception of who was in charge and public confidence in that institution (be it "science", "government" or "private industry") greatly affected public attitudes toward nuclear power in the 1970's prior to the Three Mile Island (TMI) incident. At both WPI and Clark University there was high confidence in science as an institution, but only the WPI students perceived scientists to be in charge of the nuclear industry via the Nuclear Regulatory Agency. The Clark University students viewed the nuclear industry as a venture of the private sector, known for cost cutting in areas related to public safety.

After the TMI (Three Mile Island) incident in 1979 and the Chernobyl accident in 1986 (Ukraine in the then USSR) the dynamics changed, in part due to the discrediting of all the organizations in charge of the technology. The nuclear establishment seemed not to have been worthy of public trust and the charges of institutional failure were now specific rather than possibilities derived by analogy. In the case of the nuclear debate, the release of the film "The China Syndrome", shortly before the TMI incident, had already presented the possibility of a nuclear meltdown disaster due to corporate evasion of safety regulations during the construction of a nuclear power plant. At Clark University the TMI incident moved campus opinion from 60% anti-nuclear to 80% anti-nuclear. At WPI it went from 55% pro-nuclear to 75% pro-nuclear. Hence, there was an incident associated with the polarization of opinion about this technology in that case. We seem to be in the pre-polarization period of public attitudes toward robotics as there is not yet a famous incident to interpret as evidence of how safe the technology is and why.

The WPI response may seem surprising, but it depends on how the facts were interpreted. At Clark the key fact was that the experts said this kind of accident was highly improbable (1 in 1,000,000) and would probably never happen and yet it did. At WPI the prevailing view was that even with idiots and incompetents abusing a nuclear reactor they had not been able to make it meltdown to the point of breaching containment and harming the public. It was an economic disaster for the industry to be sure, but human error had been mitigated by built in automatic safety systems. Indeed, if all the operators had taken a coffee break when the first alarm went off and left the system alone it would have shut down safely and the emergency core cooling system would have kept the system acceptably stable. The real problems began when the operators, confused about what had happened, shut down the ECCS.

Note the temptation by technologists to design humans out of the system and make them peripheral rather than create a transparent and fault tolerant man-machine interface and depend on well trained and highly paid operators. This issue is returning in the robotics debate as the "human in the loop" question about whether or not one really wants to seek fully autonomous systems. Economics push one to reduce the caliber and number of operators if possible. Other considerations push back the other way.

The robotics debate is still in its pre disaster phase and analogy based perceptions of the institutions in charge are likely to be very important, hence the scenarios we designed move the lead role from government to various forms of public and private or entirely private commercial ventures. On the other hand there has been a lot of science fiction literature raising concerns about this technology's development. The bulk of the nuclear power references in science fiction tended to be fairly optimistic by comparison to those about robotics, but the first nuclear application was not a power plant, but an atom bomb that destroyed two whole cities. That history of surprise, dread and the strong reassurances given the public that "Atoms for Peace" had been tamed may have contributed to the public reaction of shock when nuclear technology finally did get out of control. The experts really were not on top of things and the unthinkable nearly happened at TMI and then did at Chernobyl. So, the issues of autonomy, subordination and control, highlighted by Asimov, are the focal point of this part of the perceived desirability variable tapped by this item.

If this scenario came about, how likely would it be to raise severe or challenging ethical concerns? This item serves as a crosscheck item for the ethical concerns raised by the man-machine relationship. Major ethical concerns may be indicated by the man and machine relationship, but it is also possible that other values, especially an environmental ethic, and possibly issues having to do with the meaning of work from various religious perspectives, have significant bearing on reactions to the questions that robotics raises for humanity. An item that asked about the level of concern provoked by each scenario that was not specific to what those concerns were, seemed appropriate. This question is an estimate of the odds that severe ethical concerns would be raised by the technology developing for the purposes indicated under the control of the given institution in each scenario.

A consensus on high levels of ethical concern would be a very significant "red flag" even if the respondents did not see the ethical stakes rising with each violation of one of Asimov's laws, as we expected. Responses to this question will be used to determine a relationship between Asimov's laws and perceived ethical concerns. This serves as a hypothetical test of Asimov's laws as ethical guidelines for robotics technology. The results of this question will also be compared with the scenarios deemed most likely to come about. In this case the two likelihood items will indicate whether the most likely scenarios are also the ones most likely to raise ethical concerns and challenges. If the current direction of the technology is deemed problematic on grounds of the emerging man machine relationship and those involved will likely be faced with ethical dilemmas, it is time to examine whether this is the direction the field or the funding agencies want to go. (End of borrowed descriptive section from Brauckmann, 2013)

This study validates the STS 2208 class as a model population roughly comparable to the larger data set at the outset of the class. This is more than a replication study. It makes the group interesting to study as it develops a consensus in the process of a political debate over the use and governance of these robots, as the results might generalize and reveal what is likely to happen as a broader social debate breaks out on these same issues.

It also allows one to classify a range of typical responses, to the kinds of questions Singer raises and reveals whether these concerns intensify or are mitigated by ensuing debate with others who reacted differently at first. We will document what the policy future of the US would be if the members of this class were in charge of shaping the future of robotics and that is interesting since what they did in role as republican and democratic politicians and what they said as individuals speaking in their own voices was substantially different. In short, they do not expect the system to produce the decisions they collectively consider to be the right and wise course of action.

We consider the outcome to be a validation this course as a consciousness raising teaching tool to expand the complexity of thought and increase the ethical consideration and understanding of the issues raised by far reaching technological change. Its value to robotic majors is evident, other majors also benefited greatly as indicated by the student's reflection and thought processes revealing in the time series data we examined. The question is whether students in all majors at WPI should have such an opportunity to consider the future of their technical specialties? The case for doing it in one field, whether or not it is your own, and then hopefully applying those lessons and logic to the problems faced or raised by one's own chosen field, seems strong.

Watching the robotics majors as they commented about paths to the future while commenting about charting one's career path given the alternatives was revealing. The robotic majors clearly want alternatives to working on military applications and the possibility of working on space applications was highly appealing to them. Interestingly, some of the necessary capabilities were so similar that crossover in both directions was likely, but it still mattered to them why the technology was being developed. It was perceived as impacting the likely social implications of their life's work.

Sample

STS 2208 the Technology -Society Debate Seminar, is a class designed to impress on the students taking it the importance of oversight and reasoned judgment when it comes to decision making about the future of robotics, and other emergent technologies. The continuing issue that is the theme has to do with the conditions under which technology gets out of social control. Escalations such as a competitive arms race emerge as classic examples. There is also a lot of discussion of the so called "technological mentality" in which efficiency criteria trump all other considerations in deciding about whether to develop or deploy a technology.

The class develops parallels to the current situation in robotics applied to warfare from the nuclear arms race of the cold war, citing it as simply the last arms race and most likely not the last we will see. In past years the issue of man against machine warfare has been brought into the spotlight with all the recent US governmental activity concerning the use of drones in the "War on Terror". With its announced intension to be a debate, and the tradition of there being a live role playing game akin to a model UN as part of the course, STS 2208 was a natural setting for our study. The decision to move to a US policy debate this year and have the *Wired for War* book by Singer be the main briefing paper for the class members took it from being a promising setting for the study to being a near perfect one. Ironically, during the mock congressional debate the UN started to take up the issue of whether the USA was guilty of war crimes for it policies on the use of UAV drones over foreign skies against foreign nationals. By next year a Model UN debate may be appropriate, but not if the Singer book remains the main briefing paper.

The T1 survey administration included all 27 students in the class for the initial study and 12 students completed the survey a second time after reading the Singer text for the longitudinal study. All the students wrote reviews of the Singer book but on examining them we found that one's views even the military scenario were not regularly revealed by these documents. They did reveal whether one had engaged the material whether one was impressed or offended by the book.

Comparing our findings to that of the previous survey we find that our sample is fairly representative of the WPI "other technical major" distribution of responses. In order to see how much impact the course readings, particularly the Singer book, had, we needed to compare our first and second questionnaire administrations which were about a month apart. It was considered unlikely that reading Vonnegut's Player Piano written in the 1950's about automation, but not robotics, or Gaviotas (which is about the appropriate technology movement in sustainable 3rd world technologies) would directly impact views on robotics. However, at a deeper level these books were about the technological mentality run amok in Player Piano and an alternative way of making decisions about technological development and deployment in Gaviotas. Hence, they could have had a predisposing effect on how one read the Singer book which was after all critical of how decisions about robotic technology were being made by the military.

For the purpose of monitoring change over this month of reading we built a delta matrix of the answers by assigning a value from 1 to 4 for unlikely/undesirable to likely/desirable and subtracting the trial 2 (T2) response from the trial 1 (T1) response. These data we broke down by participant, scenario and question. In order to analyze the data we developed four statistics. These were the percentage of participants to change their mind, (i.e. percentage with non-zero delta matrix entries) pure average of the positive and negative changes, average magnitude, and standard deviation.

From the above key statistics to be interesting a few assumptions are necessary. If the percentage of participants who changed their minds from T1 to T2 is large (over 50%) then most of the participants changed their minds during this part of the class. The average tells us the overall movement of the class, so if it is large (>0.5) there was a lot of movement in the same direction. Similarly the average magnitude tells us how much movement in general there was, a large number (>0.5) in this category means there was a fair amount of movement from T1 to T2. Finally we have the standard deviation. This tells us how well people agreed, or how close they were to average change from T1 to T2. The smaller this number is the more contiguously the group moved from T1 to T2. These metrics facilitate our analysis of the change in the Perceived likelihood and desirability of the robotic scenarios under consideration by the students from T1 to T2.

Development of the Debate

One of the pillars of the class which we developed was a debate to help the students comprehensively overview current and future legislative processes within our system of government. This exercise was developed during, and concurrently with, the progression of the class. We set out to replicate a government hearing process akin to what our government will do to decide how to regulate and fund automated robotic systems. Efforts were taken to ensure the students would be able to tailor the discussion to describe some of their own views, even though they were given an agenda to portray. This was accomplished by encouraging the students to develop their own characters for participation in the debate.

The groups the students represented consisted of 6members of the House of Representatives, 6 Senators, 4 members of the National Academy of Sciences, 4 staff members from the office of the US Ambassador to the United Nations, 4 senior staff from the Department of Defense, and 4 State Department staffers. Each group consisted of several members often with opposing viewpoints. The Senate and House were divided by Democrats and Republicans, and each of the different groups brought their own concerns to the table. By allowing the students to model their characters off what they perceived the debate to look like, the students were forced to see the debate from various viewpoints. This amalgamation of different positions served to bring issues like defense spending, lead agency, and regulatory control into the mock hearing and the debate that followed.

Each of the groups of students was prepared in their own way by a coach in an attempt to help the students represent these characters. Each of these characters had an agenda; sometimes they brought other agendas to the table as well. An example of this kind of activity would be represented by lobbyist, people who pay and or bribe legislators to change their opinion on a bill of law. For instance the team from the UN had to bring the views of the countries that they communicate with; each member of this group came from a regional “desk”. When it came to the D.o.D..., Peter Campisano was in a position to coach the people in those roles so as to give them some real world input and make it feel real. His people literally impersonated the person with the actual job and looked up their actual positions to the extent possible. Professor Wilkes coached somewhat more flexibly but wanted them to have a role model, and the play an actual member of Congress.

During the debate the professor played a role in the proceedings. Professor John Wilkes played the role of John D Rockefeller, previously an important business man with powerful political and business ties. Now he was a Senator from West Virginia and chairman of the committee on Commerce, Science and Transportation. As such he could portray a partisan and corporate, slant on controlling and regulating robotics. In character Mr. Rockefeller attempted to sway the votes of Congress to plan on building a lunar base from which to mine He-3, a fuel used in fusion reactors abundant on the moon but not found on Earth. . However in proposing his legislation he not only tried to put NASA in place as the lead agency developing robotics moving forward, but he also set out to ensure that private corporations would take over developing the moon after the infrastructure was put in place an government expense. The idea of the public paving the way for private enterprise by removing much of the risk is not uncommon in American history, but it offended enough of the role playing congressmen that his bill was amended and then voted down anyway. He seemed to be trying the wrest the lead in robotics from the military so that it would be under the jurisdiction of his committee, (which covered civilian science activity by not research carried out by the armed services), which was under the purview of another committee. However, the larger issue was his attempts to get the U.S. Government to create the moon base only to have individuals gain the final profit before the government could recoup its investment costs. This was straight out of one of the scenarios in the questionnaire but no one seemed to recognize it as such even when he justified it based on “national” survey data suggesting that there was strong public support for shifting priority to the civilian sector in developing robotics.

After the students had a chance to voice their own opinions, in role, we had the class collaborate in order to propose legislation. By accumulating the views and ideas of all the students we managed to condense the many individual proposals into three Bills. These bills were then dissected and reworked by the class, and finally voted on. This process was to find out what the students think the government is likely to do to face these pressing new world technological concerns and then see if that is what they really think ought to be done but having them write reflection papers on how the game turned out and their views on robotics after having read the Singer book and participated in a debate about the issues he raised- or should have raised.

Chapter III: Findings

The findings chapter will be divided into four sections. The first section presents the relationship between our first questionnaire distribution results and the previous study by Brauckmann et. al.. The second section will deal with the first and second questionnaire administration in this two month class. A problem was created by the inability to get more than half of the second wave of questionnaires collected before an analysis had to be carried out. This set the stage for Castro's extension study which started out trying to get that missing data but once that was not possible it evolved into a more precise and quantitative analysis of the qualitative reflection essay data first examined by Conwell et. al.. This set the stage for the third section data that will report the content analysis, new coding system developed by Conwell and the analysis of the new qualitative data codes is the work of Castro. He executed both the parts which assessed the intercoder reliability of the new codes and analyzed the new data. His focus was on the relationship of the variables to each other but he also recoded some of the initial questionnaire data so it could be correlated with the new variables reflecting changed positions at the end of the course.

The first series of tables in section A was produced and distributed to the class as a way of illustrating that on the whole the two were similar. There were still a few discrepancies in the prior data and the new class data.

Though the class comparison to the prior data set is based on only the likelihood and man-machine relationship items it makes the point that the desirable scenarios are not the most likely in terms of that made sense for those in the course. The man-machine relationship was a main theme in the course. It is therefore interesting that Conwell et. al. decided to use questions 1 (likelihood), 3(desirability) and 5(ethical issues raised) for their analysis and dropped the man-machine relationship item. Castro followed suit using questions 1 and 3 but did not pursue question 5 in part because there was no qualitative code for dealing with ethical concerns in the data. This first series of tables makes the point that on the whole, the class distribution reflects that of the prior study. This sets the stage for addressing Conwell et. al.'s fundamental question of whether this distribution would remain stable as the students learned more about the subject and discussed the social implications of robotics with their peers. In effect they are asking whether the distribution reported by Brauckmann et. al. is going to tell you much about the debate that will unfold if you only know the initial positions the students held at the outset (in this case upon starting the class, well before entering the in class debate). Castro took upon himself the task of trying to predict prior positions from later positions and in one case later positions from prior positions. He reports on the extreme difficulty of recovering from the failure to gather data at the time participants are gathered and in the process under study. He finally gave up on making estimates from other available data after trying to predict the positions of the

12 people for which there was a second questionnaire, based on their first questionnaire responses and their description of whether and how their views had changed in their reflection essays. He was surprised by the actual second questionnaire positions about half the time.

Section A Comparison of First Questionnaire to Prior Findings

The first series of tables in section A was produced and distributed to the class as a way of illustrating that on the whole the views of the class reflected the prior larger study of about 100 WPI students in Brauckmann et. al.'s study. In short, the two were similar but not identical.. This analysis includes the likelihood and only one of the desirability variables. The emphasis of the class was on man-machine relationships so that item was selected for presentation out of the three possible desirability indicators. The major focus of the in class debate was the common finding for both the prior data set and the class study that the most desirable scenarios were less likely than the least desirable scenario.

There were a few discrepancies in the prior data and the new class data but some of them are not evident in these data. For example, the class found all the scenarios to be about equally likely to raise ethical issues whereas the prior sample reported major differences in the level of ethical concern they had scenario by scenario. The differences between the Space and Military scenarios were particularly striking, as the likelihood that the space applications would raise ethical issues was rated far lower than that of the military applications by the prior and more representative sample. Still, on the whole, the two were similar.

NASA Scenario Likelihood

		Unlikely	Somewhat Unlikely	Somewhat Likely	Likely
Prior Data (69)	RBE (41)	5%	32%	44%	20%
	Other Tech (28)	18%	32%	43%	7%
Class Data (28)	RBE (16)	19%	19%	38%	25%
	Other Tech (12)	0%	25%	75%	0%

Man-Machine Relationship

		Undesirable	Somewhat Undesirable	Somewhat Desirable	Desirable

Prior Data	RBE	0%	20%	54%	27%
	Other Tech	15%	15%	59%	11%
Class Data	RBE	6%	25%	56%	13%
	Other Tech	0%	42%	33%	25%

Water world Scenario Likelihood

		Unlikely	Somewhat Unlikely	Somewhat Likely	Likely
Prior Data (69)	RBE	12%	48%	33%	7%
	Other Tech	26%	48%	15%	11%
Class Data (28)	RBE	27%	47%	13%	13%
	Other Tech	8%	58%	33%	0%

Man-Machine Relationship

		Undesirable	Somewhat Undesirable	Somewhat Desirable	Desirable
Prior Data	RBE	5%	32%	46%	17%
	Other Tech	11%	22%	48%	19%
Class Data	RBE	13%	20%	60%	7%

	Other Tech	8%	33%	33%	35%

China Eldercare Scenario Likelihoood

		Unlikely	Somewhat Unlikely	Somewhat Likely	Likely
Prior Data (64)	RBE	14%	24%	38%	24%
	Other Tech	30%	30%	30%	11%
Class Data (28)	RBE	19%	19%	38%	25%
	Other Tech	0%	25%	75%	0%

Man-Machine Relationship

		Undesirable	Somewhat Undesirable	Somewhat Desirable	Desirable
Prior Data	RBE	15%	42%	27%	17%
	Other Tech	30%	15%	33%	22%
Class Data	RBE	6%	25%	56%	13%
	Other Tech	0%	42%	33%	25%

Military Scenario Likelihood

		Unlikely	Somewhat Unlikely	Somewhat Likely	Likely
Prior Data (64)	RBE	2%	14%	42%	41%
	Other Tech	21%	4%	36%	39%
Class Data (28)	RBE	0%	0%	69%	31%
	Other Tech	0%	0%	50%	50%

Man-Machine Relationship

		Undesirable	Somewhat Undesirable	Somewhat Desirable	Desirable
Prior Data	RBE	33%	33%	21%	12%
	Other Tech	25%	11%	46%	18%
Class Data	RBE	44%	25%	25%	6%
	Other Tech	25%	42%	33%	0%

Section B Change Data: The First and Second Questionnaire Distributions

The following section is an analysis of change in three items referring to four different scenarios for a total of 12 change findings presented in four tables. The analysis is limited to only 12 cases (about half the data set) due to an inability to gather all of the second wave questionnaires before the class ended. It was hoped that James Castro would be able to fill in this gap in the data set later on. This team faced a deadline which prevented them from attempting to gather the rest of the questionnaires one by one from the 14 students who did not respond to a mass appeal. Nonetheless, there is considerable evidence of positions changing in response to learning more about the subject and having the chance to debate it amongst one’s peers. The team decided to devote its attention to analysis of qualitative data collected at the end of the course rather than risk delaying the submission of a report by trying to get the missing questionnaire data.

