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Technical Project Team Members
Will Ayscue
David Gibbs
Catherine Hanafin
Blake Mager
Brendan Schneider
Hope Wheeler

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature _Lauren Hancock_ Date 11/2/2020

Lauren Hancock

Advised by Professor Tsai-Hsuan Ku, Department of Engineering and Society

Introduction

Throughout history, weapons and warfare have become more and more advanced in order to make nations powerful and to protect themselves from others. These military advancements come in many forms, such as improved techniques and strategies, more powerful guns and missiles, attack aircraft and fighters, nuclear warfare, armory, and more. By constantly improving these things, defense and protection are better for the user, but at a cost to whomever it is used against. Scientists and engineers have been necessary and responsible for many of these technological military advancements and they are still in high demand to continue doing so. However, these engineers are ultimately creating something with the intention of harming others, which brings up an ethical dilemma. It has been previously thought that the purpose of an engineer is to benefit and improve society. Is engineering warfare hypocritical to this role? A technical project is being performed where this dilemma can be experienced firsthand. STS components and practices will be outlined and implored throughout this project, and hopefully will shed light onto this problem.

Technical Project Summary

As a fourth-year undergraduate aerospace engineering student at the University of Virginia, a capstone project was given to design a light attack aircraft with given mission requirements and specifications. An attack aircraft is a type of military aircraft that supports ground troops by conducting attacks from the air in the form of strafing. The concept of an attack aircraft was first introduced in World War I, and as air combat became more common, the planes needed modifications and improvements in order to endure enemy fire while still aiding ground troops. World War II was a turning point in the development of attack aircrafts as the demands of war and the rapid growth of improved technological warfare caused refinements to be made such as improved aerodynamics, weapon's accuracy, survivability, lightweight options, and new monoplane designs. Many of the characteristics of these aircrafts are still seen in modern attack aircraft today.

More specifically, a light attack aircraft is small and has a low weight compared to other attack aircraft. This size and weight allows for a lower cost and enhanced survivability. For the capstone project, the American Institute of Aeronautics and Astronautics (AIAA) released a Request for Proposal (RFP) for an austere field light attack aircraft. The author, along with 6 other teammates, will work throughout the school year to submit a final design proposal to the AIAA competition. This aircraft must include defense mechanisms such as armor and reduced noise, as well as 3000 pounds of weaponry including integrated guns, missiles, and bombs, and must have the ability to takeoff and land in austere environments. Additionally, the aircraft should have short and vertical takeoff and landing (STOL/VTOL) capabilities in order to clear a 50 foot obstacle in less than 4000 feet. There are two missions that this aircraft must be able to accomplish, each specifying different service ceilings and endurances at different stages of flight. Lastly, this attack aircraft must be lightweight in order to save on costs.

Ultimately, there is little control and input by the team members for how the attack weapons are used within the design. The RFP already includes 6 hard points that must be incorporated and it is not up to the team members to decide the type or complexity of the armament. The design choices that can be made by the team members include, but are not limited to, the size and shape of the aircraft, the weight, the thrust and power, the stealth and noise, the type of propulsion, and the wing and airfoil design. All of these components must be integrated, and the design choices that are made must be able to support the aircraft in an attack scenario.

There currently exists several light attack aircraft designs that are currently used for military purposes, such as the AT-6 Wolverine and the A-29 Super Tucano. These are currently being used in this project as a comparison, and the goal is to achieve a final design that can outperform previous examples such as these in terms of cost, efficiency, and mission requirements. Many steps have already been taken on working towards a final design such as initial configurations, design reviews, concept down-selects, trade studies, and more. By the end of the year, the completed design should be an outline for a fully functioning and capable light attack aircraft and will be submitted to the AIAA competition to be reviewed and judged against other submissions.

Prospectus Introduction

Many different components must be taken into account when designing any type of aircraft, including but not limited to weight, propulsion, fuel efficiency, aerodynamics, size, and cost. However, when specifically designing an attack aircraft, defensive mechanisms must be included as well as armament and weaponry. A question of ethics arises when designing something that causes harm: does the engineer's role in improving military technology benefit society regardless of the required means? It is thought that engineers should use their abilities to make life easier and to improve systems for the betterment of others. However, lives are being stripped away at the expense of these technological advancements. This isn't simply a question of whether or not the engineers are being ethical or not, it is also a question of how ethics are perceived differently by each party involved. Moving forward, it will be important to ask questions regarding how engineers view ethics and if they believe they should incorporate it into their work. This can also lead to several other questions about whether scientists and engineers should simply focus on the defensive side of military operations, that way their actions are protecting society without harming others. All of these considerations should be taken into account when creating something that could be detrimental to others, specifically in this case, when designing a light attack aircraft that could kill people. Certain design choices can affect this problem as well. A design choice such as increased safety and complexity can make it more difficult to implement attack measures. Throughout this semester, a course on engineering ethics is being taken alongside the progression of the capstone project, which will help stimulate the conflict of this ethical dilemma that is faced by many scientists and engineers everyday, and is now being faced personally while designing a light attack aircraft. Further investigation into this complex problem can provide insight to all sides of the argument and help understand how this large system impacts the way engineers view their ethics, as well as their role in society and in designing a light attack aircraft.

