RESEARCH QUESTION

“As our society becomes increasingly dependent on technology, it is also more and more vulnerable to and impacted by technology”
- Margaret Singleton, a professor at the U.S. Army Computer Science School

Margaret Singleton (Singleton 1991) had the foresight to push for engineering ethics to be incorporated in education in the early nineties because she recognized that as the technological world we know today emerged, the engineers developing such technologies would need to take on some responsibilities for the societal impacts of their creations (see Appendix A, part 1). As the United States engages in what is termed the ‘War on Terror’ (Goraya 2011), a particular technology known as unmanned aerial vehicles (UAVs), otherwise known as military drones, has become controversial. These military planes and helicopters have the ability to fly, locate, and strike targets without the use of an on-board pilot or flight-crew. The obvious advantage to such technology is such aircraft reduces casualties of military personnel. However, the negative societal and political implications are numerous.

The goal of this research is to answer the question, “Should the United States government place more funding into the development (engineering) and use of UAVs?” by exploring the engineering ethics, as Singleton would suggest, and the perspectives of various groups and individuals.

BACKGROUND CONTEXT

The common theme across the various topics of this Capstone course has been that technology shapes the societies in which we live, and in many ways shapes both the history and future of humanity. Therefore, the topic of military technology policy is significant in a general sense because it will shape the future of warfare, ultimately deciding who lives, who dies, and the rules of international war. UAVs, or “drones”, are of particular importance at the current time for several reasons. First, their use in the American “War on Terror” has resulted in the deaths of thousands of civilians in the Middle East, causing more international relations issues for the United States government. Also in regards to this war, the United States is under scrutiny for breaking international laws for using UAVs in Pakistan without the permission of the ally government. Second, the autonomy of these vehicles is a technological phenomenon that many citizens fear, and the extent to which that autonomy should be regulated is being currently debated (Arkin 2010, Davies 2009). UAVs are an asset to any military because they save the lives of the humans that would otherwise be piloting such aircraft, but the ethical issues
mentioned above greatly hinder this benefit. Finally, the United States government is currently facing large budget deficits, indicating that any further spending should be carefully chosen. There are many perspectives on the use of the limited resources being put toward the expensive UAV technology, which already have political setbacks.

There has been extensive research on the subject of drone technology, but the issue of government spending on these vehicles is only a recent public concern. The main argument against continued investment in drones is due to their unethical use, and researchers have found that if ethical questions are not addressed before technology is released, there can be catastrophic implications (Katz 2011). The most relevant research on my particular topic came to conflicting conclusions and opinions, even within classified groups. However, in general, I found a majority viewpoint within groups of researchers (engineers, government officials, military personnel, etc.). Engineers seem to agree it is a matter of maintaining ethical standards in technological design (Cooklev 2010). Military journals conclude that spending on drones to be necessary and to avoid this technology would be unethical (Arkin 2010). Government officials seem to present an objective view, varying mainly to please voters, but otherwise considering both sides (Gertler 2012). Finally, foreign research has shown to be widely against American drones on both ethical and personal grounds (Sharkey 2010).

I believe it to be of the utmost importance that the Lafayette community forms the bridges necessary to get students, who will one day be making the decisions on this question, to think about this issues. The engineering students will need to understand the ethical and policy implications of the technology they produce, and the public policy and international affairs students will need to face the ever increasing technological issues in this modern world.

**Methods**

Consistent with the theme of society centering on technology, I decided a website would be the final product of this research endeavor. A website offers a unique format with which to organize the perspectives of different groups in addition to providing a means of instant feedback and comments from the outside world. It also is the easiest way for the Lafayette community to access this research and hopefully bridge the gap between the various departments whose interests overlap in this project since they can communicate through the site.