Data Analysis

Our project was an extension of an existing project and so the first thing we tried to do was relate the two studies. Hence, we used the same questionnaire and scenarios as the previous studies, however rather than administer that survey to a wider group and simply add to the available data we decided to look at the effects of a class studying the future of robotics issue at WPI. We gave the students the survey within the first week of the class in order to get their initial standpoint and to compare our sample to the larger samples from previous studies. This gave us a baseline from which to further look at how these students processed the problem especially with the guidance of the briefing papers required for the class. At the end of the class we asked the students to complete the survey again. Unfortunately only 12 students answered the second survey; however we were able to both see what rate of change in opinion was for that half of the class and validate the qualitative respective data gathered at the end of the course to see if those who reported a change in opinion at that point in the class really had had one as noted by the survey administered at the time. If the retrospective data was accurate, we could use the final reports to fill in the missing data point in general qualitative terms, and analyze their responses adequately for our qualitative interests. The final piece was the reflection paper each student wrote, this allowed us to hear them describe the process from beginning to end including which experiences they believed were most influencing. We found these papers to be revealing about the process of opinion change. They allowed is to see if increased awareness and information gathering was a predictor of opinion change. The larger process of the refinement and shaping of opinion was also captured. .

Question No. 1

In our first round of data collection we had 28 students. Of those 16 were robotics majors and 12 were other technical majors (Appendix B.) The previous study had 41 robotics students and 28 other technical majors from WPI. (Appendix A.) The ratio of robotics engineers to other technical majors in our study was 1.33, in the previous study it was 1.46. Given the size of our study these ratios are very close. The previous study also included surveys from Boston University and had a total of 99 participants. In order to compare these two similar samples we will break down the survey first by question and then by scenario, though we will only look at 3 of the five questions. Further we will examine all of the four answer categories in each question, comparing the percentage of the total number of participants in each study to give each answer. This will give us a good idea of how representative our sample is of the previous study and will tell us what each sample thought was most likely or desirable.

The NASA scenario was considered somewhat likely overall by both the previous study and our study. In the previous study 11.1% said this scenario was unlikely and *10.7% gave that answer in our study. An additional 29.3% said it was somewhat unlikely in the* previous study and 21.4% from our study. Many participants disagreed marking that this study was somewhat likely including 47.5% from the earlier study and 53.6% from our study. Finally 12.1% from the original study and 14.3% from our study thought this was a likely scenario. Here we see a very close correlation between the data sets. Both considered this scenario somewhat likely overall but with many disagreeing.

NASA	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely	

RBE	3	3	6	4	
OTHER	0	3	9	0	
TOTAL	3	6	15	4	
RBE %	18.75	18.75	37.5	25	
OTHER %	0	25	75	0	
TOTAL %	10.71	21.43	53.57	14.29	

The water world scenario people considered to be less likely though again there was a fair amount of disagreement. 19.2% of participants in the first study and 18.5% of students in our study thought this scenario was unlikely. In the first and second study 41.4% and 51.8% respectively thought this scenario was somewhat unlikely. The previous study was somewhat more receptive to the water world scenario with 29.3% of participants marking it a somewhat likely scenario compared with 22.2% from our study. Very few thought this scenario was likely with only 10.1% in the first group and just 7.4% in the second. Despite the minor differences these numbers again correlate fairly well with the majority in both studies finding this scenario to be somewhat unlikely

Water	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely	
RBE	4	7	2	2	
OTHER	1	7	4	0	
TOTAL	5	14	6	2	
RBE %	26.67	46.67	13.33	13.33	
OTHER %	8.33	58.33	33.33	0.00	
TOTAL %	18.52	51.85	22.22	7.41	

The China scenario showed some differences between the groups. The original group was fairly evenly divided on the likelihood of this scenario whereas our participants found it to be very likely. The first category showed 19.2% in the previous study and 14.3% in our study. In the previous study 28.3% of participants found this scenario somewhat unlikely vs. just 17.9% from our group. Many participants from both groups thought this scenario was somewhat likely with 36.4% of the first sample and 39.3% from the second sample. The final category shows the largest discrepancy between the groups with only 16.2% from the first study and 28.6% from the second study. When you note that the first study is 47.5% for unlikely and 52.5% for likely vs. 32.2% to 67.8% for our study it is clear that our study found this scenario to be more likely. There are many factors that could lead to this difference of opinion most obviously the time elapsed between the studies. China is often a controversial issue in the U.S. News and the kind of public scrutiny and awareness that brings can rapidly change opinion in a population.

China	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely	
RBE	1	3	7	5	
OTHER	3	2	4	3	
TOTAL	4	5	11	8	
RBE %	6.25	18.75	43.75	31.25	
OTHER %	25.00	16.67	33.33	25.00	
TOTAL %	14.29	17.86	39.29	28.57	

Almost every participant believed the military scenario was at least somewhat likely. This scenario describes something which is ongoing, the military shift to non-human combatants. This is likely why responses to this scenario are so unanimous. In the broader study 11.1% of participants marked this scenario unlikely and 12.1% marked it somewhat unlikely. No participants in our study marked this scenario as even somewhat unlikely. Of the remaining Participants in the previous study 40.4% marked somewhat likely and 36.4% thought this scenario was likely. In our study 60.7% of participants thought it was somewhat likely and 39.3% thought it was likely. Almost 40% of participants in both studies marked this scenario as likely. This unprecedented correlation is more than likely due to the fact that 90% or more of all funding in the field of robotics comes from the U.S. Government.

Military	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely	
RBE	0	0	11	5	
OTHER	0	0	6	6	
TOTAL	0	0	17	11	
RBE %	0	0	68.75	31.25	
OTHER %	0	0	50.00	50.00	
TOTAL %	0	0	60.71	39.29	

Question No. 3

The next question is the one of desirability. The participants were asked to rate each scenario on the merit of the desirability of the change in quality of life they thought were likely. This allows us to look at the relationship between likelihood and desirability. If a scenario seems likely (to the participants) but is undesirable then we know participants are apprehensive of that future. If a scenario seems desirable but is unlikely then we know participants see a need for more funding in the organizations that would facilitate making that potential a reality. In order to compare the results in this category from both studies the information will be presented similarly to above.

Neither group found the NASA scenario to be undesirable with just 4.1% from the first group and 3.6% from the second in that category. A few respondents found this scenario to be somewhat undesirable, 14.4% from the first study and 25.0% from the second. The largest category by far, somewhat desirable had 59.8% of respondents in the first group and 42.9% in the second. A good number of participants were enthusiastic about this prospective future with 21.6% from the first study and 28.6% from our study. Clearly the two groups correlate very closely on this fairly benign and even beneficent scenario with the majority agreeing that it would be at least somewhat desirable.

NASA	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable	
RBE	1	3	8	4	
OTHER	0	4	4	4	
TOTAL	1	7	12	8	
RBE %	6.25	18.75	50	25	
OTHER %	0.00	33.33	33.33	33.33	
TOTAL %	3.57	25.00	42.86	28.57	

Neither group agreed strongly on the water world scenario but both leaned slightly towards somewhat desirable. 15.2% of the initial sample found this scenario undesirable and

7.4% of our sample agreed. Many people in both samples fell into the weak opinion categories; 24.2% in the first study found this somewhat undesirable compared with 37.0% in our first survey. In the largest overall category for this scenario 37.4% of participants in the first study and 33.3% of participants in our study found this scenario to be somewhat desirable. Finally in the desirable category we have 23.2% from the first and 22.2% from the second. Although there are some differences between the studies there is overall agreement between the two for somewhat desirable. Looking back, both groups found this scenario to be somewhat unlikely so this is a scenario that both groups think would require a push to begin development.

Water	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable	
RBE	1	6	5	3	
OTHER	1	4	4	3	
TOTAL	2	10	9	6	
RBE %	6.67	40.00	33.33	20.00	
OTHER %	8.33	33.33	33.33	25.00	
TOTAL %	7.41	37.04	33.33	22.22	

The China scenario was found by both studies to be fairly desirable. The first study found 14.3% and the second 17.9% in the undesirable category. A not insignificant portion of both studies found this scenario to be somewhat undesirable with 23.5% of the first study and 21.4% of our study. The majority found it somewhat desirable with 38.8% from the first study and 32.1% from the second. Many found it desirable with 23.5% of the first study and 28.6% of ours in this category. Unsurprisingly many people find the idea of medical assistant robotics desirable. In the question of likelihood we saw that first group seemed somewhat unsure on this topic whereas our group was fairly well in agreement that it was a likely scenario. Many outside the field of robotics are not aware of the level of technology penetration in the medical field. Looking at the breakdown by major of the earlier study (Appendix A) we can see that the robotics majors interviewed found the scenario to be likely.

China	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable	
RBE	2	4	3	7	
OTHER	3	2	6	1	
TOTAL	5	6	9	8	
RBE %	12.50	25.00	18.75	43.75	
OTHER %	25.00	16.67	50.00	8.33	
TOTAL %	17.86	21.43	32.14	28.57	

The first study found the military scenario to be fairly undesirable and our study found it to be very undesirable. In the strong category of undesirable we had 29.3% in the previous study and 35.7% in our study. 27.3% in the previous study and 32.1% in our study found it to be somewhat undesirable. Some found this scenario somewhat desirable with 27.3% of the previous study and 28.6% of our study. Finally very few found this scenario to be desirable with 16.2% of the first study and just 3.6% of our study. This is the only scenario that was considered undesirable and it was considered undesirable by both groups. Looking back at likelihood this was also perceived to be the very likely by both. This shows that in both populations we see considerable concern about this scenario and concern that this is the direction we are already headed in.

Military	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable	

RBE	7	4	4	1	
OTHER	3	5	4	0	
TOTAL	10.00	9.00	8.00	1.00	
RBE %	43.75	25.00	25.00	6.25	
OTHER %	25.00	41.67	33.33	0.00	
TOTAL %	35.71	32.14	28.57	3.57	

Question No. 5

The final question we compared was the question of the likelihood of each scenario to create ethical concerns. This is a more ephemeral question and presents us with some information about what the students considered ethically questionable; more importantly it prompted the students to consider the ethical concerns surrounding this potential uses of robotics. A relationship between ethics and likelihood gives us a good idea of which kinds of developments need to be closely monitored and regulated.

Both groups thought the NASA scenario was likely to cause ethical concerns. This was somewhat unexpected given the data we have already looked at but when considering the scenario this concern does not seem misplaced. 11.2% of participants from the first study thought this scenario was unlikely to cause ethical concern as well as 3.6% from our study. An additional 24.5% from the first study and 10.7% from our study thought this was somewhat unlikely. 34.7% from the previous study and 21.4% believed ethical concerns were somewhat likely. In the largest overall category 29.6% from the first study and 64.3% from our study found ethical concerns to be likely. Our study appears to be much more concerned about the ethics of this scenario; however in the breakdown of the previous data (Appendix A) it is clear that the WPI data from the previous study correlates closely to our findings. In fact in every scenario our study found it to be highly likely to cause ethical concerns as did the previous study to the extent that in no instance did our study find fewer than 85% or the previous study find under 65% of participants thought a scenario was likely to cause ethical concerns. From this it is clear that most people thought that robotics, in any setting would be ethically challenging. One scenario stood out as the most likely to cause ethical concerns with 89.8% from the first study and 92.8% agreeing that it was at least somewhat likely to cause ethical concerns. Clearly robotics is likely to cause ethical concerns, which is unsurprising because it is an emergent technology and historically emergent technology is an ethically challenging subject.

Comparison of Surveys

After the students had taken the survey the first time (T1, Appendix B) read the two books and finally participated in the debate, they were asked to take the survey again (T2, Appendix C) so we could see their change of opinion after spending so much time in the class considering these issues. Only 12 people responded the second time however that was adequate for our longitudinal study. In order to compare their initial reaction to the survey and their stance on the issues after taking the class we assigned number values to the answer from 1 for unlikely or undesirable to 4 for likely or desirable. We then subtracted the T2 answers from the T1 answers in order to show the change from one to the other. We did this for each scenario developing four tables of changes or delta tables (Appendix D) again we report here only the most relevant questions of likelihood, desirability and likelihood to cause ethical concern. Because of the way we defined our delta tables (that is T1-T2=d) a negative number corresponds to a higher response in the second survey, that is a shift towards more likely or more desirable. A positive number corresponds to change towards less likely or desirable. We also report several statistics for each question, the percent of participants to change their mind from one survey to the next (%diff,) total average change (Avg,) total average magnitude (Avg Mag) and standard deviation (StDev.)

NASA Scenario

In the NASA scenario we saw a fair amount of movement, over 50% changed their answer in all three questions. On the question of likelihood the average of -.17 indicates overall slight shift towards more likely, however the average magnitude of .67 shows that many changed their answer. Because our categories are one through four the standard deviation analysis is somewhat difficult to use, however it generally confirms the findings of disagreement or agreement in the average versus average magnitude comparison where smaller values correlate to better agreement.

There was some movement around the question of desirability and all in the same direction. The average of -.67 shows that there was movement towards more desirable. The average magnitude was .67, the same magnitude as the average showing that all movement was in the same direction.

Interestingly almost everyone was less concerned about the ethical questions this scenario might bring up, 91.7% changed their answer from the first survey. Both the average and average magnitude are 1.25 showing large movement towards less likely to cause ethical concerns. There was even want student, participant 25, who completely reversed their opinion from likely to cause ethical concerns (4) to unlikely (1.)

Participant	Q1	Q3	Q5
1	0	0	2
3	0	-1	1
6	-1	-1	1
7	0	-1	1
8	1	-1	1
13	-1	0	1
14	1	-1	1
22	-1	0	2
23	-1	-1	1
24	0	0	3
25	-1	-2	1
27	1	0	0
%diff	66.66667	58.33333	91.66667
Avg	-0.16667	-0.66667	1.25
Avg Mag	0.666667	0.666667	1.25
StDev	0.834847	0.651339	0.753778

Water World Scenario

Almost every participant who took both surveys changed their opinion from the first time; over 60% in every category. On the question of likelihood we saw 90.9% of participants changed their opinion. The average of -.55 shows some movement towards more likely. The average magnitude of .91 shows there was some movement in the opposite direction.

81.8% of participants changed their mind on the desirability of the water world scenario. The average of -.36 shows general movement towards more desirable, however the average magnitude of .72 shows that there was some disagreement in the direction of change.

The fewest number of participants changed their opinion on the ethical question with 63.6%. The average of .18 shows a small movement towards less likely to cause ethical concerns. The average magnitude of .73 shows there was some movement and that there was not much agreement in direction.

Participant	Q1	Q3	Q5
1			
3	0	1	-1
6	1	-1	-2
7	-1	-1	2
8	1	-1	1
13	-1	-1	1
14	-1	0	0
22	-2	-1	0
23	-1	-1	1
24	-1	1	0
25	0	0	0
27	-1	0	0
%diff	90.90909	81.81818	63.63636
Avg	-0.54545	-0.36364	0.181818
Avg Mag	0.909091	0.727273	0.727273
StDev	0.934199	0.80904	1.07872

China Scenario

The china scenario had less change with fewer than 70% changing their opinion in every category. In the category of likelihood 58.3% changed their opinion in the second survey. The average of -.58 shows general movement towards more likely. The average magnitude of .75 shows there was some disagreement but most movement was in the same direction.

Only 41.6% changed their opinions on the question of desirability. With an average of just .08 the overall movement was negligible; however the average magnitude of .42 confirms there was a good amount of movement.

66.7% changed their opinions on the question of ethical concerns. The average of .08 shows negligible overall movement towards less likely. The average magnitude of .92 shows that there was large disagreement as well as large movement.

Participant	Q1	Q3	Q5
1	-1	1	-2
3	-3	-1	-2
6	-1	0	2
7	0	0	1

8	1	1	1
13	0	-1	1
14	-1	0	0
22	0	0	0
23	0	1	0
24	-1	0	1
25	-1	0	0
27	0	0	-1
%diff	58.33333	41.66667	66.66667
Avg	-0.58333	0.083333	0.083333
Avg Mag	0.75	0.416667	0.916667
StDev	0.996205	0.668558	1.240112

Military Scenario

Overall there was the least amount of movement in opinion on the military scenario. 41.6% changed their opinion on the question of likely hood. The average of -.42 shows movement in the direction of more likely. The average magnitude of .42 shows that there was total agreement in the direction of movement. 58.3% changed their opinion on the question of desirability. The average was .08 showing almost no continuity in the direction of change. The average magnitude was .58 showing there was some movement overall.

There was only one change of opinion on the question of the likelihood to cause ethical concern and that was in the direction of more likely. In this category almost everyone already had the most likely category selected.

Participant	Q1	Q3	Q5
1	0	-1	0
3	0	0	0
6	-1	0	0
7	0	0	-1
8	-1	1	0
13	0	-1	0
14	0	1	0
22	-1	0	0
23	-1	1	0
24	0	0	0
25	-1	1	0
27	0	-1	0
%diff	41.66667	58.33333	8.333333
Avg	-0.41667	0.083333	-0.08333
Avg Mag	0.416667	0.583333	0.083333
StDev	0.514929	0.792961	0.288675

Those interested in the characteristic shift in opinion between our first and second questionnaires should direct their attention to the average magnitude line of the above tables. This statistic shows the overall amount of change in opinion in each question. Overall we found significant change in most of the answers (>.05) and little change in a few where opinions were already strong. In general compared to the military scenario, the others, especially the space application, looked better and more desirable.

The first was the NASA scenario and the relationship between optimism and desirability and likelihood all while keeping their change throughout the course as a control variable when it was not the dependent variable. A second set of analyses done were on the Military scenario using the same comparisons.

The robotics students have a greater empathy for the current robotics direction, even commenting on more stringent requirements in testing efficiency. This appears to be attributed to the fact they are looking for employment. These students are aware of the money involved in government spending and this extreme. This excessive defense spending develops job security just so long as you create weapons. This disparity is observable in the general demeanor of the robotics students taking about the military applications; most students that eviscerated our current model were non-technical.

Though the Robotics majors were more likely to show empathy toward the current direction the overwhelming majority of test subjects wanted more funding in the private sector. It is our belief that due to this discrepancy between people's views and the real world drastic action is required to steer this technology in the direction of the common good. If one thing is certain people don't like where robotics are going, the military robotic application scenario was the only one that was listed as both very likely and very undesirable. Drastic action needs to be taken to not only stop the proliferation of this technology but to retard the advancement in technologies so detrimental to society.

We found another overwhelming consensus dealing with keeping a human in the loop to make life or death tactical calls. On the question of regulation, the papers showed an average of 3.5, meaning that most of the students suggest some sort of controlling structure whether it is an oversight committee or some other agency. All of the students believe that a human should ultimately make the call of whether or not to take human life. The reason a computer will never be at the level of complexity of a human, at least not in the near future. This therefor lays out a good guideline for future legislation, a view that seemingly everyone shares, keep a human in the loop, making all decision on the ending of life. However there is one caveat, it was suggested that in times of desperation the use of drones that automatically end life could be used. This meaning if there was no other option, i.e. you would be overrun and ended if you do not deploy robotic sentries to fend off attackers. This raises the obvious that when faced with adversity there is no telling where or how this technology could be used.

Discussion of Results

The first question we asked ourselves was if our data set is representative of the previous study. In comparing the individual questions we found that our class not only met the 50:50 technical/nontechnical, but also closely followed the previous studies results. We were only interested in three of the five questions, numbers one, three, and five. The first question dealt with likelihood of the scenario. The third question spoke to the desirability of the future portrayed in the scenario, and finally the fifth question was to determine any perceived ethical concerns the scenario will bring up.

Overall the groups appear fairly similar in question one. There is more agreement about the military scenario in our study and our participants found the china scenario to be more likely than the previous group. Although these studies are separated by more than 6 months there were no major changes in robotics or the direction of robotics during that time. Both groups agree that the NASA scenario is somewhat likely and both agree that the water world scenario is somewhat unlikely. The first group was quite divided on the china scenario whereas our group thought it was fairly likely. Finally both groups thought the Military scenario was highly likely. Overall there is a good level of similarity between the groups.

From the data in question three it is easy to see why Asimov developed the laws he did. Every scenario proposed in the survey for robotics is found to be somewhat desirable except the military one. Clearly it is a serious concern for everyone who took this survey and it suggests that we should look closely at where the technology is going and more importantly where we are sending it. This warrants more investigation of people's concerns regarding enforcement type robotics.