Literature Review

Before moving forward, it is important to provide evidence and highlight previous research studies and perspectives on this ethical dilemma. For engineers, and for everyone, ethics can be perceived differently based on personal views and even based on company policies. At many companies and organizations, there are codes of ethics and guidelines that employees have to follow. For engineers, the standard guidelines that are followed are laid out in the National Society of Professional Engineers (NSPE) Code of Ethics. According to the Code of Ethics, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct (National Society of Professional Engineers, 2019). Aside from these technical guidelines, researchers still believe that it can be taken further. Michael Davis, author of Ethical Issues in the Global Arms Industry, says that other than what is outlined according to the NSPE, ethics can be divided into three categories: morality, ethics, and moral theory. The latter refers to more of an attempt to understand morality as part of a reasonable undertaking (Davis, 2015). Engineers' actions and responses to their ethical dilemmas is entirely dependent on how they perceive that dilemma. Additionally, in a book titled Controlling Technology: Ethics and the Responsible Engineer, author Stephen Unger argues that it is the engineer's responsibility to develop and apply technology that is directed toward humane ends. The outcome of the use of the technology is entirely the fault of the engineer who created it (Unger, 1994). Although both Davis and Unger clearly indicate the importance of ethics in professions, especially in engineering, others believe that it is too heavily focused on. Some researchers believe that guidelines, like those laid out in the NSPE code of Ethics, should not be part of the profession. In an article titled There's No Such Thing as Engineering Ethics, author Coy Veach believes that we "have made the concept of ethical behavior so complex and confusing that we fail to act" (Veach, 2006). Furthermore, Veach says that specifically for engineering professions, ethics should not be necessary if it blinds them to their work at hand. Some researchers also say that engineers are not solely to blame for how society uses their tools and technology that they make. Engineers, along with their fellow citizens, are equally responsible (Florman, 1989). Florman continues in his publications to say that although engineers contribute to war by improving military weapons that cause harm, engineers do not control the result of those weapons. “Engineers do not make people war-like. People are not more aggressive with guns than they are with clubs.” (Florman, 1989). His argument concludes that regardless of the advanced weaponry and technology, the users have just as much power and responsibility over the result as the builders. Similarly, in his book, War and the Engineers: The Primacy of Politics Over Technology, author Keir Alexander Lieber says that although some technological advancements may cater to war and others to peace, the technology itself does not promote one over the other. Lieber believes that politics is the major contributor to harmful actions such as offensive aggression in war by acting as the decision-maker and the leader of the builders and user of the technology. Overall, “technology alone cannot influence war, but it is politics that play a much larger role… politics is the master, technology the servant.” (Lieber, 2008).

A real-life scenario of an engineering militaristic ethical dilemma was the Manhattan Project; the creation of the atomic bombs that killed thousands of civilians in Japan to end World War II. Many researchers use this as an example of how important ethics are for engineers, especially those working with military technology advancements, since many of the scientists involved in this project regretted it later due to ethical reasons. Robert Oppenheimer, a lead scientist in the Manhattan Project, came forward years later stating his disappointment and regret. In a research panel conducted by UC Berkeley, Professor Joonhong Ahn said that he believed Oppenheimer’s motivation was patriotism: he was simply doing what he could for the United States (Ahn, 2014). Instead of using a guideline of ethics, a moral conscience, or a previously understood implication of his work, Oppenheimer viewed his patriotism as an effective ethical means, only to regret it years later. Penny Gilmer, author of a research paper on the ethics of the Manhattan Project, says that one of the best ways to address this problem is to teach and understand it at a young age. She says that it is critical to teach students the social and ethical responsibilities of scientists and engineers so that in the future, they are more aware of the implications of their work (Gilmer, 2002). According to Gilmer’s beliefs, those scientists involved in the Manhattan Project would have been better prepared for their ethical dilemma if they had been taught those responsibilities previously.

Currently, there are systems in place that attempt to address this ethical dilemma like company codes of conduct, the previously mentioned NSPE Code of Ethics, and even federal laws. For example, the Arms Export Control Act, the International Traffic in Arms Regulations (ITAR), and the Arms Trade Treaty (Fichtelberg, 2006). All these regulations help control how the military technologies are implemented and shared, which should make engineers and scientists feel better about their involvement with weaponry. This brings up a relevant question posed by Aaron Fichtelberg in his report on Applying the Rules of Just War Theory to Engineers in the Arms Industry: since there are so many policies in place to protect others and to ensure that workers are holding up to moral standards, why do engineers still face this ethical dilemma? (Fichtelberg, 2006). In Samuel Florman’s book, The Civilized Engineer, he outlined a study that was conducted by the Institute of Electrical and Electronics Engineers. They gave a questionnaire to thousands of engineers, and 39% of respondents said they would prefer not to engage in work with defense technology (Florman, 1989). This proves that regardless of previous attempts at a solution, this problem requires further attention and more perspectives. Gayle Davis said it best in her paper on military engineering ethics: “there is not one solution to this problem, one attempt may be useful and important, but none by itself is likely to be adequate.” (Davis, 2008).