The method used was to collect various forms of research (government documents, scholarly journal articles, news and magazine articles, and documentary videos and photos). After compiling the information, I separated the research into subcategories in order to attribute viewpoints to the groups I described in the above section. I determined what was unique and relevant about each piece and explained its contribution to my research in the attached Appendix. I then presented the research on the website in an organized and aesthetic fashion. The site is broken up into pages, each with a specific purpose. They include: an About, History, News, Debate, Technology, Media, and Opinions page. Within the Debate page, there are
subpages for the perspectives that were researched to help answer the question, and they include the groups: engineering, government, military, civilian, and foreign perspectives. Each of the pages listed include a summary of its content, access either via link or embedded citation to the source documents. The Opinions page acts as a place for public comment/discussion for all readers in blog format.

The informative aspect of the project was aided by the collaborator Stephen E. Lammers, a Lafayette College Professor. The IT design piece was aided by Courtney Bentley, the Director of Instructional Technology in Skillman Library.

### Conclusions and Outcomes

The final product is the primary outcome to the research and can be accessed at:

https://sites.lafayette.edu/egrs451-sp12-uav/

This outcome is one that is visually appealing, creatively designed, informative and well researched, error-free, and demonstrative of the interdisciplinary of Engineering Studies major. The general conclusion of the research, based on the numerous perspectives that were included, was that the United States should invest further into military drone technology. While this was the majority view of the combined perspectives, it was only by a small margin. The pros and cons of using UAVs are unfortunately immeasurable, as they include intangibles such foreign relationships, civilian lives, and future war malpractice. However, it is fair to say that a majority are in favor of increased spending on drones because the majority of research I found, written by what can be considered experts in their perspective fields, agreed on this point, regardless of their background. Political scientists, engineers, philosophy professors, military journals, and government researchers, all agree that drone technology is a logical investment for the United States. Even foreign sentiment seems to be opposed the United States using drones against their consent, but not opposed to the technology or its use in general. Most of the sources suggested a regulated approach and articulated fears in the advancement of UAVs.

In addition, this topic is growing into a private sector issue as the drones are being designed for civilian purposes (Richards 2009). The civilian applications currently include geological surveys, crop spraying, border patrols, monitoring pollution, hurricanes, and forest fires. However, the limit to applications may only be the imagination of the engineer. The concerns regarding these applications are only relevant to this particular research question insofar as it is something to consider as a future implication of investing in such technology in the present.

### Recommended Next Steps

First and foremost, I would recommend future students continue to update and maintain the current website because the technology will dramatically change quickly. My dream for the project, if you will, is that Lafayette will one day have a future expanded version of the site, which discusses all military technology and the
ethics of their development. The UAV site entitled "Dollars for Drones" would be a subset of the future expanded site, and the forum for the site would be a place for the Lafayette Community to discuss their views, fears, and possibly theoretical solutions to the dilemmas technologies pose. Finally, I would suggest a page on this expanded site explaining the overlap of these military technologies into civilian life. Brian and Kim's website will provide a place for my research to extend to other class years and grow with time.

APPENDIX A

Annotated Bibliography:

Part 1: Engineering Ethics


Todor Cooklev is a Ph.D. and Professor of Electrical Engineering at San Francisco State University, and he reports in this scholarly article, the need he sees for incorporating engineering ethics, among other "soft skills" into engineering curriculum. He argues that the standards and demand for engineering are rising; therefore, the standards of engineering education should also increase. He further clarifies that by increase or better the curriculum, he means instill design ethics and standards into engineering students. He recommends including these standards as part of homework, lab, and classroom work in order to maintain ABET accreditation whilst keeping up with the ever changing standards.


Doorn recognizes that there are several ways to approach responsibility in technological innovation, and he considers the implications on engineering development from each of the three main approaches he perceives. He considers the issues of efficiency and fairness in each of the three approaches, as these things concern scientists of all kinds.


Eric Katz provides an interesting, albeit extreme, example of engineering without ethical standards. He explains that the technical engineers and scientists of the
Third Reich in Nazi Germany practiced “good” engineering, but their technological innovations were purposed to the genocidal deaths of innocent Jewish people. Katz goes on to answer the question of how engineers can evaluate the values behind their technological products and the responsibility they have to create a better world.