The ethical challenges of robotics are likely to appear in any setting, even ones that are likely to be beneficial. This is because ethics must change when, with time, new things come into existence. Any new thing requires a new set of ethics related to it. It is important to be careful, then, when developing any new technology especially controversial ones such as robotics. It is clear we will have to tread carefully when developing new regulations and when encouraging development of this technology.

The debate was one of the foundational elements in our experimental process and to the class. During the debate the students had free rein to bring any thoughts to the table, even if they did not reflect their own. One of the most interesting things was the divergence of thought perceived in the debate. While some persons were intent on decreasing budget, still others wanted to expand it. When we looked through the final reflection papers we noticed that even though there were disagreements in the debate, the students in this class appeared to agree when not presented the questions in a debate format. This goes to suggest that the students brought controversy into the debate because they were modeling a controversial system that thrives just so long as no-one agrees.

Democrats or liberals typically support government action to level the playing field for all. However in-terms of military spending the Democrats almost always advocate for a smaller budget in an attempt to shift resources to social justice and equity issues rather than just defend the status quo. It is a matter of social priorities rather than an effort to balance the budget. . This was indicative of our debate, where the Democrats were the only ones to express an interest in decreasing defense spending citing the United States as almost 2:1in spending against the rest of the world. In this case it took the form of shifting resources for robotics development to other agencies for disbursement rather than decreasing investment in this field. The Republicans were the majority on our committees dealing with the armed services and science. This is not always the case, at least in the Senate, but the vote was going to have to pass both Houses to the Democrats with parity in the Senate were unlikely to propose something unlikely to get any moderate Republican support and vice versa. It is surprising that we heard no Republican voice for balancing the budget or cutting the deficit or even reducing taxes in this debate. What we heard was that the Defense department should get what it wanted or needed in a period when the manpower pool was being downsized. Bases on D.o.D... testimony, it wanted to build up its robotics effort as part of a larger strategy. This was a scary scenario presented in their testimony but it was not questioned in the Congressional debate. It was late in reflection papers that people expressed reservations about where this was headed and did not want to fund the proposed initiative. Concerns about desirability and ethics of the military led robotics development effort had become universal in the class.

Republicans are supposed to be conservatives, meaning that they vote for small government and less regulation. However in the respect of the military the republicans always advocate an increased military spending budget. So when the students from the Republican side of the House of Representatives and the Senate presented in the debate they pushed for an increase in the defense budget.

The international community is even more diverse when it comes to ideas on the regulation and proliferation of technology in general and robotic arms in particular. Many of the concerns we saw appear in the debate were anti-China, in-terms of people trying to limit China's development. This is an extremely close minded view, it basically is stating that we are ok to develop this technology but no-one else (who is a rival) can. That is unjust as well as unrealistic. This disparity, thinking that the United States is more capable of understanding and contending with the problems created by this technological advance, is very revealing. It illustrates a trust in our own internally conflicted government that is unwarranted combined with a distrust of all those around us. This may be due to a superiority complex that Americans too often have, and far too often see in our politician suggesting that the USA is the best ones for the job of maintaining world order and will not abuse this capability. The record for the use of Nuclear arms and proving a hugely expensive arms race in the last RMA does not leave one much case for complaisance or optimism about what we will do with an edge in robotic technology. There is already international concern about our use of UVA's many considering it akin to war crimes. .Many countries will now enter this field in part of secure their own airspace from others with this capability and our rivals will feel the greatest need to develop or buy these devices and the infrastructure to deploy them. Pakistan already feels it has been singled out and humiliated by our "arrogant and unlawful" actions in its airspace targeting the Taliban.

The National Academy of Sciences (NAS) is a private and nonprofit society of scientists with the goal of furthering science for the good of all mankind, but they also advise the president and Congress about what is probably best for the USA as well, given that it is the best use taxpayer's money that is at issue. Students taking these roles did a very good job of depicting a concerned sober look at the future of this technology, sighting slippery slopes and arms proliferation a serious future concerns. Their testimony may not have affected the mock Congressional voting, but it was evident I nth reflection papers and seemed to set the tone for them as a group. This is typical of the scientific community; with which WPI students identify in many ways and the technical community is understandably upset with the direction funding has been taking the application of their theoretical and applied research.

The most powerful force in the direction robotics will take is money; whether it is the influence of the federal budget, or private R and D investment, or a multinational corporation under the influence a billionaire with an agenda. We saw this creep into the discussion when one of the characters, playing John D. Rockefeller, proposed legislation that would use public money to start a private moon enterprise he tentatively referred to as Luna Corp which would come to monopolize the fusion reactor fuel market after the oil era ends in about 50 years if left unchecked. This future is all too likely, in terms of an individual or corporation with power influencing the future by getting advantages through legislation that earmarks funding to government agencies to develop certain capabilities. However, likely it is clear that the population does not like it when the elite tried to present corporate self-interest as action in the public good. The members of the House and Senate in our debate voted down the bill by a staggering margin. However, that did not mean that the technical initiative carried out by government did not get some attention, what they struck down was the proposed provision that would force the government to turn the technological infrastructure over to private interests as soon as it was up and running oddly enough Congress has done something similar in preventing NASA from developing a next generation rocket with the power of the Saturn Moon rocket, which allowing the Falcon 9 to be built by a private company with access to NASA technology and supported by many NASA contracts and grants. Privatizing space is actually the official policy of the USA and it is gutting NASA as a capable space agency, as well as making it hard for NASA to recruit top technical talent. .

The final papers were our most interesting look into the minds of our subjects. We were able to evaluate the different points of view that exist in our class without the slant seen in the debate, where the students were given or choose roles to play. One of the first things that were noted was the lack of a certain viewpoint, it appears, while it was brought up in the debate that the class did not believe that military spending should increase. In fact none of the students even proposed maintaining the current budget; it seems that the class is less interested in the military applications of this technology than the government and current authority. Indeed, most of the robotics majors are hoping for careers in which they will be able to work for some other agency (usually on a contract while employed by a company) on some other initiative. They find the space applications very appealing and challenging as well as ethically more acceptable. This brings the direction question into focus, who is driving the technology if the individuals do not want this expansion in military applications, but the system seems to foster it anyway? Most likely the primary driving force in this direction is the military establishment, which is sometimes called a “military-industrial complex,” obsessed with the notion that the US must maintain a technological edge- and that means outspending them on R and D. and allowing no others may approach our level. The justification for this is in the 20th century experience of fighting Germany with inferior tanks and Japan and Germany with initially inferior fighter aircraft and even having fewer aircraft carriers than Japan until the battle of Midway. Then we were stunned by the German jet and rocket capabilities toward the end of the war.

Then we fell behind the USSR in jet (Korean War) and rocket capabilities (Sputnik) and fought our way back through the “moon race”, which was really more about ICBM and submarine capabilities. We had the edge with nuclear explosives, but then the USSR caught up and developed rocket delivery system that by passed our superiority in aircraft, especially the B52 bomber resulting in the cold war era of neither peace nor wars, except proxy wars like Afghanistan for the Russians and Vietnam for the USA. However, the real scare was the Cuban Missile Crisis when the cold war almost turned hot, but at the price of promising not to invade Cuba, the USA faced down that threat with overwhelming sea power.

Given that history it is evident why the D.O.D... does not want to be on the wrong side of an RMA again. However, its advantage in conventional arms so great it is not clear why it would want to foster one that allows nations with fewer resources and technical capability to close the gap. That is the great challenge of whether or not to push the robotic revolution. It may not be in our long term advantage, though the short term advantages are evident. It is this kind of logical analysis and exercise of wisdom we want to see coming from the NAS and used to guide our political leaders. But something is wrong with the system. The message is not getting through and our ability y to plan and think long terms is limited. Indeed, the only arm of government that does seem to get a free hand to plan a long term strategy and invest in it is the D.O.D... operating through DARPA. Everything else seems to be dominated by short term economic thinking and political calculus.

How can the civilian side of the technology development capability in government get something like DARPA? It is needed to both invest in our future and counterbalance the influence of DARPA itself. Further, can Republican be persuaded to let government become resource rich and effective when their mandate is to foster private enterprise and starve government- all except the military?

The marvel of this course is that nearly everyone in their own way came to see the structural problem and institutional flaws leading to our present impasse and inability to shift resources within government in line with the public and the experts in robotics want. There is not a consensus on how to change things but the outline of the problem is coming into focus.

The robotics students actually have a greater appreciation for (if not acceptance of) what it took to get the robotic revolution under way. Singer has documented an important historical moment. Certainly the Air Force did not want to go this way and obsolete human pilots but the logic of efficiency drove them to explore and adopt this technology in the midst of the current wars of "terror" and state that promote and protect terrorists. How the current robotics movement and direction got going is quite a story. Looking at things in contest the next generation of experts in the field seem prepared to accept and even empathize with and promote more stringent requirements in testing the efficacy, efficiency and even the social impact of their inventions.

This appears to be partly due to their seeing and understand the grounds for a public backlash and international outcry yet they want to see things keep developing in this "hot" field due in part to the fact they love it, have invested in mastering it and will soon be looking for employment in the field and hope to cash in on that investment. These students are aware that the money involved in government spending for this kind of application in their field is at an extreme. This excessive defense spending develops job security just so long as you create weapons. This disparity is observable in the general demeanor of the robotics students taking about the military applications; most students that eviscerated our current model were non-technical or at least not majoring in robotics. The robotics majors have ethical concerns but also a vested interest in the system. That does not mean they would not welcome the greater diversity of job prospects if the money taken away from robotics in the D.O.D... was invested in developing other robotic applications. Indeed that seems to be the policy of the Obama administration endorse by a think tank at Carnegie Mellon but the dollar amounts available are pitifully small if it has to be done with newly appropriated money. The only way to get it to work is to use the money DARPA is investing in the field already in a new way, and there is no mechanism for it. This is an institutional crisis as much as it is a technological challenge.

Though the Robotics majors were more likely to show empathy toward the current directions in funding, the overwhelming majority of test subjects wanted more funding in the private sector. It is our belief that due to this discrepancy between people's views and the real world, since drastic action would be required to steer this technology in the direction of the common good. As soon as military funding is cut, other interest groups concerned about other social priorities that may or may not lend themselves to robotic solutions will want to divert the government funding in their own directions. If one thing is certain people don't like where robotics applications are going, the military robotic application scenario was the only one that was listed as both very likely and very undesirable. Drastic action needs to be taken to not only stop the proliferation of this technology but to retard the advancement in technologies so potentially detrimental to society.

We found another overwhelming consensus dealing with keeping a human in the loop to make life or death tactical calls. All of the students believe that a human should ultimately make the call of whether or not to take human life. The reason they offer is that a computer will never be at the level of complexity of a human, at least not in the near future. This emerging consensus therefore lays out a good guideline for future legislation, a view that seemingly everyone shares. As a matter of principle one should keep a human in the loop, making all decision on the ending of life and as a practical matter we should diversify our investment in robotics technology development and application. However there is one caveat in even the man in the loop position. It was suggested that in times of desperation the use of drones that automatically end life could be used. This meaning if there was no other option, i.e. you would be overrun and ended if you do not deploy robotic sentries to fend off attackers. This raises the obvious that when faced with extreme adversity to the point of desperation to preserve your own life on the defense there is no telling where or how this technology could be used.

Based on the general increase in the complexity of thought, we conclude that this class is not only important to robotics students going in to the world of technology but also the other technical major and even nontechnical major students in psychology and management. It is important for people to understand both the ethical and social concerns of the technology they create, depend upon and support indirectly as tax payers. This course serves to inform the students of the plethora of opinions surrounding the fields they are entering.

Summarize my results

Section C Content Analysis of the Reflection Essays

Some of the major findings from the previous study seemed vague and imprecise. There was much more that could be said if the reflective essay data was systematically coded and presented as distributions. More could be said if the new codes were linked to the old one. Castro concluded that oversight was due to the first analysis team's constant search for consensus in their findings. By limiting themselves to agreement could not see the other important findings recorded in their data that had to be reported as a frequency distribution prior to comment. They had found some movement toward consensus in their change data- but often different members of the class were moving in different directions with the effect that the averages changed little but more than half the class changed positions as individuals. They expected change had hoped a consensus would come out of the class interaction. What they found was change in more than one direction. The changes were not random and did not all cancel out, but the trend toward change did not involving the whole class either. Some changed their positions radically, others only a little, some not at all. What was more interesting was that some did not change position as much as the strength with which they held their position while others reversed position. A number also moved from or moved to neutral ground- in short they took a position for the first time or decided their position was hard to defend. These are very different actions as so I decided to look for explanations and influences on these different types of positions changing in the essay data. Both the distribution of who changed and how much change and the distributions on final positions were of interest.

In analyzing their data from a new perspective I hypothesized a few theories that I felt would hold true in for the qualitative variables as a group or compared to the initial positions taken before he students became informed about the subject. . The main issues I believed that were overlooked involved two of the scenarios presented. Since the NASA and Military scenarios were the most talked about in the class, these two will be the focus of my analysis. In effect, a call for a change in policy means shifting resources from the military to other government agencies and letting NASA emerge as a second lead agency. There is evidence that the class moved in this direction on reflection though in role as Congressmen they had voted down this proposal when Rockefeller proposed it.

The first analysis that I wanted to do dealt with the question of what it meant to be an optimist. I decided that that meant you felt that whatever your most desirable scenario was you considered it likely to be developed and implemented. t was the fate of the NASA scenario which was what the class on reflection concluded was the least problematic, but also the least likely, that was of interest. Would it be developed, especially if that meant shifting money from the D.O.D... to do it? The relationship between desirability and likelihood should be correlated with self-expressed optimism at the end of the course. Still, I wanted to consider taking their reports of change in their views during the class into account. Whether I could predict who would change position and who would not, was not yet clear, but I could at least use the change variable as a control variable and do the analysis twice, once for those that had not changed position and once for those that had, as well as doing it overall. A second set of analyses would be done on the Military scenario using the same logic. In this case a pessimist was one that did not think the military scenario was desirable, but considered it most likely to occur and did not think policy changes in funding or regulation were likely to occur or capable of changing the outcome. The tricky cases would be those in which, at least at the outset of the course, the students considered the space and military scenarios equally desirable or undesirable, and there were several cases in this position. Some would later shift toward making a distinction between these scenarios, and others did not. Like the prior team of Conwell et al. My attention shifted toward making sense of the essay data and preparing it fore systematic statistical analysis rather than collection more questionnaire data, but I tried to collect it in a sustained way and suing several strategies both group level appeals and individual one on one contacts. While they did not try nearly as hard, in the end attempt to collect the missing data was not successful. When the students that missed completing the second wave of questionnaires were contacted via email, they were hesitant to agree to meet with me to complete it. Thus we planned a group event with Professor Wilkes present and Ton Conwell presenting the results of the study and me there to moderate a discussion for Student Pugwash. The class got specific invitations and yet none came to participate. This was more than ambivalence towards helping me, it was a firm refusal to participate that had to be honored. I had wasted plenty of time trying and since a project is 3 courses worth of activity I needed another activity as challenging as one class worth data collection and analysis in order to complete my portion of the work. Hence, I sought out another opportunity and one fell into my lap. I was helping out with another Student Pugwash activity and it inspired me to ask a different question dealing with the same general topic and design a future study of another population to address it. The result of that effort will be presented in a later chapter.

In addition, I was unimpressed by the presentation of the qualitative evidence drawn from the reflection essays I decided to team up with one of the former members of the group, Thomas Conwell to redo that section of the analysis and report. . Together he and I hoped to do a more precise and structured analysis of the class essay data and hopefully encounter new and interesting findings. At the least we should be able to document their claims with some specifics based on content analysis.

But in order to do this we need a new set of codes to use to quantify the qualitative data so I asked Conwell to come up with a coding category system for the 5 most important variables he and his partners wanted to use to look for interesting relationships. This had to be something that we knew all or most students comments on and on which they did not all agree. Consensus was worth reporting, but could not produce variation- and hence a variable. He rapidly took me up on the offer and came up with 5 variables we agreed could be coded, given that we had both read the essays. We would work separately and then compare our results.

After he came up with the code dimensions and categories I personally coded the final reflection papers and compared them to the codes that he came up with for each of the 26 cases. . We did this to ensure we objectively analyzed the papers I was convinced that formal content analysis would add some rigor to the analysis. He agreed, but was not sure how far the new analysis could be taken as he pointed out that the codes used for the cases in the questionnaire data set and the codes used on the essays did not match. I was not happy to hear that but it explained why his team analyses were all at the level of the class distribution and included no correlations when they tried to compare the questionnaire data to the final essay data. I had considered the result vague, and still felt that was, so the result was a request to have Professor Wilkes use the key of names to symbols to recode the original essays to reflect the number series in the questionnaire case numbers. In the end, after several hours of work I was able to reorder the qualitative codes and link the questionnaire data from the outset of the class with the codes that came out of the final paper- including their own assessment of how optimistic they were at the end of the class and whether they had changed their views over the course of the class. There was also the all-important code of whether they wanted change- especially change in what the lead agency developing robotics was. As it emerged in the game this was the D.o.D.. vs. NASA debate. It normally took the potion of a call for a shift in funding, but was sometimes referred to directly as the "lead agency" question. This was the code in which Tom and I were most likely to disagree. Several times when he saw a tendency to what the D.O.D... or NASA to be Lead, I thought they were calling for the two agencies to split the resources equally. We concluded that both were a call for a policy change that was massive. Currently the D.O.D... spends more that 80% of the money devoted to the development of robots. I was left to decide whether to use my own more conservative or Tom's more "read between the lines" codes- or a composite of the two, in my analysis.

Reliability of Coding

By using new codes to quantify the qualitative data, there had to be very specific rules on when deciding a person's position on certain topics. As stated previously, the codes were done in an ordinal scaling to allow us to easily analyze the data. The other step taken to ensure the reliability of the coding was to have two sets of codes for the reflections papers then check for their correlation. After verifying, there was an overwhelming correlation between the two different sets of codes with a few variations. The raw codes can be found in the appendix of this report. Since there was such a high correlation the two codes were then subjected to one more review and agreed upon making a composite set of codes to be used for the analysis.

While we considered a simple averaging of the codes to make a composite, I decided to have a meeting a listen to Tom's case for a lead agency (this was the issue in the cases of about half the discrepancies on all 5 variables) or optimism or whatever. About half the time he convinced me that there was a basis for his coding decision and could identify it specifically in the essay. Hence, we came to a negotiated composite set of ratings rather than one in which we agreed to disagree and averaged the results. However, I still wanted to do an analysis of the original differences to see how much it mattered, since there were differences of degree on specific cases, but we seemed to be arraying the cases in pretty much the same order on all the variables. Further there were some categories that were not being used every often and I wanted to collapse a few codes into fewer categories.

While the majority of the codes were kept as presented, one code's scale had to be shortened. The change code had a value of 1-5 but was reduced to 1-3 in order to denote the three major kinds of change; little to no change, medium change and position reversal.

These are the frequency distributions for each of the new codes being used are as follows.