Margaret Singleton, a professor at the U.S. Army Computer Science School, was ahead of her time in presenting this research on engineering education at the Frontiers in Education Conference in 1991. She foresaw the technologically dependant society the world was becoming and used historical examples to show how major changes in technology resulted in disaster if ethical standards were not enforced. She uses these examples to encourage ethics be taught to engineers so that society may at the very least, may have new generations of engineers with ethical standards education.

Part 2: Perspectives


The thesis of this research paper from the *Journal of Military Ethics* is that unmanned systems will potentially be capable of performing more ethically in warfare than human soldiers. The hypothesis is supported by an assessment of human ability in modern warfare and the technical advances that are ongoing and foreseen in the near future. Ronald Arkin, a Ph.D. in Computer Science and Professor at the Georgia Institute of Technology, argues that even if the drones are imperfect in their ethical decisions, they will still reduce civilian casualties and property damage in warfare as long as they are superior to their human counterparts in their ethical choices.

Arkin, a specialist in behavior-based reactive control in robots, has performed research that greatly supports the United States furthering their investment in military drones on an ethical basis. This directly relates the goals of this research project which is to present both sides of the argument regarding increased military spending on unmanned aerial vehicles. The limitations of this article are that it does not consider the financial costs of advancing military drones to the point of ethical superiority.


The argument Alan Brown makes in this article is that drones have been great assets to the United States military, but there is great risk inherent if another force is able to produce superior robotics. The article does deal with the issue of disconnect between soldiers and actual warfare, but ultimately, it gives the
impression that without furthering this technology, the United States may be left at a disadvantage.

This source is an article from a technical engineering journal, with an audience of primarily engineers and technology professionals; therefore it describes the models of Unmanned aerial vehicles in more technical detail. This will be important in differentiating between which models are most worth further investment. Brown is a veteran technology writer and consultant, focusing most of his 30-year career on how technology can provide a competitive advantage to business. This project is concerned with the United States investing in military drones in the future, which can be considered another way as the question of UAV technology being able to provide enough of a competitive advantage to justify further investment. Therefore, this article acts as a source in support of further military spending on drone warfare.

Davies, S. S. (2009). It’s war - but not as we know it [autonomous military robotics]. Engineering & Technology (17509637), 4(9), 40-43. doi:10.1049/et.2009.0907

The article argues that it is much too soon to fear robots taking over the world as they do in popular media; however, unmanned aerial vehicles are on a “slippery slope” in that direction. The author, Sean Davies, is a technology journalist who typically writes for this publication, but his views are supported with evidence from various experts, including Peter Singer, a military expert and author of the book “Wired for War”. Davies, as a journalist, gives an objective argument, citing data and opinions from many different sources as to the extent in which military drones will shape the future of warfare.

The goal of this research project is to answer the question “Should the United States government continue to invest in Unmanned Aerial Systems (military drones)” and to present the arguments for both sides in the form of a website. In order to decide if the U.S. should invest further in this technology, it is critical to know the extent UAVs are currently being used and how they will affect warfare in the future. The only reason to invest in anything is if there is an expected future benefit; therefore it is necessary to understand the projected costs and benefits drones will have in the future in comparison to the present. Davies provides these answers, and the limitations of the article are simply the lack of depth it provides on each benefit and cost it describes.


Jeremiah Gertler is a senior fellow at the Center for Strategic and International Studies in Washington, D.C., and he has compiled this Congressional report as a specialist in military aviation. This report may act as the primary source for the research project, as its purpose is to answer the main research question of United States government spending on unmanned aerial systems. The report provides a thorough background of the advantages of using UAVs for military
purposes, the various capabilities, the history of spending on drones in the past, and various congressional considerations. Quantitative as well as qualitative data is presented in an organized fashion on the funding, pace, management, development facilities, trade-offs, and effectiveness of military drone spending. The document even details the advantages and disadvantages of specific models of UAVs.

The limitation of the document is that it does not argue against or in support of further spending, but rather presents positive and negative implications. This may also be considered a strength of the source.