Cases	LeadAgencyJ	LeadAgencyT	OptimisticJ	OptimisticT	RegulationJ	RegulationT	ChangeJ	ChangeT	ControlJ	ControlT
1	5	5	2	3	3	3	4	4	5	5
2	2	2	4	4	2	2	2	2	5	4
3	5	5	5	5	3	3	1	1	5	5
4	1	2	4	4	4	4	4	4	4	4
5	2	2	2	2	4	4	3	3	3	3
6	4	4	4	4	4	3	3	3	3	2
7	3	2	3	3	4	4	2	2	5	5
8	2	2	1	1	4	4	4	4	2	2
9	3	2	1	2	4	4	3	3	4	4
10	3	3	3	3	5	4	3	3	4	4
11	2	3	2	2	4	4	4	4	2	2
12	3	4	4	4	2	2	4	4	3	3
13	2	2	5	4	3	4	1	1	2	3
14	3	3	4	4	4	4	2	2	4	4
15	3	3	2	2	3	4	4	4	5	4
16	2	2	4	4	3	3	4	4	2	2
17	5	4	4	4	3	3	2	2	4	4
18	1	1	2	2	5	5	5	5	3	3
19	2	2	3	3	4	4	1	2	5	5
20	3	3	1	1	4	4	5	5	2	2
21	2	2	4	4	5	5	3	3	4	4
22	2	3	2	2	3	3	3	4	4	4
23	2	2	1	1	3	3	1	1	1	1

24	3	4	2	2	3	3	2	2	2	1
25	3	3	4	4	3	3	2	3	4	4
26	2	3	3	3	3	3	2	2	3	3
Differences	7		4		4		3		5	

Coding the Reflection Papers Using New Variables

The final papers are the single best source of data for this study. The papers however are written in free form and thus any casual observations would be unsystematic and potentially skewed by the qualitative nature of the data. For this reason a variable coding system was developed to classify the papers on a scale from 1 to 5 in five different category systems to create 5 new variables. The categories go as follows, lead agency, optimism, regulation, change, and finally control. These variables are operationally defined elsewhere, but in general deal with the views of the students on whether the D.o.D.. should remain the lead agency with 80% of the funding or the lead role should be shared or go to another agency, whether the students came out course optimistic or pessimism about the likelihood of positive outcomes from robotic technology, the appropriate amount of regulation required for robotics applied to war, how much they changed their position over the 2 months of the course, and who they consider to be in control, the humans or the robots, essentially a question of how autonomous this technology is or is likely to become. Prior to coding the papers, very specific rules were laid out to ensure that the coding could be as objective as possible. In other to give a piece of information a certain code, that sentence, quote, or phrase had to be clearly stated and not derived from the content of the paper. With having these rules the coding could be as accurate as possible. The following are the distributions of the 5 different variables that were used for coding.

Lead Agency

		Frequency	Percent	Frequency	Percent
Valid	1	2	7.7	1	3.8
	2	11	42.3	11	42.3
	3	9	34.6	7	26.9
	4	1	3.8	5	19.2
	5	3	11.5	2	7.7
	Total	26	100.0	26	100.0

Change

		Frequency	Percent	Frequency	Percent
Valid	1	4	15.4	3	11.5
	2	7	26.9	7	26.9
	3	6	23.1	6	23.1
	4	7	26.9	8	30.8

	5	2	7.7	2	7.7
	Total	26	100.0	26	100.0

Optimism

		Frequency	Percent	Frequency	Percent
Valid	1	4	15.4	3	11.5
	2	7	26.9	7	26.9
	3	4	15.4	5	19.2
	4	9	34.6	10	38.5
	5	2	7.7	1	3.8
	Total	26	100.0	26	100.0

Regulation

		Frequency	Percent	Frequency	Percent
Valid	2	2	7.7	2	7.7
	3	11	42.3	10	38.5
	4	10	38.5	12	46.2
	5	3	11.5	2	7.7
	Total	26	100.0	26	100.0

Control

		Frequency	Percent	Frequency	Percent
Valid	1	1	3.8	2	7.7
	2	6	23.1	5	19.2
	3	5	19.2	5	19.2
	4	8	30.8	10	38.5
	5	6	23.1	4	15.4
	Total	26	100.0	26	100.0

The following are the correlations between Tom's and my sets of qualitative codes for each of the five variables. This reflects more whether we got the cases in the same order than whether we agreed on the code in each case. It is how well you could predict my rank ordering using Tom's and a .9 correlation means that one could do so about 81% of the time. A correlation of 1.0 means that one could accurately predict the value of the other variable every time.

Lead Agency Correlation

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.935	.058	6.141	.000
N of Valid Cases		26			

Optimism Correlation

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	1.000	.000	16.978	.0001
N of Valid Cases		26			

Regulation Correlation

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.978	.027	6.595	.0001
N of Valid Cases		26			

Change Correlation

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	1.000	.000	19.360	.0001
N of Valid Cases		26			

Control Correlation

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	1.000	.000	31.996	.0001
N of Valid Cases		26			

Each of the papers were coded twice by different people, then the results were compared and correlated variable by variable. While there were some discrepancies the overall relationship was quite high, so a composite of the two rating systems was created by negotiating the few cases that were discrepant. In order to make this new composite coding, the original codes were negotiated and each difference in code was discussed and had to be proven to the other person in order to change the code.

The question of lead agency is probably the vaguest of the five categories. This is because the student were able to more in more than 1 direction i.e., there were more than 2 lead agencies to choose from. But for the purposes of this exercise we decided to use a binary system where the extremes were 1-NASA lead agency or any public domain work, and 5-D.O.D... all military funding. A 1 denotes the student asking for a complete reversal in the direction of robotics with the emphasis on the public sector. A 3 denotes a 50:50 D.O.D... to public split in robotic funding/control. A 5 means the student would like to see almost exclusively robotic funding a slight increase from the current situation.

Optimism, the students were asked to rate themselves as utopian or dystopian, so nearly every student directly commented on this data point making it easy to rate. A 1 denotes optimism meaning they are hopeful looking forward. A 3 denotes either no information or no preference, many students fell on the fence not sure of their feelings. A 5 illustrates pessimism or a negative outlook on the future of robotics.

Regulation was one of the mere important aspects of the class discussions both in the format of the debate and in the class STS 2208. A 1 denotes little or no regulation, meaning that the technology was not controlled and allowed to develop naturally. A 3 means that the student suggested the formation of oversight committees and/or the implementation of one man to one machine rule to make the people accountable for robots they controlled.. A 5 suggests that the student was in favor of applying Asimov's laws to all robots basically removing the ability for a killing robot.

Assessing change was made easier by the inclusion of the topic in the essay prompt, a majority of the students mentioned specific examples of ways the class changes either their thought process, or their opinion on some of these issues. A 1 means that the student did not change his mind on anything or had very little change, basically the student is suggesting that the class barely affected him or her. A 2 denotes a change but not reversal of opinion, it can also mean that there was a noted increase in complexity of thought. This was a medium change in the coding. Finally, a 3 means that the student reversed at least one position on the surveys.

The last category is control, this question was addressed in both the Kelly book (*What Technology Wants*) as well as the Singer book (*Wired For War)* basically it asked if the students believe the technology is in control, expanding without our help, or if it is humans who are in control shaping and driving robotics into the future. A 1 denotes that the technology is in control, referred to as the singularity, or as technetium, the new kingdom of technology. A 3 either denotes no preference, uncertainty or simply a lack or addressing the statement in the papers. A code of 5 means that the student believes that humans are in control, i.e., they drive the direction with their own intent and with their own agendas.

Using Composite Codes

As mentioned previously I decided to use the composite codes for any of the analyses I performed. By doing so I could get a good sense of the positions the class had taken throughout the class and more importantly how these positions evolved during the class and if they were correlated. The two initial correlations I wanted to verify were; how optimistic the students said they were at the end of the class versus how much control they believed we had over the technology and their optimism versus the amount of regulation that they believed was required for robotic technology. The correlations can be seen below and a more detailed cross tabulation can be seen in the appendix.

Optimism vs Control

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.337	.208	1.517	.129
N of Valid Cases		26			

My original hypothesis was that the more optimistic a student was the more in control they believe we have over technology but according to the correlation, there is not enough evidence of a statistically significant relationship to support this claim. There is a modest relationship in this data set, .34 explaining about 10% of the variance, but the chances that that relationship would not generalize to the large WPI population a 13 in 100. My decision rule for a significant relationship is the same as Brauckmann's or 1 in 10 chance of error. It would seem that it is very difficult to track a student's change throughout the course and that it needs to be used as a control agent to further analyze the data.

Optimism vs Regulation

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	-.346	.230	-1.467	.142
N of Valid Cases		26			

My original hypothesis was that the more optimistic the student was the less change in regulation they would suggest since it is at the place they believed should be but again there is not enough evidence to support this claim.

My original hypothesis was that the more optimistic a student was, the more in control they felt we were of robotic technology. The correlation is close but not nearly significant enough to be considered correlated. There is a 13 in 100 chance that I this would not generalize into the WPI population.

So in the end my initial hypotheses were proven to be incorrect due to the lack of evidence. Though the correlations are below acceptable significance, they all show a trend of moving into the same direction. In a future section I will analyze other correlations but use very specific parameters to get the data to fully express itself.

T1 to T3 Connection

Even though there is a considerable amount of data missing from the middle portion of the class, I do have the beginning and endpoints of the data and can use them to make predictions about relationships and run correlation analyses to test these hypotheses.. I know that most members of the class did change their minds but that change is hard to interpret when all the data is indicates changes in both directions rather than a trend toward consensus t. By consolidating the codes and allowing the data to be collapsed, I can make an honest effort in finding out if the pattern of change in the class is predictable.. The changed positions seem to have been greatly influenced by the role playing game the students participated in during the class.

In order to try to make an overall correlation we decided to look for something that should logically occur in this kind of study. The main tool we used as a measure of the overall outlook the students had was whether or not they could be labeled an optimist. By making the student's optimism an their overarching characteristic subject to change we can incorporate many of variables that would logically be associated and find how other variables interacted with the student's optimism. Some of the other variables being used in conjunction with the final level of optimism include and effort to code an initial optimism level out of the desirability and likelihood of the NASA/Space scenario or of the Military scenario rating in the questionnaire while keeping the student's decision on lead agency in the equations as well. The logic behind this is that if a student is optimistic at the end, the scenario they voted to be most desirable should also be their most likely. While a student that may be labeled as a pessimist is determined by the way they look at the likelihood of their most desirable scenario.

To simplify this question we made a few new variables that were encoded with the previous variables but were more compact to try to create the polarity of optimism: pessimist or optimist. The three variables that were recreated were desirability, likelihood, optimism and lead agency.

Desirability was reduced to an ordinal scale containing 3 codes. A value of 1 meant the student preferred the military which would encapsulate the previous 3s and 4s of the desirability of the military scenario. A value of 2 meant the student had no preference and would incorporate the previous values in which a student assigned the same value to the desirability of both the NASA/Space scenario and the Military scenario. A value of 3 meant the student preferred the NASA/Space scenario and would encapsulate the 3s and 4s of the desirability of the NASA scenario.

Likelihood was collapsed in order to be able to more easily compare the different variables. A value of 1 meant the student believed the military was the most likely and would encapsulate the previous 3s and 4s of the likelihood of the military scenario. A value of 2 meant the student had no preference and would incorporate the previous values in which a student assigned the same value to the likelihood to both the NASA/Space scenario and the Military scenario. A value of 3 meant the student believed the NASA/Space scenario was most likely and would encapsulate the 3s and 4s of the likelihood of the NASA scenario.

Optimism was reduced to 3 values as well. Previously the range was from 1-5 but since there was a slight distinction between a value of 1 and 2, both of which represented pessimism, they could be reduced to make a single value: pessimist. The same holds true for the other side of the spectrum, a value of 4 and 5 were so similar in terms of optimism reducing them to a single value was ideal and would not alter the findings. A 1 meant that the student could be labeled as a pessimist. A 2 meant the student was neither a pessimist nor an optimist. A 3 meant the student could be labeled as an optimist.

Lead agency was the final code that was reduced to 3 values. Since we were using the students' view of how the defense budget should be spread out, leanly towards one side or the other of the scale meant that were favoring either NASA or the D.o.D.. as the agency that should have access to the budget. A 1 meant that they were leading towards and would incorporate the 1s and 2s of the lead agency variable. A 2 meant that the students were indecisive of how to allocate the budget but did feel that the budget should be adjusted and would incorporate the previous 3s. A 3 meant that the student was leaning towards the D.o.D.. as the predominant benefactor of the budget and would incorporate the 4s and 5s.

By doing these reductions the data started to present us with new correlations and findings of which will be discussed later in this report.

Section D Correlations Between New and Old Variables

The old variables that were being used were desirability and likelihood while the new variables that were being used to correlate against were lead agency, optimism, regulation, change and control. Desirability dealt with how desirable a student felt a specific scenario was to them. It ranged from undesirable to very desirable. Likelihood dealt with how likely a student felt a specific scenario would unfold in the future. It ranged from unlikely to very likely. The lead agency variable dealt with the direction in which the student wanted to shift the budget. The optimism variable dealt with how optimistic the student left the course. The regulation variable dealt with the degree of regulations that the student wanted to see enforced on robotic technology. The change variable dealt with how much the student had changed throughout the course. The control variable dealt with how secure the student felt in our ability to control the robotic technology or if it was controlling us. In order to relate these two very different sets of codes I had to create codes that would incorporate them and allow the correlation to be done.

By trying to correlate the prior data and the new data, there had to be some sort of unifying variable that could allow me do begin analyzing the data. This meant collapsing a few codes and creating a new variable called optimist. Optimist was made in order to incorporate many different possible combinations of how a true optimist looked like. This mainly meant that a true optimist was one that had a high desirability for a scenario and at the same time had a high likelihood. While a pessimist is one that had a high desirability but a low likelihood and if there was no clear statement on optimism they were labeled in the middle.

NASA Scenario

Optimism vs Desirability

As can be seen, the pessimists and the optimists are in a near perfect stalemate. This can be seen as the students did change but not in the direction I had hoped. It seems that as you learn new information and get exposed to various different new concepts you can see how desirable an outcome may be. But at the same time it is evident that some people are very set in their ways and will not change their opinion. Those that had little to no change along with those that had position reversals, tended to find the NASA run robotic scenario as more desirable than those with medium change.

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.026	.253	.104	.917
N of Valid Cases		26			

Optimism vs. Likelihood

The people that had little to no change were leaning towards the suggestion that the NASA scenario was more likely to happen. These people were not very optimistic which sounds counterintuitive to the findings. While the people that ended up being more optimistic at the end of the course felt that the likelihood of the NASA scenario to keep existing in its current state was short sighted and will definitely change in their favor.

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.472	.207	2.150	.032
N of Valid Cases		26			

Military Scenario
Optimism vs. Desirability

The more change you had throughout the course the less desirable the status quo stressing the Military scenario became, which makes sense. With new information many of the participants felt that they have been enlightened and can finally see the bigger picture of what our military is doing overseas. These same people understood the need for a military and could not complete discredit it. While those people that did not change as much but ended up being optimistic felt that the Military scenario was less desirable as well.

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.471	.223	1.938	.053
N of Valid Cases		26			

Optimism vs. Likelihood

It would seem that the class had a consensus on the likelihood of the Military scenario. It would seem regardless of their change in position or optimism; they all saw the Military scenario as the most likely of the scenarios to occur. This is because we are currently in a war using robots to carry out tasks. The likelihood of it to continue is high due to its effectiveness and lack of human sacrifice. The students all agreed that even though they would want change, the current situation is that we are using robots for war and will continue to until there is no need for them. Some of the students justified it as better to have robots killed than our soldiers dying out there while others suggested that the robots are solely used to remove blame from the humans involved.

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	-.710	.179	-3.166	.002
N of Valid Cases		26			

Chapter IV: Discussion of Results

The Final Paper Prompt

At the culmination of this process the students wrote a reflection paper to comment on their experiences in this class. The students cataloged their views on the future of this technology and what regulation they would impose. Second, the question of class content was scrutinized as the students commented on what portions of the class were useful in shaping their opinion. Third the students characterized their state of mind and perspective on the robotics question as utopian (optimistic) or dystopian (pessimistic) at this point in the class. . Finally, the students assessed the value and content of Singer. This all helped us to understand the student's decision making processes.

The students were first asked to share their own thoughts. This meant for the first time since the debate they would drop their roles and give insight into what they are thinking on all aspects of robotics, from funding to oversight control mechanisms to what influenced their internal debate about what the best course of action would be the intention here was to try to develop a relationship between what we saw in the debate, multiple views all opposing, and what they think in a non-hostile environment. This was also an opportunity for the students to speak out as to whether they think the current the direction of development and trend toward autonomy in robotics is socially beneficial and if not where they would like to steer this emerging field of technology. How they might do so was also fair game.

In the second section of the prompt the students were able to comment on whether they believed the class was important in the shaping of their own ideas. They were also able to comment on the debate; perhaps the primary focus of the class, indicating what views and characters changed their minds and influenced their opinions. Finally the readings in Singer and Kelly were dissected and their relative merit commented upon. This part of the final essay speaks to the intellectual effects of the different components of this course and to the overall validity of continuing to offer general theory before jumping into the robotics debate or further narrowing the range of the material covered in this course. Narrowing and focusing would to make it more of an extended briefing to prepare for the debate and let the issue of robotics dominate the course rather than illustrate the course theme issue of how technology in general gets out of control.

Further the students were asked to comment on their mindset and optimism pertaining to the future of robotics and where it was taking us. Was a singularity imminent?

Though the papers were semi-structured, they did not all touch on all the issues and certainly not in the same way or in the same order. Hence, we had to set up a Content Analysis qualitative data coding system to classify the papers (cases) in the class along the same dimensions as the prior scenarios assessment questionnaires and on some other subjects that had emerged in debate. Our goal was primarily to assess the degree of consensus that had emerged and tie that to the amount of position changes that had occurred. Was the class converging, polarizing or were there no pattern and little but random change. If individuals were changing their minds were they cancelling each other out so that overall the distribution was unchanged?

This was accomplished by the implementation of a coding system after we had read all the papers and linked them to the T1 and T2 data collection efforts. Some classifications were easy, for example in the two value utopian/dystopian variable the students typically categorized themselves. Additionally by assessing their paper we characterized the students once again but without the bias that comes from allowing the students to assess their own positions. This section also included a look at whether the students are drawing parallels between what is happening now in the world of robotics, with the rapid expansion/arms races of previous RMA's due to technological change. These two codes often showed us whether the students like the direction in which robotics.is going, and they often left us in no doubt on that matter by commenting on it directly.

Finally, the students were asked to give a critical review of Singer's book. They were encouraged to focus on the theme and thesis of his book and to compare it to the current events we all hear in the news. We sought primarily to find out whether they believed technology shapes society or society shapes technology. This is a basic issue of control, who or what is in control of this technology and where is this technology going was a theme in the course and the goal was to see if they were taking an active or passive position on the nature of technology in general and robotics in particular.

This final set of paper's qualitative date that would convert into a number system for analysis, proved to be one of our most important and insightful data point. Shedding light on many perceptions, and beliefs the students share, as well as the subjects that are embroiled with controversy. Once this information was compiled and compared to what we observed in the mock debate (and in their comments about real world events), we were be able to see trend and started to understand the connection the students have to what is currently happening in this field, which was for the majority of the class, their major at WPI... The final step in our analysis was to see if there was a discrepancy between the students' views and prevailing political opinion. There was likely to be one and if so the nature of the debate is likely to change over the next generation as these concerned technologist come to maturity and get positions of influence and authority, If there is an emerging consensus, and there was, it was likely to frame the robotics debate of the next generation since it was the product of studying the matter more carefully. This is a process that will slowly occur anyway. We just telescoped the process to get an early glimpse of what the thoughtful and informed technologist of their generation this is the best course of action. These expectations may or may not predict the actual future of the field, but they will still influence the debate and hence the social institutions developed to shape the future of the technology.

T1 and T3 Correlations and Findings

As previously mentioned here is one of the findings that arose from the whole new reduction of variables. Although the correlation is just below the 0.5 threshold and the significance is just above the 0.05 significance used for Brauckmann's analyses, we can see that there is a relationship between the student's preference and the most likely scenario they believed was true. A more detailed cross tabulation can be seen in the appendix.

Preference Between Space and Military Scenario vs Likelihood of Space and Military Scenario

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.467	.242	1.875	.061
N of Valid Cases		26			

Final Reflection Paper

The final piece of information we collected was the final reflection paper. We have already discussed the essay prompt which asked the students to reflect on what may have changed their minds and what they thought their final outlook was. This was one of the most valuable pieces of information we collected as it was the closest to direct opinion from the students. In these papers many students recounted the influence of class reading and participation.

Funding was one of the main concerns of the students as in this quotation: "…They[sic] way to steer the technologies are[sic] through funding, choosing to fund the technologies that would benefit society as a whole." As the main recipient of governmental robotics funding many people discussed the Department of Defense budget. The students were overwhelmingly in favor of decreasing military spending; as in this rather direct sentiment "I don't believe that we should be building robots for the military, making any technological advancement in that direction…" Instead the students favored encouraging private sector development in the open market. These robots, unlike military applications, would be able to follow Asimov's laws, and therefore would be more favorable.

Some students thought that a regulating body of some kind would be a good precaution. "Other policies that I am in favor of… include officially labeling and defining the different tiers of the autonomy of a robot, as well as the different ratios of humans and robots being deployed together at any given time." Implicitly these students trust the lead agency and U.S. Government at the helm of this technology. "…made me feel confident that there are competent people running the military and they probably know the risks this technology has." Others showed some misgivings about the current direction of development and funding. "However, I have little trust in the people that have the ability to influence the development and deployment of technologies."

From this evidence we can see that the class allowed the students to consider many possibilities and to increase their complexity of thought. “My overall views were definitely broadened and I came to understanding[sic] of different controversies that could emerge.” The students themselves recognized this well and knew that the experience had been instrumental in informing and in forming their opinions. “For example, there should be more classes about the [sic] robotics in college offered to all students; students major[sic] in robotics or relating field[sic] should be required to take some of these classes.”

Conclusions

The final papers were our most interesting evidence on the process of changing perceptions, opinions and policy positions on the part of our study participants. . We were able to evaluate the different points of view that exist in our class without the slant seen in the debate, where the students were given or choose roles to play. One of the first things that was noted was the lack of a certain viewpoint, it appears, while it was brought up in the debate, that the class did not believe that military spending should increase. The final paper coding showed that the students averaged 2.9 meaning that the students want to see approximately 50:50 distribution of spending meaning a drop in the military sector of over 35%. This brings the direction question into focus, who is driving the technology if the individuals do not want this expansion in military applications. Most likely the primary driving force in this direction is the government, and more importantly the notion that the US must stay at the peak of destructive force and no others may approach our level.

Based on the general increase in the complexity of thought, we conclude that this class is not only important to robotics students going in to the world of technology but also the nontechnical students. When rating the students degree of change the average value was a 2.9, this does not seem like much however much of the changes seen in the students were in reasoning not position. Meaning that the students mostly had their opinions before the class began however their positions were baseless before the class and after they were more informed of the issues and the positions represented in the community. It is important for people to understand both the ethical and social concerns of the technology they create. This course serves to inform the students of the plethora of opinions surrounding the fields many of the students are entering. While the new proposed study can help connect the bridge between the general public and the elitists in the field of robotics and its future.

Within my content analysis I have managed to conclude that the class wanted to change. This change can be inferred from the data because the correlation is under the accepted percentage. There is strong indication that the recreated optimism variable is a strong indicator of how a student evolves their opinion as they are given new information. The overall ability to record this can help in the endeavor to generalize this kind of study to the general public to see what they feel about the future of robotics.

Future Work

The future of robotics is hard to predict and some would claim it to be unknowable in the context of a singularity, but if our research is any indication, people’s perception of the future is richly textured, nuanced and encompasses a fair amount of complex interactions. Subjective judgment based on immersion in the debate, historical analogy and logical extrapolation is not to be scorned when so many people end up in about the same place and it feels right, but it is not where we are headed and they know it. You get the picture just from looking at the cross-sectional data, but after adding the insights of the longitudinal data to that the picture becomes pretty clear and not very encouraging. This line of research is showing promise and should be continued.

When this research continues several aspects of the study will need to be retooled. One suggestion that we would make to future efforts on the subject, is to replace the Water World scenario with another, more thought provoking one. In an attempt to bring autonomy into focus, i.e. robots making decision and not having a person in the loop, we developed an outline for a scenario involving robotic police units. These robots would have artificial intelligence and would have the ability to judge the population in terms of our laws. The robots would still fallow Asimov's laws and therefore be incapable of harming a human, but the ethical question of a "big Brother" force like that is sure to provoke debate over the use of these robotic police. In contrast to the current military application where we are using the robotic weapons on "Terrorists", this scenario would force the students to put themselves at the receiving end of robotic abuse. Still with the robotic police the concerns are not directly comparable to weaponized drones used to kill. After this change in the survey one next step in research would be assessing the validity of including previous works, and studies, in assessing new data, when the scenarios in the datasets differ.

In our work we have found that this class adds to the complexity and depth to with the students engage the issues. The students develop "verstehen", a sympathetic understanding or form of empathy for differing viewpoints that gives them a global view of the problems and a clearer idea of how to state and begin to address them. As stories involving drone strikes continue to surface, and debate continues to roar, this class is becoming more and more relevant.

It is our impression, and we will make the assertion, that this class not only continues to be offered at WPI, but also if possible starts to be offered at neighboring institutions to further the understanding of these important issues. Holy Cross, which has participated in previous common offerings, would be an excellent option. If would be great to have more non-technical majors mixed into the role playing groups. After this additional class is established future students could research the changes of perception due to this class with much greater visibility not only because of greater sample sizes but also with greater diversity in the sample.

As mentioned earlier, there has been an attempt to make this study more generalized. In order to broaden the scope of opinion, going to other grade levels would prove to be informative. The most ideal candidates would be high school students about to enter college if one wanted to use the existing questionnaire. . They would provide with the most current opinion on robotics while not being polluted with any technical information provided from engineering courses in college. The problem is high school students are not readily available for this kind of study. On the other hand, middle school students are more readily available since WPI has a standing connection with Elm Park School and the 5th and 6th grade teachers would be willing to help out.

While my partners were going on with their research, my separate research allotted me with the chance to elaborate on their work and ask new questions. Although some of my questions would prove to be counterintuitive, they helped broaden the results of this study. Not to say that my questions were not answered but rather the answers I was seeking were hidden elsewhere in the data. The data shows that the students did change throughout the course and had actually taken into account all that was being discussed but when the data is shown it is obscure.

This obscurity is caused by the inability to predict an individual's stance at the end without having had any information pertaining to the middle of the process. This implies that once new ideas are presented to a student, it will, without exception, change their views on certain topics. Although many state that they have not changed their opinions, they have certainly begun to see it from a different perspective than when they entered the class.

Going to other sources for this kind of study is the first step in finding out what the general public believes about the future of robotics. This attempt can lead to many other studies that would add value to this one. By finally leaving the small bubble of elites, we can find new opinions that could prove to be crucial in the future debates that would most likely occur in the public scope. With many major political and ethical issues, the voice of the people will be heard and it is only a matter of when they will voice their opinions as well as in what direction.

Chapter V

Planning a New Study

As James was volunteering to help Student Pugwash out with an event, a field trip for 55 fifth graders coming to campus, he found himself in charge of an activity that involved space applications of robotics and the appropriate man- machine relationship on a lunar expedition. As he observed the students doing this mission design activity the thought struck him that this was a close analog of one of the 4 scenarios in his study. Observational data unobtrusively gathered was falling into his lap. The sample was twice the size the class study of his teammates and the population understudy was clearly part of the next generation of the robotic policy debates-- and more representative of the general population than the college students from elite institutions. It was even closer to the general population than the Worcester state sample that had raised such interesting questions in Mike Brauckmann's study.

Since James had some time to explore the idea he wondered how one would gather data on the other scenarios from a population of 10 year olds? He had the contacts to ask the school if he could do a second activity with these two classes at their school. What would a parallel study look like and did he already have at least a third and maybe half of the data he needed to make the comparison.

Either way, he needed more data to further complete an analysis. Still, as an intellectual exercise, he tried to envision a parallel study that could be applied to a 5th grade class. Once he had come up with 2-3 ways to do such a study, he asked his advisor, John Wilkes, to contact the teacher about when and if he could meet with the class again. The teacher, Francis Mahoney, liked the idea in principle, but could not accommodate the schedule James needed to gather data in time to meet his WPI term end deadline to graduate. Due to state testing, the activity could not be fit in until May, after the preparation for the test and the testing itself. However, the teacher was encouraging him to work up a plan in detail. He was actively considering it. Hence, James decided to write up the idea for future teams to consider and report on the space scenario data collection pilot study to demonstrate what one could hope to get out of data collected in this fashion.

In his proposed parallel study he proposed to have someone gather the same kind of qualitative data by means of presenting the students with a problem solving activity akin to "Lunar Expedition". However, there would be more than one activity and the key one to contrast to space would be a military mission, possibly one involving finding and extracting hostages. Ideally there would be a third activity involving an elder care scenario in which an elder with episodes of dementia and memory loss asks a robot to do something that would or could cause harm but this is a lucid time for the elder and it really was the lesser of two evils and a reasonable moral choice by the elder, despite the risk involved. The robot would be programmed to refuse, but should there be an override for a human in this condition to insist and be obeyed? Following the activity he would ask them to fill out a survey that would ask questions similar to that of our survey but adapted for a younger audience. Afterward that, they would be presented with Asimov's Laws and then asked to see if these laws are in line with their opinions on the future of man machine relationships with robotics. Then it can be pointed out which of the scenarios they already rated violate one or more of the laws, and they can further explain their opinions about these applications, or change their minds. This study would take place over the course of the length of a typical 5th grade class and would be provide data similar to the college level questionnaire data allowing one to see if the pattern found in the college data is likely to generalize to the general population, which it would if such a radically different population in terms of social class, age and education came to the same position in terms of rank ordering the applications from best to worst in terms of ethical issues and likely social implications. This plan looked promising until the teacher suggested a writing assignment that could be done as homework, so as not to use so much class time. James is not keen on approach, but since the study is not going to be done immediately the details can be negotiated later.

Proposed Parallel Study

During the field trip that the Elm Park School 5th graders had to WPI, I had the opportunity to give them a "mission". In this scenario, they needed to travel across the surface of the Moon and reach a designated spot (a cave opening to possible lava tubes) over a thousand miles away from, their base. The mission was exploration all while keeping the "Expedition" personnel and the equipment safe. Given the half hour time constraint, they were presented with four possible methods that they could use to accomplish this task but were free to combine and manipulate them in any way they sought fit. They were problem solving and doing design strategy as well as learning about the lunar environment. I was observing them with a rather different goal. I wanted to ascertain their attitudes towards technology in general and robots in particular. The man-machine relationship they created would provide insight about a theme I was exploring in a study of college students, and now extending that to 10 years old children.

In this short time I had with the various groups it was evident to me that they were clearly capable of handling such a complex problem via brainstorming. Most teams of 3 came up with various effective or promising solutions. One was less promising but very innovative. They also conveyed their feelings towards technology and mainly robots and depicted how they thought they should interact with humans. The main theme that they mentioned was that of having the robots do the tedious or risky work while the humans would do more of the analytical and intellectual work once they arrived at the site of a possible lunar base. Above all else the robots highest task was to protect the humans at all costs. The robots were expendable, a means to an end, mere tools and that the personnel could use them effectively in order to carry out their mission. The hostile nature of the lunar space environment for fragile humans seemed to be well understood and the robots were to be an extension of human senses that could be put in harm's way. The robots were not autonomous, they did into exactly take the place of the humans, but they minimized the risk to the human investigators. They did not know it, but these 5th graders had just taken a position in the technology-society debate in which the theme of technology getting out of control plays a large role.

The proposal for this project is to perhaps do a study that parallels one in which over 200 students at WPI, Clark University and other colleges participated over the last year. This started as a questionnaire based evaluation of 4 scenarios for the future application of robotics and for each they recorded their assessment of likelihood and desirability on the different scenarios presented to them. One class of about 26 at WPI later went on to express more detailed opinions and viewpoints in essays that involved the future of robotics and necessary regulation of how robotics might be applied. What I want to do is do a one or two class study (25- 50 students) of 5th graders that culminates in essays they write about what is okay and not okay in the use of robots. I hope to figure out how to get reactions to all the scenarios, but I really have observational data on just one (lunar applications) at present. I need to have comparative data on at least one more, the military application of robotics, to address the same space, military, human caregiver issues that came out of the other study.

These scenarios would be altered to ensure the major themes can be understood by the 5th graders. By administering this survey on the 5th graders we can see what the future generations of the public believes we are and should be doing with robotics and whether or not they would want to change the direction we are headed in ways that they see as better alternatives. One of the scenarios presented may be more controversial than the others due to the fact that it involves military engagements usually resulting in death. This scenario can either be completely replaced by an activity parallel to the space application or edited in order to meet the standards necessary to administer a survey on a sensitive and "violent" topic to minors.

The three scenarios that have been altered for 5th grade terminology; they are very brief and can be elaborated upon as needed:

1. Military – Currently we are using "robots" to carry out missions that do not involve person being in the place as where the mission occurs. In the future we posited whole armies of robots with no humans present on the battle field though they are in the background controlling them. These robots will follow the orders of one person and complete their missions which may include killing "enemy operatives, agents and soldiers" be they human, animal or robotic.
2. Space – In the future we will have robots help us mine the materials on the Moon so we can use them in space or on Earth. Eventually they will be able do this work themselves if we allow them to be automatic instead of controlled by a human overseer. In space there will probably be robots that make other robots, i.e. ,that reproduce. There will be implications an Earth when this next generation of space robots, with a lot of artificial intelligence, return to Earth.
3. Ocean – In the future we will start using robots to help gather our food mainly from the ocean. We will use shark-like robots that will herd large amounts of fish to shore. This will help provide food for the human population that lives near the coasts and there is less farm land available due to rising sea levels. The question is do we really know what will happen if we upset the natural biological balance of the seas?
4. Healthcare – In the future we will have robots taking care of our elderly as nurses and our children as nannies and they will never get cross, tired or be grossed out

by this work. The main concerns are whether or not we should let machines take care of those that are helpless and not in control of the robots they depend upon.

Since the students did a very similar space activity at WPI in the station we called "Expedition", the data from that activity has already been recorded and can be used for analysis. The military scenario is going to be adjusted into an activity for the students in order to provide them with the same mission oriented environment as the space expedition activity they did at WPI. This activity will be detailed later in this report. As for the healthcare scenario, I have decided to solely do a presentation describing the current technology that exists for this kind of scenario. The presentation will involve showing the current models that have been developed for this kind of work and then going into the potential problems presented by these kinds of robots. I am going to drop the Ocean scenario to save time and because the man-machine relationship issues are more subtle.

Shortly after presenting them these scenarios I will hand out a survey that will ask them to place the scenarios in order of desirability, though the question will be it terms of which are the best and worse ideas in terms of what could go wrong. Also there will be room to explain why they placed the scenarios in that particular order. The order that they would rate them would indicate to me their inclination towards what they felt was the correct course for robotics and if they had any reservations about these proposed applications. This kind of information is important when trying to parallel the previous study done at WPI.

After these scenarios are presented to the students and they have filled out their surveys, I will be able to then present to them Asimov's Laws. By giving them these laws I hope to see if they can see the ethical issues raised by these scenarios as well as try to give them a chance to be able to further explain themselves if they could not find the right words to describe their feelings about what was problematic about some of these scenarios. With their surveys I can see if there is any sort of correlation between the WPI students' views of robotics and that of the 5^{th} graders'.

Appendices

A: Previous Study

```
CROSSTABS
  /TABLES=SAMPLE BY Nasa_Likely Nasa_spin_off Nasa_Quality Nasa_Machine Nasa_
Ethics Water_Likely Water_spin_off Water_Quality Water_
   Machine Water_Ethics China_Likely China_spin_off China_Quality China_Machi
ne China_Ethics Military_Likely Military_spin_off
Military_Quality Military_Machine Military_Ethics Nasa_Desire Water_Desire Ch
ina_Desire Military_Desire
  /FORMAT=AVALUE TABLES
  /STATISTICS=CHISQ
  /CELLS=COUNT ROW
  /COUNT ROUND CELL.
```

Crosstabs

[DataSet1] C:\Users\Mike\Documents\RBE-BU.sav

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
SAMPLE * Nasa_Likely	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Nasa_spin_off	97	95.1%	5	4.9%	102	100.0%
SAMPLE * Nasa_Quality	97	95.1%	5	4.9%	102	100.0%
SAMPLE * Nasa_Machine	98	96.1%	4	3.9%	102	100.0%
SAMPLE * Nasa_Ethics	98	96.1%	4	3.9%	102	100.0%
SAMPLE * Water_Likely	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Water_spin_off	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Water_Quality	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Water_Machine	98	96.1%	4	3.9%	102	100.0%
SAMPLE * Water_Ethics	99	97.1%	3	2.9%	102	100.0%
SAMPLE * China_Likely	99	97.1%	3	2.9%	102	100.0%
SAMPLE * China_spin_off	99	97.1%	3	2.9%	102	100.0%
SAMPLE * China_Quality	98	96.1%	4	3.9%	102	100.0%
SAMPLE * China_Machine	98	96.1%	4	3.9%	102	100.0%
SAMPLE * China_Ethics	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Military_Likely	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Military_spin_off	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Military_Quality	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Military_Machine	99	97.1%	3	2.9%	102	100.0%
SAMPLE * Military_Ethics	98	96.1%	4	3.9%	102	100.0%

Page 1

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
SAMPLE * Nasa_Desire	97	95.1%	5	4.9%	102	100.0%
SAMPLE * Water_Desire	98	96.1%	4	3.9%	102	100.0%
SAMPLE * China_Desire	98	96.1%	4	3.9%	102	100.0%
SAMPLE * Military_Desire	99	97.1%	3	2.9%	102	100.0%

SAMPLE * Nasa_Likely

Crosstab

			Nasa_Likely		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	4	7	17
		% within SAMPLE	13.3%	23.3%	56.7%
	RBE	Count	2	13	18
		% within SAMPLE	4.9%	31.7%	43.9%
	Tech	Count	5	9	12
		% within SAMPLE	17.9%	32.1%	42.9%
Total		Count	11	29	47
		% within SAMPLE	11.1%	29.3%	47.5%

Crosstab

			Nasa_Likely	
			Very Likely	Total
SAMPLE	BU	Count	2	30
		% within SAMPLE	6.7%	100.0%
	RBE	Count	8	41
		% within SAMPLE	19.5%	100.0%
	Tech	Count	2	28
		% within SAMPLE	7.1%	100.0%
Total		Count	12	99
		% within SAMPLE	12.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.163[a]	6	.306
Likelihood Ratio	7.312	6	.293
N of Valid Cases	99		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 3.11.

SAMPLE * Nasa_spin_off

Crosstab

			Nasa_spin_off			
			Somewhat Unlikely	Somewhat Likely	Very Likely	Total
SAMPLE	BU	Count	0	13	17	30
		% within SAMPLE	.0%	43.3%	56.7%	100.0%
	RBE	Count	0	16	24	40
		% within SAMPLE	.0%	40.0%	60.0%	100.0%
	Tech	Count	1	13	13	27
		% within SAMPLE	3.7%	48.1%	48.1%	100.0%
Total		Count	1	42	54	97
		% within SAMPLE	1.0%	43.3%	55.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.254[a]	4	.516
Likelihood Ratio	3.227	4	.521
N of Valid Cases	97		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is .28.

SAMPLE * Nasa_Quality

Crosstab

			Nasa_Quality		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	0	4	19
		% within SAMPLE	.0%	13.3%	63.3%
	RBE	Count	1	6	24
		% within SAMPLE	2.5%	15.0%	60.0%
	Tech	Count	3	4	15
		% within SAMPLE	11.1%	14.8%	55.6%
Total		Count	4	14	58
		% within SAMPLE	4.1%	14.4%	59.8%

Crosstab

			Nasa_Quality	
			Very Desirable	Total
SAMPLE	BU	Count	7	30
		% within SAMPLE	23.3%	100.0%
	RBE	Count	9	40
		% within SAMPLE	22.5%	100.0%
	Tech	Count	5	27
		% within SAMPLE	18.5%	100.0%
Total		Count	21	97
		% within SAMPLE	21.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.046[a]	6	.538
Likelihood Ratio	5.309	6	.505
N of Valid Cases	97		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is 1.11.