Caitlin H. Lee, a military aviation correspondent who has covered defense issues on Capitol Hill for Congressional Quarterly, suggests that the United States government “embrace” autonomy in military drones. The term “embrace” can be taken to mean financially support further advancements, and this answers the main research question of the project. However, she urges the Pentagon to avoid a totally independent bomber and ensure verification and validation procedures for highly autonomous drones. Essentially, Lee acknowledges the risks in heightened levels of autonomy in this technology, but believes that continued research would help solve these issues of risk.

Lee gives an impressive argument for further spending on these military drones, but her argument is still limited in the sense that she is a military strategist. Lee considers the risks of autonomy for the American people, but the journal article does not thoroughly consider the ethical issues.


There is always concern when technologies first emerge that their intended use will be altered by society, and this article explains that this will definitely be true for unmanned aerial vehicles; it is only a matter of time. The civil applications of the now “military” drones include geological surveys, crop spraying, border patrols, monitoring pollution, hurricanes, forest fires, and is limited purely by the imagination of engineers. Despite Richards’ argument that these applications will not be available for 3 or 4 years due to the numerous hurdles, it is still important to consider the implications of this technology in the hands of civilians. One perspective might be to view these other future applications as additional future benefit to government investing in advancing drone technology. On the other hand, policy makers and engineers may need to consider the risks of these technologies being used for commercial use. How will the public react to having drones monitoring their pollution quota? Who will have access to these machines? How will they be regulated? These concerns may make investing in this technology a poor political decision. This limitations of this piece are that these commercial uses have not yet been made available so the issues surrounding them are only speculative.

Noel Sharkey, a Professor of Artificial Intelligence and Robotics in the UK, has a full understanding of the technical capabilities of unmanned aerial vehicles, but her concern is that these capabilities will result in breaches of International Humanitarian Law. Sharkey's research paper is presented in this academic journal as an argument against further spending on military drones. A stark contrast between Sharkey and many other sources in support of this issue is that he is not an American. Sharkey explains that targeted killings are already occurring without much regulation, and the civilian casualties are far passing an acceptable percentage according to just war standards.

This article provides an argument against further government spending on military drones on an ethical basis, and it provides suggestions for controlling the future advancement of such technology. This direct link to the research project is particularly useful from such a well-known source.


This technological article explains in detail the capabilities (as of 2007) of unmanned aerial vehicles. Particularly, the article focuses on advancing soldiers' ability to pilot more than one aircraft at once from a remote control station. The sole purpose of this article is to describe the technological advancements and goals in regards to unmanned aerial vehicles. There is some consideration given to the effect of this change in warfare tactics on the soldiers controlling this technology, but otherwise, it is simply to describe the current military situation.

Philip Stevens is a military reporter and photographer who has focused on the development of unmanned aircraft in recent years. The perspective he provides is one of enthusiastic technology professional. The information and opinions of the soldiers interviewed by Stevens can be used as objective facts on the advancement of drones. The basic facts underlying this broader societal debate are important to the research as well because they provide a foundation on which to base the analysis of the more ethical and political arguments.


Bradley Strawser, a Ph.D. in Philosophy, presents his argument that the United States has an obligation to use UAVs in military application. The reasoning for his argument is admittedly solely on principal and ignores the technological concerns regarding uninhabited aerial vehicles. Strawser states that the United States military has a responsibility to protect its soldiers to the fullest extent as long as their mission is a “justified” act of war. In the situation where the mission is
unjust, the technology does not make the act more or less so, but simply protects the individual soldier. Therefore, Stawser reasons, UAVs are perfectly in accordance with just war theory.

The qualified Strawser provides a philosophical argument against each objection to the use of military drones. This article matches the goals of this research project because by arguing against the ethical objections to military drones, it eliminates the argument against further investment in UAVs, assuming one agrees with the responses Strawser provides. The limitation of this article is that it does not support its claims of the technical abilities of drones with quantitative data. It must be used solely on a philosophical basis.

Part 3: News Articles

Note: These sources were used as representations of this debate in the popular press. However, these sources were not used in conclusions or elsewhere for writing on the site because they cannot be considered scholarly resources. They were used for the News page on the website for readers to view recent updates according to popular media and press.