SAMPLE * Nasa_Machine

Crosstab

			Nasa_Machine		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	0	1	21
		% within SAMPLE	.0%	3.3%	70.0%
	RBE	Count	0	8	22
		% within SAMPLE	.0%	19.5%	53.7%
	Tech	Count	4	4	16
		% within SAMPLE	14.8%	14.8%	59.3%
Total		Count	4	13	59
		% within SAMPLE	4.1%	13.3%	60.2%

Crosstab

			Nasa_Machine	
			Very Desirable	Total
SAMPLE	BU	Count	8	30
		% within SAMPLE	26.7%	100.0%
	RBE	Count	11	41
		% within SAMPLE	26.8%	100.0%
	Tech	Count	3	27
		% within SAMPLE	11.1%	100.0%
Total		Count	22	98
		% within SAMPLE	22.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.913[a]	6	.010
Likelihood Ratio	17.826	6	.007
N of Valid Cases	98		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is 1.10.

SAMPLE * Nasa_Ethics

Crosstab

			Nasa_Ethics		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	4	12	9
		% within SAMPLE	13.3%	40.0%	30.0%
	RBE	Count	2	10	16
		% within SAMPLE	4.9%	24.4%	39.0%
	Tech	Count	5	2	9
		% within SAMPLE	18.5%	7.4%	33.3%
Total		Count	11	24	34
		% within SAMPLE	11.2%	24.5%	34.7%

Crosstab

			Nasa_Ethics	
			Very Likely	Total
SAMPLE	BU	Count	5	30
		% within SAMPLE	16.7%	100.0%
	RBE	Count	13	41
		% within SAMPLE	31.7%	100.0%
	Tech	Count	11	27
		% within SAMPLE	40.7%	100.0%
Total		Count	29	98
		% within SAMPLE	29.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.350[a]	6	.055
Likelihood Ratio	13.477	6	.036
N of Valid Cases	98		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 3.03.

SAMPLE * Water_Likely

Crosstab

			Water_Likely		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	7	8	11
		% within SAMPLE	23.3%	26.7%	36.7%
	RBE	Count	5	20	14
		% within SAMPLE	11.9%	47.6%	33.3%
	Tech	Count	7	13	4
		% within SAMPLE	25.9%	48.1%	14.8%
Total		Count	19	41	29
		% within SAMPLE	19.2%	41.4%	29.3%

Crosstab

			Water_Likely	
			Very Likely	Total
SAMPLE	BU	Count	4	30
		% within SAMPLE	13.3%	100.0%
	RBE	Count	3	42
		% within SAMPLE	7.1%	100.0%
	Tech	Count	3	27
		% within SAMPLE	11.1%	100.0%
Total		Count	10	99
		% within SAMPLE	10.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.754[a]	6	.257
Likelihood Ratio	8.446	6	.207
N of Valid Cases	99		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 2.73.

SAMPLE * Water_spin_off

Crosstab

			Water_spin_off		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	0	4	15
		% within SAMPLE	.0%	13.3%	50.0%
	RBE	Count	0	6	20
		% within SAMPLE	.0%	14.3%	47.6%
	Tech	Count	3	3	9
		% within SAMPLE	11.1%	11.1%	33.3%
Total		Count	3	13	44
		% within SAMPLE	3.0%	13.1%	44.4%

Crosstab

			Water_spin_off	
			Very Likely	Total
SAMPLE	BU	Count	11	30
		% within SAMPLE	36.7%	100.0%
	RBE	Count	16	42
		% within SAMPLE	38.1%	100.0%
	Tech	Count	12	27
		% within SAMPLE	44.4%	100.0%
Total		Count	39	99
		% within SAMPLE	39.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.430[a]	6	.151
Likelihood Ratio	9.286	6	.158
N of Valid Cases	99		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .82.

SAMPLE * Water_Quality

Page 8

Crosstab

			Water Quality		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	5	11	7
		% within SAMPLE	16.7%	36.7%	23.3%
	RBE	Count	4	9	22
		% within SAMPLE	9.5%	21.4%	52.4%
	Tech	Count	6	4	8
		% within SAMPLE	22.2%	14.8%	29.6%
Total		Count	15	24	37
		% within SAMPLE	15.2%	24.2%	37.4%

Crosstab

			Water Quality	
			Very Desirable	Total
SAMPLE	BU	Count	7	30
		% within SAMPLE	23.3%	100.0%
	RBE	Count	7	42
		% within SAMPLE	16.7%	100.0%
	Tech	Count	9	27
		% within SAMPLE	33.3%	100.0%
Total		Count	23	99
		% within SAMPLE	23.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.363[a]	6	.078
Likelihood Ratio	11.229	6	.082
N of Valid Cases	99		

a. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 4.09.

SAMPLE * Water_Machine

Crosstab

			Water_Machine			
			Undesirable	Somewhat Undesirable	3	Somewhat Desirabley
SAMPLE	BU	Count	1	8	0	16
		% within SAMPLE	3.3%	26.7%	.0%	53.3%
	RBE	Count	2	13	0	19
		% within SAMPLE	4.9%	31.7%	.0%	46.3%
	Tech	Count	3	6	1	12
		% within SAMPLE	11.1%	22.2%	3.7%	44.4%
Total		Count	6	27	1	47
		% within SAMPLE	6.1%	27.6%	1.0%	48.0%

Crosstab

			Water_Machine	
			Very Desirable	Total
SAMPLE	BU	Count	5	30
		% within SAMPLE	16.7%	100.0%
	RBE	Count	7	41
		% within SAMPLE	17.1%	100.0%
	Tech	Count	5	27
		% within SAMPLE	18.5%	100.0%
Total		Count	17	98
		% within SAMPLE	17.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.060[a]	8	.751
Likelihood Ratio	4.880	8	.770
N of Valid Cases	98		

a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .28.

SAMPLE * Water_Ethics

Crosstab

			Water_Ethics		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	2	2	12
		% within SAMPLE	6.7%	6.7%	40.0%
	RBE	Count	3	6	8
		% within SAMPLE	7.1%	14.3%	19.0%
	Tech	Count	3	1	6
		% within SAMPLE	11.1%	3.7%	22.2%
Total		Count	8	9	26
		% within SAMPLE	8.1%	9.1%	26.3%

Crosstab

			Water_Ethics	
			Very Likely	Total
SAMPLE	BU	Count	14	30
		% within SAMPLE	46.7%	100.0%
	RBE	Count	25	42
		% within SAMPLE	59.5%	100.0%
	Tech	Count	17	27
		% within SAMPLE	63.0%	100.0%
Total		Count	56	99
		% within SAMPLE	56.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.665[a]	6	.353
Likelihood Ratio	6.547	6	.365
N of Valid Cases	99		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 2.18.

SAMPLE * China_Likely

Crosstab

			China_Likely		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	5	10	12
		% within SAMPLE	16.7%	33.3%	40.0%
	RBE	Count	6	10	16
		% within SAMPLE	14.3%	23.8%	38.1%
	Tech	Count	8	8	8
		% within SAMPLE	29.6%	29.6%	29.6%
Total		Count	19	28	36
		% within SAMPLE	19.2%	28.3%	36.4%

Crosstab

			China_Likely	
			Very Likely	Total
SAMPLE	BU	Count	3	30
		% within SAMPLE	10.0%	100.0%
	RBE	Count	10	42
		% within SAMPLE	23.8%	100.0%
	Tech	Count	3	27
		% within SAMPLE	11.1%	100.0%
Total		Count	16	99
		% within SAMPLE	16.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.875[a]	6	.437
Likelihood Ratio	5.702	6	.457
N of Valid Cases	99		

a. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 4.36.

SAMPLE * China_spin_off

Crosstab

			China_spin_off		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	0	1	11
		% within SAMPLE	.0%	3.3%	36.7%
	RBE	Count	1	1	12
		% within SAMPLE	2.4%	2.4%	28.6%
	Tech	Count	2	4	10
		% within SAMPLE	7.4%	14.8%	37.0%
Total		Count	3	6	33
		% within SAMPLE	3.0%	6.1%	33.3%

Crosstab

			China_spin_off	
			Very Likely	Total
SAMPLE	BU	Count	18	30
		% within SAMPLE	60.0%	100.0%
	RBE	Count	28	42
		% within SAMPLE	66.7%	100.0%
	Tech	Count	11	27
		% within SAMPLE	40.7%	100.0%
Total		Count	57	99
		% within SAMPLE	57.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.855[a]	6	.131
Likelihood Ratio	9.769	6	.135
N of Valid Cases	99		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .82.

SAMPLE * China_Quality

Crosstab

			China_Quality		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	4	8	14
		% within SAMPLE	13.3%	26.7%	46.7%
	RBE	Count	2	11	19
		% within SAMPLE	4.9%	26.8%	46.3%
	Tech	Count	8	4	5
		% within SAMPLE	29.6%	14.8%	18.5%
Total		Count	14	23	38
		% within SAMPLE	14.3%	23.5%	38.8%

Crosstab

			China_Quality	
			Very Desirable	Total
SAMPLE	BU	Count	4	30
		% within SAMPLE	13.3%	100.0%
	RBE	Count	9	41
		% within SAMPLE	22.0%	100.0%
	Tech	Count	10	27
		% within SAMPLE	37.0%	100.0%
Total		Count	23	98
		% within SAMPLE	23.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.614[a]	6	.016
Likelihood Ratio	16.096	6	.013
N of Valid Cases	98		

a. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 3.86.

SAMPLE * China_Machine

Crosstab

			China_Machine		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	5	12	5
		% within SAMPLE	16.7%	40.0%	16.7%
	RBE	Count	6	17	11
		% within SAMPLE	14.6%	41.5%	26.8%
	Tech	Count	8	4	9
		% within SAMPLE	29.6%	14.8%	33.3%
Total		Count	19	33	25
		% within SAMPLE	19.4%	33.7%	25.5%

Crosstab

			China_Machine	
			Very Desirable	Total
SAMPLE	BU	Count	8	30
		% within SAMPLE	26.7%	100.0%
	RBE	Count	7	41
		% within SAMPLE	17.1%	100.0%
	Tech	Count	6	27
		% within SAMPLE	22.2%	100.0%
Total		Count	21	98
		% within SAMPLE	21.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.351[a]	6	.214
Likelihood Ratio	8.959	6	.176
N of Valid Cases	98		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.23.

SAMPLE * China_Ethics

Crosstab

			China_Ethics		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	2	2	7
		% within SAMPLE	6.7%	6.7%	23.3%
	RBE	Count	3	1	7
		% within SAMPLE	7.1%	2.4%	16.7%
	Tech	Count	3	3	3
		% within SAMPLE	11.1%	11.1%	11.1%
Total		Count	8	6	17
		% within SAMPLE	8.1%	6.1%	17.2%

Crosstab

			China_Ethics	
			Very Likely	Total
SAMPLE	BU	Count	19	30
		% within SAMPLE	63.3%	100.0%
	RBE	Count	31	42
		% within SAMPLE	73.8%	100.0%
	Tech	Count	18	27
		% within SAMPLE	66.7%	100.0%
Total		Count	68	99
		% within SAMPLE	68.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.068[a]	6	.667
Likelihood Ratio	4.115	6	.661
N of Valid Cases	99		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is 1.64.

SAMPLE * Military_Likely

Crosstab

			Military_Likely		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	4	5	12
		% within SAMPLE	13.8%	17.2%	41.4%
	RBE	Count	1	6	18
		% within SAMPLE	2.4%	14.3%	42.9%
	Tech	Count	6	1	10
		% within SAMPLE	21.4%	3.6%	35.7%
Total		Count	11	12	40
		% within SAMPLE	11.1%	12.1%	40.4%

Crosstab

			Military_Likely	
			Very Likely	Total
SAMPLE	BU	Count	8	29
		% within SAMPLE	27.6%	100.0%
	RBE	Count	17	42
		% within SAMPLE	40.5%	100.0%
	Tech	Count	11	28
		% within SAMPLE	39.3%	100.0%
Total		Count	36	99
		% within SAMPLE	36.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.327[a]	6	.156
Likelihood Ratio	10.732	6	.097
N of Valid Cases	99		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is 3.11.

SAMPLE * Military_spin_off

Crosstab

			Military_spin_off		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	0	4	9
		% within SAMPLE	.0%	13.8%	31.0%
	RBE	Count	2	1	14
		% within SAMPLE	4.8%	2.4%	33.3%
	Tech	Count	1	2	8
		% within SAMPLE	3.6%	7.1%	28.6%
Total		Count	3	7	31
		% within SAMPLE	3.0%	7.1%	31.3%

Crosstab

			Military_spin_off	
			Very Likely	Total
SAMPLE	BU	Count	16	29
		% within SAMPLE	55.2%	100.0%
	RBE	Count	25	42
		% within SAMPLE	59.5%	100.0%
	Tech	Count	17	28
		% within SAMPLE	60.7%	100.0%
Total		Count	58	99
		% within SAMPLE	58.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.690[a]	6	.584
Likelihood Ratio	5.556	6	.475
N of Valid Cases	99		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .85.

SAMPLE * Military_Quality

Crosstab

			Military_Quality		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	10	9	8
		% within SAMPLE	34.5%	31.0%	27.6%
	RBE	Count	13	14	10
		% within SAMPLE	31.0%	33.3%	23.8%
	Tech	Count	6	4	9
		% within SAMPLE	21.4%	14.3%	32.1%
Total		Count	29	27	27
		% within SAMPLE	29.3%	27.3%	27.3%

Crosstab

			Military_Quality	
			Very Desirable	Total
SAMPLE	BU	Count	2	29
		% within SAMPLE	6.9%	100.0%
	RBE	Count	5	42
		% within SAMPLE	11.9%	100.0%
	Tech	Count	9	28
		% within SAMPLE	32.1%	100.0%
Total		Count	16	99
		% within SAMPLE	16.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.210[a]	6	.116
Likelihood Ratio	10.052	6	.122
N of Valid Cases	99		

a. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 4.53.

SAMPLE * Military_Machine

Crosstab

			Military_Machine		
			Undesirable	Somewhat Undesirable	Somewhat Desirabley
SAMPLE	BU	Count	10	7	11
		% within SAMPLE	34.5%	24.1%	37.9%
	RBE	Count	14	14	9
		% within SAMPLE	33.3%	33.3%	21.4%
	Tech	Count	7	3	13
		% within SAMPLE	25.0%	10.7%	46.4%
Total		Count	31	24	33
		% within SAMPLE	31.3%	24.2%	33.3%

Crosstab

			Military_Machine	
			Very Desirable	Total
SAMPLE	BU	Count	1	29
		% within SAMPLE	3.4%	100.0%
	RBE	Count	5	42
		% within SAMPLE	11.9%	100.0%
	Tech	Count	5	28
		% within SAMPLE	17.9%	100.0%
Total		Count	11	99
		% within SAMPLE	11.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.163[a]	6	.118
Likelihood Ratio	11.083	6	.086
N of Valid Cases	99		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 3.11.

SAMPLE * Military_Ethics

Crosstab

			Military_Ethics		
			Unlikley	Somewhat Unlikely	Somewhat Likely
SAMPLE	BU	Count	1	1	8
		% within SAMPLE	3.4%	3.4%	27.6%
	RBE	Count	2	2	3
		% within SAMPLE	4.9%	4.9%	7.3%
	Tech	Count	2	2	7
		% within SAMPLE	7.1%	7.1%	25.0%
Total		Count	5	5	18
		% within SAMPLE	5.1%	5.1%	18.4%

Crosstab

			Military_Ethics	
			Very Likely	Total
SAMPLE	BU	Count	19	29
		% within SAMPLE	65.5%	100.0%
	RBE	Count	34	41
		% within SAMPLE	82.9%	100.0%
	Tech	Count	17	28
		% within SAMPLE	60.7%	100.0%
Total		Count	70	98
		% within SAMPLE	71.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.865[a]	6	.334
Likelihood Ratio	7.409	6	.285
N of Valid Cases	98		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 1.43.

SAMPLE * Nasa_Desire

Crosstab

			Nasa_Desire				
			1.00	1.50	2.00	2.50	3.00
SAMPLE	BU	Count	0	0	0	5	16
		% within SAMPLE	.0%	.0%	.0%	16.7%	53.3%
	RBE	Count	0	1	1	9	15
		% within SAMPLE	.0%	2.5%	2.5%	22.5%	37.5%
	Tech	Count	2	1	2	6	10
		% within SAMPLE	7.4%	3.7%	7.4%	22.2%	37.0%
Total		Count	2	2	3	20	41
		% within SAMPLE	2.1%	2.1%	3.1%	20.6%	42.3%

Crosstab

			Nasa_Desire		Total
			3.50	4.00	
SAMPLE	BU	Count	3	6	30
		% within SAMPLE	10.0%	20.0%	100.0%
	RBE	Count	10	4	40
		% within SAMPLE	25.0%	10.0%	100.0%
	Tech	Count	5	1	27
		% within SAMPLE	18.5%	3.7%	100.0%
Total		Count	18	11	97
		% within SAMPLE	18.6%	11.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.895[a]	12	.196
Likelihood Ratio	17.086	12	.146
N of Valid Cases	97		

a. 12 cells (57.1%) have expected count less than 5. The minimum expected count is .56.

SAMPLE * Water_Desire

Crosstab

			Water_Desire				
			1.00	1.50	2.00	2.50	3.00
SAMPLE	BU	Count	0	1	10	6	6
		% within SAMPLE	.0%	3.3%	33.3%	20.0%	20.0%
	RBE	Count	1	2	5	13	11
		% within SAMPLE	2.4%	4.9%	12.2%	31.7%	26.8%
	Tech	Count	2	3	3	3	5
		% within SAMPLE	7.4%	11.1%	11.1%	11.1%	18.5%
Total		Count	3	6	18	22	22
		% within SAMPLE	3.1%	6.1%	18.4%	22.4%	22.4%

Crosstab

			Water_Desire			Total
			3.25	3.50	4.00	
SAMPLE	BU	Count	0	4	3	30
		% within SAMPLE	.0%	13.3%	10.0%	100.0%
	RBE	Count	0	5	4	41
		% within SAMPLE	.0%	12.2%	9.8%	100.0%
	Tech	Count	1	9	1	27
		% within SAMPLE	3.7%	33.3%	3.7%	100.0%
Total		Count	1	18	8	98
		% within SAMPLE	1.0%	18.4%	8.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.405[a]	14	.092
Likelihood Ratio	21.033	14	.101
N of Valid Cases	98		

a. 14 cells (58.3%) have expected count less than 5. The minimum expected count is .28.

SAMPLE * China_Desire

Crosstab

			China_Desire				
			1.00	1.50	2.00	2.50	3.00
SAMPLE	BU	Count	3	2	5	9	4
		% within SAMPLE	10.0%	6.7%	16.7%	30.0%	13.3%
	RBE	Count	2	2	8	10	10
		% within SAMPLE	4.9%	4.9%	19.5%	24.4%	24.4%
	Tech	Count	4	4	4	2	5
		% within SAMPLE	14.8%	14.8%	14.8%	7.4%	18.5%
Total		Count	9	8	17	21	19
		% within SAMPLE	9.2%	8.2%	17.3%	21.4%	19.4%

Crosstab

			China_Desire		
			3.50	4.00	Total
SAMPLE	BU	Count	3	4	30
		% within SAMPLE	10.0%	13.3%	100.0%
	RBE	Count	6	3	41
		% within SAMPLE	14.6%	7.3%	100.0%
	Tech	Count	2	6	27
		% within SAMPLE	7.4%	22.2%	100.0%
Total		Count	11	13	98
		% within SAMPLE	11.2%	13.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.410[a]	12	.413
Likelihood Ratio	12.948	12	.373
N of Valid Cases	98		

a. 12 cells (57.1%) have expected count less than 5. The minimum expected count is 2.20.

SAMPLE * Military_Desire

Crosstab

			Military Desire				
			1.00	1.50	2.00	2.50	3.00
SAMPLE	BU	Count	7	3	6	5	7
		% within SAMPLE	24.1%	10.3%	20.7%	17.2%	24.1%
	RBE	Count	11	4	7	10	5
		% within SAMPLE	26.2%	9.5%	16.7%	23.8%	11.9%
	Tech	Count	4	4	1	3	7
		% within SAMPLE	14.3%	14.3%	3.6%	10.7%	25.0%
Total		Count	22	11	14	18	19
		% within SAMPLE	22.2%	11.1%	14.1%	18.2%	19.2%

Crosstab

			Military Desire		
			3.50	4.00	Total
SAMPLE	BU	Count	1	0	29
		% within SAMPLE	3.4%	.0%	100.0%
	RBE	Count	2	3	42
		% within SAMPLE	4.8%	7.1%	100.0%
	Tech	Count	4	5	28
		% within SAMPLE	14.3%	17.9%	100.0%
Total		Count	7	8	99
		% within SAMPLE	7.1%	8.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.030[a]	12	.148
Likelihood Ratio	19.323	12	.081
N of Valid Cases	99		

a. 11 cells (52.4%) have expected count less than 5. The minimum expected count is 1.98.

B: Class Study T1

Question 1

NASA	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely
RBE	3.0	3.0	6.0	4.0
OTHER	0.0	3.0	9.0	0.0
TOTAL	3.0	6.0	15.0	4.0
RBE %	18.8	18.8	37.5	25.0
OTHER %	0.0	25.0	75.0	0.0
TOTAL %	10.7	21.4	53.6	14.3

Water	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely
RBE	4.0	7.0	2.0	2.0
OTHER	1.0	7.0	4.0	0.0
TOTAL	5.0	14.0	6.0	2.0
RBE %	26.7	46.7	13.3	13.3
OTHER %	8.3	58.3	33.3	0.0
TOTAL %	18.5	51.9	22.2	7.4

Question 2

NASA	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable
RBE	1.0	3.0	8.0	4.0
OTHER	0.0	4.0	4.0	4.0
TOTAL	1.0	7.0	12.0	8.0
RBE %	6.3	18.8	50.0	25.0
OTHER %	0.0	33.3	33.3	33.3
TOTAL %	3.6	25.0	42.9	28.6

Water	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable
RBE	1.0	6.0	5.0	3.0
OTHER	1.0	4.0	4.0	3.0
TOTAL	2.0	10.0	9.0	6.0
RBE %	6.7	40.0	33.3	20.0
OTHER %	8.3	33.3	33.3	25.0
TOTAL %	7.4	37.0	33.3	22.2

Question 3

NASA	Unlikely	Somewhat Unlikely	Somewhat likely	Very likely
RBE	0.0	3.0	4.0	9.0
OTHER	1.0	0.0	2.0	9.0
TOTAL	1.0	3.0	6.0	18.0
RBE %	0.0	18.8	25.0	56.3
OTHER %	8.3	0.0	16.7	75.0
TOTAL %	3.6	10.7	21.4	64.3

Water	Unlikely	Somewhat Unlikely	Somewhat likely	Very likely
RBE	1.0	0.0	4.0	10.0
OTHER	0.0	0.0	6.0	6.0
TOTAL	1.0	0.0	10.0	16.0
RBE %	6.7	0.0	26.7	66.7
OTHER %	0.0	0.0	50.0	50.0
TOTAL %	3.7	0.0	37.0	59.3

China	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely
RBE	1.0	3.0	7.0	5.0
OTHER	3.0	2.0	4.0	3.0
TOTAL	4.0	5.0	11.0	8.0
RBE %	6.3	18.8	43.8	31.3
OTHER %	25.0	16.7	33.3	25.0
TOTAL %	14.3	17.9	39.3	28.6

Military	Unlikely	Somewhat Unlikely	Somewhat Likely	Very Likely
RBE	0.0	0.0	11.0	5.0
OTHER	0.0	0.0	6.0	6.0
TOTAL	0.0	0.0	17.0	11.0
RBE %	0.0	0.0	68.8	31.3
OTHER %	0.0	0.0	50.0	50.0
TOTAL %	0.0	0.0	60.7	39.3

China	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable
RBE	2.0	4.0	3.0	7.0
OTHER	3.0	2.0	6.0	1.0
TOTAL	5.0	6.0	9.0	8.0
RBE %	12.5	25.0	18.8	43.8
OTHER %	25.0	16.7	50.0	8.3
TOTAL %	17.9	21.4	32.1	28.6

Military	Undesirable	Somewhat Undesirable	Somewhat Desirable	Very Desirable
RBE	7.0	4.0	4.0	1.0
OTHER	3.0	5.0	4.0	0.0
TOTAL	10.0	9.0	8.0	1.0
RBE %	43.8	25.0	25.0	6.3
OTHER %	25.0	41.7	33.3	0.0
TOTAL %	35.7	32.1	28.6	3.6

China	Unlikely	Somewhat Unlikely	Somewhat likely	Very likely
RBE	1.0	1.0	4.0	10.0
OTHER	1.0	1.0	1.0	9.0
TOTAL	2.0	2.0	5.0	19.0
RBE %	6.3	6.3	25.0	62.5
OTHER %	8.3	8.3	8.3	75.0
TOTAL %	7.1	7.1	17.9	67.9

Military	Unlikely	Somewhat Unlikely	Somewhat likely	Very likely
RBE	1.0	0.0	2.0	13.0
OTHER	0.0	1.0	2.0	9.0
TOTAL	1.0	1.0	4.0	22.0
RBE %	6.3	0.0	12.5	81.3
OTHER %	0.0	8.3	16.7	75.0
TOTAL %	3.6	3.6	14.3	78.6

C: Class Study T2

Question 1

NASA	Unlikely	Somewhat Unlikely	Somwhat Likely	Very Likely
RBE	0.0	1.0	4.0	1.0
OTHER	0.0	2.0	1.0	3.0
TOTAL	0.0	3.0	5.0	4.0
RBE %	0.0	16.7	66.7	16.7
OTHER %	0.0	33.3	16.7	50.0
TOTAL %	0.0	25.0	41.7	33.3

Water	Unlikely	Somewhat Unlikely	Somwhat Likely	Very Likely
RBE	0.0	1.0	5.0	0.0
OTHER	0.0	1.0	4.0	1.0
TOTAL	0.0	2.0	9.0	1.0
RBE %	0.0	16.7	83.3	0.0
OTHER %	0.0	16.7	66.7	16.7
TOTAL %	0.0	16.7	75.0	8.3

Question 2

NASA	Undesirable	Somewhat Undesirable	Somwhat Desirable	Very Desirable
RBE	0.0	1.0	2.0	3.0
OTHER	0.0	0.0	4.0	2.0
TOTAL	0.0	1.0	6.0	5.0
RBE %	0.0	16.7	33.3	50.0
OTHER %	0.0	0.0	66.7	33.3
TOTAL %	0.0	8.3	50.0	41.7

Water	Undesirable	Somewhat Undesirable	Somwhat Desirable	Very Desirable
RBE	0.0	1.0	3.0	2.0
OTHER	2.0	1.0	2.0	1.0
TOTAL	2.0	2.0	5.0	3.0
RBE %	0.0	16.7	50.0	33.3
OTHER %	33.3	16.7	33.3	16.7
TOTAL %	16.7	16.7	41.7	25.0

Question 3

NASA	Undesirable	Somewhat Undesirable	Somwhat Desirable	Very Desirable
RBE	3.0	1.0	2.0	0.0
OTHER	2.0	1.0	3.0	0.0
TOTAL	5.0	2.0	5.0	0.0
RBE %	50.0	16.7	33.3	0.0
OTHER %	33.3	16.7	50.0	0.0
TOTAL %	41.7	16.7	41.7	0.0

Water	Undesirable	Somewhat Undesirable	Somwhat Desirable	Very Desirable
RBE	0.0	1.0	3.0	2.0
OTHER	0.0	1.0	2.0	3.0
TOTAL	0.0	2.0	5.0	5.0
RBE %	0.0	16.7	50.0	33.3
OTHER %	0.0	16.7	33.3	50.0
TOTAL %	0.0	16.7	41.7	41.7

China	Unlikely	Somewhat Unlikely	Somwhat Likely	Very Likely
RBE	0.0	1.0	4.0	1.0
OTHER	0.0	2.0	1.0	3.0
TOTAL	0.0	3.0	5.0	4.0
RBE %	0.0	16.7	66.7	16.7
OTHER %	0.0	33.3	16.7	50.0
TOTAL %	0.0	25.0	41.7	33.3

Military	Unlikely	Somewhat Unlikely	Somwhat Likely	Very Likely
RBE	0.0	0.0	1.0	5.0
OTHER	0.0	0.0	0.0	6.0
TOTAL	0.0	0.0	1.0	11.0
RBE %	0.0	0.0	16.7	83.3
OTHER %	0.0	0.0	0.0	100.0
TOTAL %	0.0	0.0	8.3	91.7

China	Undesirable	Somewhat Undesirable	Somwhat Desirable	Very Desirable
RBE	0.0	1.0	2.0	3.0
OTHER	0.0	0.0	4.0	2.0
TOTAL	0.0	1.0	6.0	5.0
RBE %	0.0	16.7	33.3	50.0
OTHER %	0.0	0.0	66.7	33.3
TOTAL %	0.0	8.3	50.0	41.7

Military	Undesirabl e	Somewhat Undesirabl e	Somwhat Desirable	Very Desirable
RBE	3.0	1.0	1.0	1.0
OTHER	2.0	2.0	0.0	2.0
TOTAL	5.0	3.0	1.0	3.0
RBE %	50.0	16.7	16.7	16.7
OTHER %	33.3	33.3	0.0	33.3
TOTAL %	41.7	25.0	8.3	25.0

China	Undesirable	Somewhat Undesirable	Somwhat Desirable	Very Desirable
RBE	3.0	1.0	2.0	0.0
OTHER	2.0	1.0	3.0	0.0
TOTAL	5.0	2.0	5.0	0.0
RBE %	50.0	16.7	33.3	0.0
OTHER %	33.3	16.7	50.0	0.0
TOTAL %	41.7	16.7	41.7	0.0

Military	Undesirabl e	Somewhat Undesirabl e	Somwhat Desirable	Very Desirable
RBE	0.0	0.0	0.0	6.0
OTHER	0.0	0.0	1.0	5.0
TOTAL	0.0	0.0	1.0	11.0
RBE %	0.0	0.0	0.0	100.0
OTHER %	0.0	0.0	16.7	83.3
TOTAL %	0.0	0.0	8.3	91.7

D: Delta Table

Delta T1 T2					
Participant	Q1	Q2	Q3	Q4	Q5
1	0	0	0	-1	2
3	0	0	-1	0	1
6	-1	-1	-1	-1	1
7	0	0	-1	-1	1
8	1	0	-1	0	1
13	-1	0	0	0	1
14	1	0	-1	-1	1
22	-1	0	0	0	2
23	-1	1	-1	-1	1
24	0	0	0	0	3
25	-1	0	-2	1	1
27	1	0	0	1	0
% same	33.33	83.33	41.67	41.67	8.33
%diff	66.67	16.67	58.33	58.33	91.67
Avg	-0.17	0.00	-0.67	-0.25	1.25
Avg Mag	0.67	0.17	0.67	0.58	1.25
StDev	0.83	0.43	0.65	0.75	0.75
	How Likely?		How Desirable?		Ethical?

Delta T1 T2					
Participant	Q1	Q2	Q3	Q4	Q5
1					
3	0	0	1	1	-1
6	1	-1	-1	0	-2
7	-1	0	-1	0	2
8	1	0	-1	-1	1
13	-1	0	-1	0	1
14	-1	-1	0	1	0
22	-2	0	-1	1	0
23	-1	-2	-1	0	1
24	-1	1	1	1	0
25	0	-1	0	-1	0
27	-1	0	0	1	0
% same	18.18	54.55	27.27	36.36	45.45
%diff	90.91	54.55	81.82	72.73	63.64
Avg	-0.55	-0.36	-0.36	0.27	0.18
Avg Mag	0.91	0.55	0.73	0.64	0.73
StDev	0.93	0.81	0.81	0.79	1.08
	How Likely?		How Desirable?		Ethical?

Delta T1 T2					
Participant	Q1	Q2	Q3	Q4	Q5
1	-1	-1	1	2	-2
3	-3	-1	-1	0	-2
6	-1	0	0	-1	2
7	0	0	0	0	1
8	1	1	1	0	1
13	0	-1	-1	-2	1
14	-1	1	0	0	0
22	0	0	0	0	0
23	0	0	1	1	0
24	-1	1	0	-1	1
25	-1	0	0	1	0
27	0	0	0	0	-1
% same	41.67	50.00	58.33	50.00	33.33
%diff	58.33	50.00	41.67	50.00	66.67
Avg	-0.58	0.00	0.08	0.00	0.08
Avg Mag	0.75	0.50	0.42	0.67	0.92
StDev	1.00	0.74	0.67	1.04	1.24
	How Likely?		How Desirable?		Ethical?

Delta T1 T2					
Participant	Q1	Q2	Q3	Q4	Q5
1	0	0	-1	-1	0
3	0	0	0	0	0
6	-1	1	0	0	0
7	0	0	0	0	-1
8	-1	0	1	0	0
13	0	0	-1	-2	0
14	0	0	1	0	0
22	-1	0	0	0	0
23	-1	0	1	1	0
24	0	1	0	0	0
25	-1	0	1	2	0
27	0	-1	-1	-2	0
% same	58.33	75.00	41.67	58.33	91.67
%diff	41.67	25.00	58.33	41.67	8.33
Avg	-0.42	0.08	0.08	-0.17	-0.08
Avg Mag	0.42	0.25	0.58	0.67	0.08
StDev	0.51	0.51	0.79	1.11	0.29
	How Likely?		How Desirable?		Ethical?

Raw Codes

Case No1	LeadAgencyJ	OptimisticJ	RegulationJ	ChangeJ	ControlJ
1	5	2	3	4	5
2	2	4	2	2	5
3	5	5	3	1	5
4	1	4	4	4	4
5	2	2	4	3	3
6	4	4	4	3	3
7	3	3	4	2	5

8	2	1	4	4	2
9	3	1	4	3	4
10	3	3	5	3	4
11	2	2	4	4	2
12	3	4	2	4	3
13	2	5	3	1	2
14	3	4	4	2	4
15	3	2	3	4	5
16	2	4	3	4	2
17	5	4	3	2	4
18	1	2	5	5	3
19	2	3	4	1	5
20	3	1	4	5	2
21	2	4	5	3	4
22	2	2	3	3	4
23	2	1	3	1	1
24	3	2	3	2	2
25	3	4	3	2	4
26	2	3	3	2	3
Average	2.69	2.92	3.54	2.85	3.46
Median	2.5	3	3.5	3	4
STDev	1.09	1.26	0.81	1.22	1.21

CaseNo2	LeadAgencyT	OptimisticT	RegulationT	ChangeT	ControlT
1	5	3	3	4	5
2	2	4	2	2	4
3	5	5	3	1	5
4	2	4	4	4	4
5	2	2	4	3	3
6	4	4	3	3	2
7	2	3	4	2	5
8	2	1	4	4	2
9	2	2	4	3	4
10	3	3	4	3	4
11	3	2	4	4	2
12	4	4	2	4	3
13	2	4	4	1	3
14	3	4	4	2	4
15	3	2	4	4	4
16	2	4	3	4	2
17	4	4	3	2	4

18	1	2	5	5	3
19	2	3	4	2	5
20	3	1	4	5	2
21	2	4	5	3	4
22	3	2	3	4	4
23	2	1	3	1	1
24	4	2	3	2	1
25	3	4	3	3	4
26	3	3	3	2	3
Average	2.81	2.96	3.54	2.96	3.35
Median	3.00	3.00	4.00	3.00	4.00
STDev	1.02	1.15	0.76	1.18	1.20

CaseNo3	LeadAgencyC	OptimisticC	RegulationC	ChangeC	ControlC
1	5	2	3	4	5
2	2	4	2	2	5
3	5	5	3	1	5
4	2	4	4	4	4
5	2	2	4	3	3
6	4	4	3	3	2
7	2	3	4	2	5
8	2	1	4	4	2
9	2	2	4	3	4
10	4	3	4	3	4
11	2	2	4	4	2
12	4	4	2	4	3
13	2	4	4	1	2
14	3	4	4	2	4
15	3	2	4	4	5
16	2	4	3	4	2
17	5	4	3	2	4
18	1	2	5	5	3
19	2	3	4	2	5
20	3	1	4	5	2
21	2	4	5	3	4
22	2	2	3	4	4
23	2	1	3	1	1
24	4	2	3	3	1
25	3	4	3	2	4
26	3	3	3	2	3
Average	2.81	2.92	3.54	2.96	3.38
Median	2.00	3.00	4.00	3.00	4.00
STDev	1.13	1.16	0.76	1.18	1.30

Correlation Tables

LeadAgencyJames * LeadAgencyTom Correlation

			LeadAgencyTom					
			1	2	3	4	5	Total
LeadAgencyJames	1	Count	1	1	0	0	0	2
		% within LeadAgencyJames	.5	.5	.0	.0	.0	1.0
		% within LeadAgencyTom	1.0	.1	.0	.0	.0	.1
	2	Count	0	8	3	0	0	11
		% within LeadAgencyJames	.0	.7	.3	.0	.0	1.0
		% within LeadAgencyTom	.0	.7	.4	.0	.0	.4
	3	Count	0	2	4	3	0	9
		% within LeadAgencyJames	.0	.2	.4	.3	.0	1.0
		% within LeadAgencyTom	.0	.2	.6	.6	.0	.3
	4	Count	0	0	0	1	0	1
		% within LeadAgencyJames	.0	.0	.0	1.0	.0	1.0
		% within LeadAgencyTom	.0	.0	.0	.2	.0	.0
	5	Count	0	0	0	1	2	3
		% within LeadAgencyJames	.0	.0	.0	.3	.7	1.0
		% within LeadAgencyTom	.0	.0	.0	.2	1.0	.1
Total		Count	1	11	7	5	2	26
		% within LeadAgencyJames	.0	.4	.3	.2	.1	1.0
		% within LeadAgencyTom	1.0	1.0	1.0	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.093	16	.000
Likelihood Ratio	31.980	16	.010

Linear-by-Linear Association	17.461	1	.000
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.935	.058	6.141	.000
N of Valid Cases		26			

ChangeJames * ChangeTom Correlation

			ChangeTom					
			1	2	3	4	5	Total
ChangeJames	1	Count	3	1	0	0	0	4
		% within ChangeJames	75.0%	25.0%	.0%	.0%	.0%	100.0%
		% within ChangeTom	100.0%	14.3%	.0%	.0%	.0%	15.4%
	2	Count	0	6	1	0	0	7
		% within ChangeJames	.0%	85.7%	14.3%	.0%	.0%	100.0%
		% within ChangeTom	.0%	85.7%	16.7%	.0%	.0%	26.9%
	3	Count	0	0	5	1	0	6
		% within ChangeJames	.0%	.0%	83.3%	16.7%	.0%	100.0%
		% within ChangeTom	.0%	.0%	83.3%	12.5%	.0%	23.1%
	4	Count	0	0	0	7	0	7
		% within ChangeJames	.0%	.0%	.0%	100.0%	.0%	100.0%
		% within ChangeTom	.0%	.0%	.0%	87.5%	.0%	26.9%
	5	Count	0	0	0	0	2	2
		% within ChangeJames	.0%	.0%	.0%	.0%	100.0%	100.0%
		% within ChangeTom	.0%	.0%	.0%	.0%	100.0%	7.7%
Total		Count	3	7	6	8	2	26
		% within ChangeJames	11.5%	26.9%	23.1%	30.8%	7.7%	100.0%
		% within ChangeTom	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.560[a]	16	.000
Likelihood Ratio	32.140	16	.010
Linear-by-Linear Association	17.892	1	.000
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.935	.059	5.863	.000
N of Valid Cases		26			

OptimismJames * OptimismTom Correlation

			OptimismTom					
			1	2	3	4	5	Total
OptimismJames	1	Count	3	1	0	0	0	4
		% within OptimismJames	75.0%	25.0%	.0%	.0%	.0%	100.0%
		% within OptimismTom	100.0%	14.3%	.0%	.0%	.0%	15.4%
	2	Count	0	6	1	0	0	7
		% within OptimismJames	.0%	85.7%	14.3%	.0%	.0%	100.0%
		% within OptimismTom	.0%	85.7%	20.0%	.0%	.0%	26.9%
	3	Count	0	0	4	0	0	4
		% within OptimismJames	.0%	.0%	100.0%	.0%	.0%	100.0%
		% within OptimismTom	.0%	.0%	80.0%	.0%	.0%	15.4%
	4	Count	0	0	0	9	0	9
		% within OptimismJames	.0%	.0%	.0%	100.0%	.0%	100.0%
		% within OptimismTom	.0%	.0%	.0%	90.0%	.0%	34.6%
	5	Count	0	0	0	1	1	2
		% within OptimismJames	.0%	.0%	.0%	50.0%	50.0%	100.0%
		% within OptimismTom	.0%	.0%	.0%	10.0%	100.0%	7.7%
Total		Count	3	7	5	10	1	26
		% within OptimismJames	11.5%	26.9%	19.2%	38.5%	3.8%	100.0%
		% within OptimismTom	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	72.773[a]	16	.000
Likelihood Ratio	60.428	16	.000
Linear-by-Linear Association	23.215	1	.000
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	1.000	.000	17.720	.000
N of Valid Cases		26			

RegulationJames * RegulationTom Crosstabulation

			RegulationTom				Total
			2	3	4	5	
RegulationJames	2	Count	2	0	0	0	2
		% within RegulationJames	100.0%	.0%	.0%	.0%	100.0%
		% within RegulationTom	100.0%	.0%	.0%	.0%	7.7%
	3	Count	0	9	2	0	11
		% within RegulationJames	.0%	81.8%	18.2%	.0%	100.0%
		% within RegulationTom	.0%	90.0%	16.7%	.0%	42.3%
	4	Count	0	1	9	0	10
		% within RegulationJames	.0%	10.0%	90.0%	.0%	100.0%
		% within RegulationTom	.0%	10.0%	75.0%	.0%	38.5%
	5	Count	0	0	1	2	3
		% within RegulationJames	.0%	.0%	33.3%	66.7%	100.0%
		% within RegulationTom	.0%	.0%	8.3%	100.0%	11.5%
Total		Count	2	10	12	2	26
		% within RegulationJames	7.7%	38.5%	46.2%	7.7%	100.0%
		% within RegulationTom	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	55.799[a]	9	.000
Likelihood Ratio	37.435	9	.000
Linear-by-Linear Association	19.030	1	.000
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.978	.027	6.595	.000
N of Valid Cases		26			

ControlJames * ControlTom Crosstabulation

			ControlTom					Total
			1	2	3	4	5	
ControlJames	1	Count	1	0	0	0	0	1
		% within ControlJames	100.0%	.0%	.0%	.0%	.0%	100.0%
		% within ControlTom	50.0%	.0%	.0%	.0%	.0%	3.8%
	2	Count	1	4	1	0	0	6
		% within ControlJames	16.7%	66.7%	16.7%	.0%	.0%	100.0%
		% within ControlTom	50.0%	80.0%	20.0%	.0%	.0%	23.1%
	3	Count	0	1	4	0	0	5
		% within ControlJames	.0%	20.0%	80.0%	.0%	.0%	100.0%
		% within ControlTom	.0%	20.0%	80.0%	.0%	.0%	19.2%
	4	Count	0	0	0	8	0	8
		% within ControlJames	.0%	.0%	.0%	100.0%	.0%	100.0%
		% within ControlTom	.0%	.0%	.0%	80.0%	.0%	30.8%
	5	Count	0	0	0	2	4	6
		% within ControlJames	.0%	.0%	.0%	33.3%	66.7%	100.0%
		% within ControlTom	.0%	.0%	.0%	20.0%	100.0%	23.1%
Total		Count	2	5	5	10	4	26
		% within ControlJames	7.7%	19.2%	19.2%	38.5%	15.4%	100.0%
		% within ControlTom	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	61.447[a]	16	.000
Likelihood Ratio	54.265	16	.000
Linear-by-Linear Association	21.888	1	.000
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.991	.012	16.282	.000
N of Valid Cases		26			

Optimism vs Desirability NASA Scenario

			Desirability				
			1	2	3	4	Total
Optimism	pessimist	Count	0	1	3	3	7
		% within Optimism	.0	.1	.4	.4	1.0
		% within Desirability	.0	.2	.3	.4	.3
	neither	Count	1	4	4	1	10
		% within Optimism	.1	.4	.4	.1	1.0
		% within Desirability	1.0	.7	.3	.1	.4
	optimist	Count	0	1	5	3	9
		% within Optimism	.0	.1	.6	.3	1.0
		% within Desirability	.0	.2	.4	.4	.3
Total		Count	1	6	12	7	26
		% within Optimism	.0	.2	.5	.3	1.0
		% within Desirability	1.0	1.0	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.766	6	.450
Likelihood Ratio	6.245	6	.396
Linear-by-Linear Association	.001	1	.981
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.026	.253	.104	.917
N of Valid Cases		26			

Optimism vs Likelihood NASA Scenario

			Likelihood				Total
			1	2	3	4	
Optimism	pessimist	Count	2	3	2	0	7
		% within Optimism	.3	.4	.3	.0	1.0
		% within Likelihood	.7	.5	.2	.0	.3
	neither	Count	0	3	4	3	10
		% within Optimism	.0	.3	.4	.3	1.0
		% within Likelihood	.0	.5	.3	.8	.4
	optimist	Count	1	0	7	1	9
		% within Optimism	.1	.0	.8	.1	1.0

		% within Likelihood	.3	.0	.5	.3	.3
Total		Count	3	6	13	4	26
		% within Optimism	.1	.2	.5	.2	1.0
		% within Likelihood	1.0	1.0	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.191	6	.083
Likelihood Ratio	14.358	6	.026
Linear-by-Linear Association	3.534	1	.060
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.472	.207	2.150	.032
N of Valid Cases		26			

Optimism vs Desirbaility Military Scenario

			Desirability				Total
			1	2	3	4	
Optimism	pessimist	Count	5	1	1	0	7
		% within Optimism	.7	.1	.1	.0	1.0
		% within Desirability	.8	.2	.1	.0	.3
	neither	Count	0	1	8	1	10

		% within Optimism	.0	.1	.8	.1	1.0
		% within Desirability	.0	.2	.7	.3	.4
	optimist	Count	1	3	3	2	9
		% within Optimism	.1	.3	.3	.2	1.0
		% within Desirability	.2	.6	.3	.7	.3
Total		Count	6	5	12	3	26
		% within Optimism	.2	.2	.5	.1	1.0
		% within Desirability	1.0	1.0	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.482	6	.008
Likelihood Ratio	18.073	6	.006
Linear-by-Linear Association	5.314	1	.021
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.471	.223	1.938	.053
N of Valid Cases		26			

Optimism vs Likelihood Military Scenario

	Likelihood	Total

			3	4	
Optimism	pessimist	Count	3	4	7
		% within Optimism	.4	.6	1.0
		vs Likelihood	.2	.4	.3
	neither	Count	4	6	10
		% within Optimism	.4	.6	1.0
		vs Likelihood	.3	.6	.4
	optimist	Count	9	0	9
		% within Optimism	1.0	.0	1.0
		vs Likelihood	.6	.0	.3
Total		Count	16	10	26
		% within Optimism	.6	.4	1.0
		vs Likelihood	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.617	2	.013
Likelihood Ratio	11.626	2	.003
Linear-by-Linear Association	5.831	1	.016
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	-.710	.179	-3.166	.002
N of Valid Cases		26			

Correlations Using the Composite Codes

Hypothesis 1

Optimism Composite vs Control Composite

			Control Composite					Total
			1	2	3	4	5	
Optimism Composite	1	Count	1	2	0	0	0	3
		% within Optimism Composite	.3	.7	.0	.0	.0	1.0
		% within Control Composite	.5	.3	.0	.0	.0	.1
	2	Count	1	1	2	2	2	8
		% within Optimism Composite	.1	.1	.3	.3	.3	1.0
		% within Control Composite	.5	.2	.5	.3	.3	.3
	3	Count	0	0	1	1	2	4
		% within Optimism Composite	.0	.0	.3	.3	.5	1.0
		% within Control Composite	.0	.0	.3	.1	.3	.2
	4	Count	0	3	1	5	1	10
		% within Optimism Composite	.0	.3	.1	.5	.1	1.0

		% within Control Composite	.0	.5	.3	.6	.2	.4
	5	Count	0	0	0	0	1	1
		% within Optimism Composite	.0	.0	.0	.0	1.0	1.0
		% within Control Composite	.0	.0	.0	.0	.2	.0
Total		Count	2	6	4	8	6	26
		% within Optimism Composite	.1	.2	.2	.3	.2	1.0
		% within Control Composite	1.0	1.0	1.0	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.532	16	.352
Likelihood Ratio	18.829	16	.278
Linear-by-Linear Association	3.322	1	.068
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	.337	.208	1.517	.129
N of Valid Cases		26			

Hypothesis 2

Optimism Composite vs Regulation Composite

			Regulation Composite				Total
			2	3	4	5	
Optimism Composite	1	Count	0	1	2	0	3
		% within Optimism Composite	.0	.3	.7	.0	1.0
		% within Regulation Composite	.0	.1	.2	.0	.1
	2	Count	0	3	4	1	8
		% within Optimism Composite	.0	.4	.5	.1	1.0
		% within Regulation Composite	.0	.3	.3	.5	.3
	3	Count	0	1	3	0	4
		% within Optimism Composite	.0	.3	.8	.0	1.0
		% within Regulation Composite	.0	.1	.3	.0	.2
	4	Count	2	4	3	1	10
		% within Optimism Composite	.2	.4	.3	.1	1.0
		% within Regulation Composite	1.0	.4	.3	.5	.4
	5	Count	0	1	0	0	1
		% within Optimism Composite	.0	1.0	.0	.0	1.0
		% within Regulation Composite	.0	.1	.0	.0	.0
Total		Count	2	10	12	2	26
		% within Optimism Composite	.1	.4	.5	.1	1.0
		% within Regulation Composite	1.0	1.0	1.0	1.0	1.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.374	12	.832
Likelihood Ratio	8.682	12	.730
Linear-by-Linear Association	1.792	1	.181
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Ordinal by Ordinal	Gamma	-.346	.230	-1.467	.142
N of Valid Cases		26			

Desirability vs Likelihood

Desirability of Space or Military Scenario vs Likelihood of Space or Military Scenario

			Likelihood			Total
			Space more likely than Military	Space and Military equally likely	Space less likely than Military	
Desirability	military preference	Count	0	5	1	6
		% within desirability	.0%	83.3%	16.7%	100.0%
		% within likelihood	.0%	41.7%	8.3%	23.1%
	No preference	Count	1	5	4	10

		% within desirability	10.0%	50.0%	40.0%	100.0%
		% within likelihood	50.0%	41.7%	33.3%	38.5%
	space preference	Count	1	2	7	10
		% within desirability	10.0%	20.0%	70.0%	100.0%
		% within likelihood	50.0%	16.7%	58.3%	38.5%
Total		Count	2	12	12	26
		% within desirability	7.7%	46.2%	46.2%	100.0%
		% within likelihood	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.356[a]	4	.174
Likelihood Ratio	7.063	4	.133
Linear-by-Linear Association	1.918	1	.166
N of Valid Cases	26		

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.467	.242	1.875	.061
N of Valid Cases		26			

New Proposed Military Scenario

Military Scenario

There is a war going on and there have been many deaths. The US military has gained information that a rebel force has captured a few American commanders with very important information. They are currently being held in a rebel base that is heavily defended with their exact location within the base unknown. The President has decided to send in troops to try to rescue these hostages alive. Asked whether and when to send in elite commandos to do the "extraction" mission he is given the option of sending in average robotic soldiers, but a lot of them, to scout around and find the hostages before they break down under torture and reveal what they know. He does not want to risk the lives of a lot of troops as well as the captured commanders so he decides to send in a squad of robotic soldiers first.

A few elite people can go in if the robots fail and once they know exactly what they are up against and where their objective is. They would have to hope the robots failure has not tipped off the enemy that an operation is underway and cost them the element of surprise. Worse they have to hope the robots did not get the hostages killed trying to escape with them. Advanced robotic soldiers are more precise marksmen than humans and can take gunfire without the risk of dying. However, they are not as versatile and act in predictable though logical and systematic ways. They are obedience but not creative and do not take advantage of unexpected opportunities. These robotic soldiers are to locate the hostages and report back, and then try to rescue them, if possible. They are very advanced and are not to allow themselves to be captured intact. If they fail in their mission they are to self-destruct. Their mission is to protect the captured commanders, and help them escape, but failing that to be sure they do not tell the enemy what they know (i.e. kill them if the escape attempt fails or they ask to be killed). The robots have been programmed with the necessary data to identify the captured commanders and to protect them until they themselves are disabled or destroyed. If they successfully find the commanders they will have to lead them from the base to a safe location for pickup.

You have been asked to assess the President's decision and have to design the mission he asked for, robots try with people as backup or tell him that it is better to lead with the people, or not send the people at all, whatever happens. If you do not follow the President's wishes, design a plan that you think has a better chance of success- that being everyone lives, or the captives get out alive even if the rescuers (man and machine) are sacrificed.

Scenario Survey

1) In what order would you place these scenarios in order of best to worst idea in terms of what can go wrong?

   a)

   b)

   c)

2) For your first choice please explain why it is the best application? Is there anything you can see that might be a problem?

3) For your second choice please explain why it is only a good application, not as good or as bad as the others. ? Is there anything you can see that might be a problem?

4) For your last choice please explain why it is the worst application idea of the 3? Is there anything that you can see that might be good about it and what is the biggest problem?

Post Survey

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given 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 Laws.

After having heard about Asimov's Laws would you be able to explain which laws each of the scenarios break, if any.

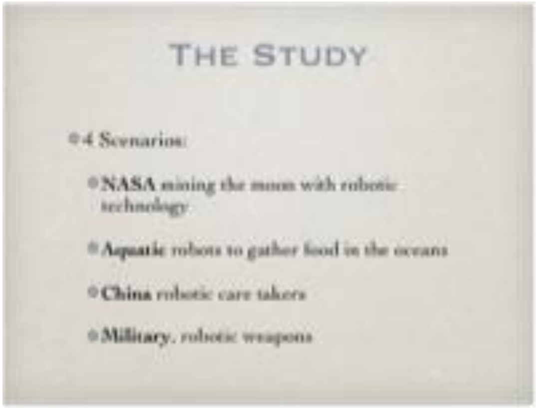
1)

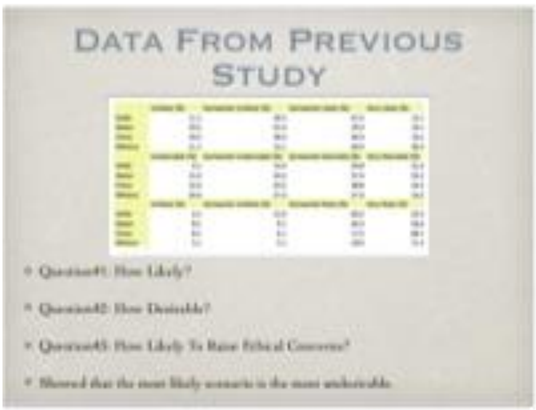
2)

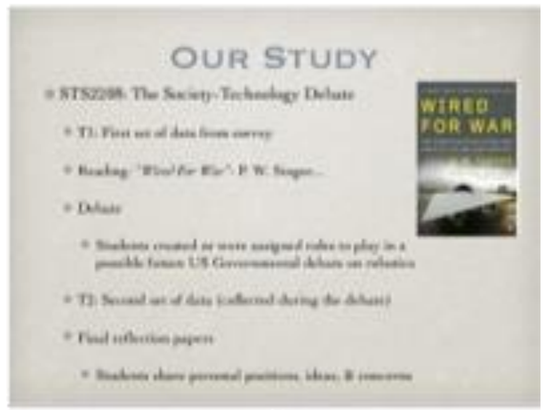
3)

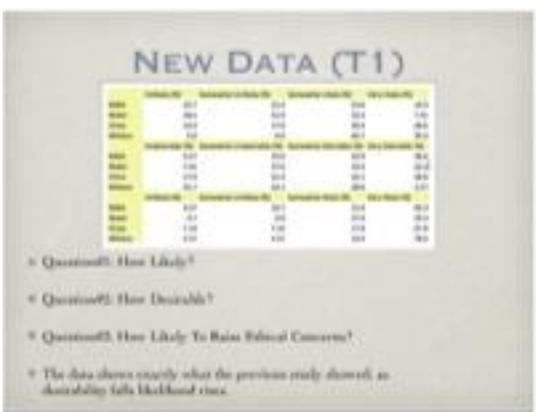
4)

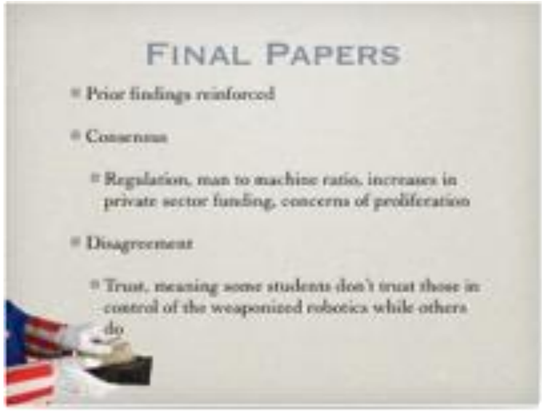
Presentation

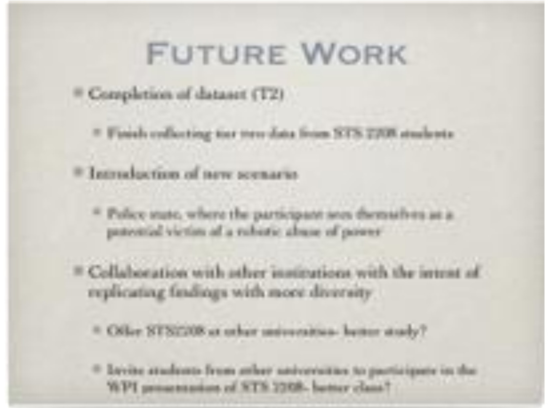









FINAL PAPERS
Prior findings reinforced
Consensus
Regulation, man to machine ratio, increases in private sector funding, concerns of proliferation
Disagreement
Trust, meaning some students don't trust those in control of the weaponized robotics while others do


FUTURE WORK
Completion of dataset (T2)
Introduction of new scenario
Collaboration with other institutions with the intent of replicating findings with more diversity
Offer STS2208 at other universities- better study?
Invite students from other universities to participate in the WPI presentation of STS 2208- better class?


IN THE NEWS
Domestic Uses of Defense Weaponry
"Rand Paul filibusters John Brennan"
Drone Attacks
Defense Spending (D.A.R.P.A.)


WHERE ARE WE GOING?
Future Regulation
Man in the loop
Class suggest a 1:1 human to machine ratio
Regulatory oversight committees governing use of robotic technologies
Get the scientific community involved in decision making and future legislative efforts
Future Technologies
Are there any limits?

Bibliography

Michael Joseph Brauckmann *Piercing the Future Fog* E-project-031113-164601

Thomas Patrick Conwell, Timothy John Sharood, Nathanael Hazely Vander Els
Fear the Robots!: A study of the Percieved future of Robotics in Modern Society
E-project-031513-095308

Singer, P. W. *Wired for War: The Robotics Revolution and Conflict in the Twenty-first Century*. New York: Penguin, 2009. Print.

Why the future doesn't need us.
by: Bill Joy

Wired (April 2000)

Kelly, Kevin. *What Technology Wants*. New York: Viking, 2010. Print.