Throughout the research conducted, every researcher had their own opinion on what ethics is and how it should be applied to the engineering profession, which just further complicates the dilemma. This goes to show how complex this problem is, which is why it will be further reviewed and a study will be conducted in the future to gauge engineer’s views on ethics in their workplace. Most of the literature reviewed had a recurring theme of how engineering ethics applies to nuclear war, and most strayed away from simpler, more practical military technologies such as attack aircrafts, which is what this capstone and thesis will focus on.

STS Framework

In order to understand the ethical dilemma of an engineer’s role in national defense, the system must be analyzed from the beginning. The main system at play is the process of designing, implementing, and evaluating the effects of a military technology created by engineers, whose sole purpose is to do good for society. The builders of this system can be interpreted differently. In one way, it can be interpreted that the system builders are the engineers themselves who are the ones designing and creating the attack and defense technologies. However, upon further review and understanding, it can also be interpreted that the system builders are chaos and enemies of the United States who ultimately caused the system to be put in place. If it weren’t for those enemies who incite terror and threats, there would be no need or demand for new militaristic technologies. The system is ultimately embedded and affected by both the current demands of threats, and by the actual engineers who create the technologies for the system.

Politically, the system was constructed in order to be powerful. The United States desires to be portrayed as a national superpower and come out on top of other nations. In order to achieve this, the federal government awards the military with increased funding to ensure that no other country outperforms the US in terms of size and strength of both attack and defense systems. Socially, engineers and scientists are used in the armed forces to protect society. Part of an engineer’s role and place in society is to serve and make things or systems that benefit the majority of others.

The main force that prevents further development of military technologies is the government. Since the military is a direct branch of the federal government, everything must adhere to a national budget and must be approved. If funding gets cut or projects get canceled, technological advancements stop. Therefore, the engineer works directly under the government and the outcome of their work, or lack thereof, depends largely on the state of the nation's government, and also on the economy which affects the amount of funding provided. Furthermore, the government is dependent on the Commander-in-Chief, the President of the United States, who is in charge of the government, and is leveraged by society who votes and directly impacts this.

In a system, both human and non-human participants lend to the success or outcome. All participants in this network are connected: human and non-human, and those who act on the system and the object that undergoes the action. When creating a light attack aircraft for military purposes, the engineer designing and building it is a human actor and an actant is the aircraft itself that performs the action of flying, protecting the pilot, and attacking the enemy. One of the actions performed by the aircraft is using the weaponry incorporated into the design to harm others. Those weapons are also non-human actants recruited into the network that were put in place by the engineers and are used to attack the enemy. Although the weapons perform the action, is the user to blame for the detrimental outcome? There exists some sort of delegation process where the responsibility gets translated from the user on to the machine. Furthermore, the outcome of the system is dependent on the design choices that are made by the actors. Each design choice can either support or refute the offensive over the defensive. Therefore, the ethical problem at hand is heavily influenced by design choices and compromises made by the engineers. The choice that is seen as more ethical or unethical is a nonhuman participating actant within the network. The final outcome of protecting or harming others is not because of the engineer who created the attack aircraft, nor because of the plane and weapons performing the act; it is the interplay between all participating members including the government, media, military pilots, engineers, the objects used, and the design choices.

Attack aircrafts have been in combat for over a century now, but they did not necessitate vast improvements and manufacturing until World War II. Thus, the problem was born: countries across the globe needed to improve their military technology in order to compete in the war. New and improved designs of attack aircrafts began to transpire, with the integration and approval of society. People from their respective countries wanted to win the war and come out on top as the global superpower. Advancements on technology in weapons and defense was an effective means to achieve this. Therefore, society's interest was grabbed with the direction of this problem. Society can act as a support system by wanting what's best for their country. Unfortunately, that support can run out if there is not always a war to fight in. When in a peaceful state, there is nothing for society to root for, and they no longer share that common goal, resulting in a failed process of translation in the network. Without the initial problem and shared common goal of the actors and actants in the system, then the technology involved would not be where it is today. Attack aircrafts would not be as necessary and would not be prioritized without the involvement of all participants, and the ethical dilemma would not have to be discussed. In conclusion, when discussing the ethics of engineering weapons to cause harm, one cannot simply look at the engineer as the cause, but all other actors and actants must be considered equally responsible.

Research Method and Timeline

In order to fully investigate the problem at hand, qualitative research must be performed in the form of interviews and document analysis. The interviews that will be conducted include a variety of people who understand the impacts of militaristic technology advancements, specifically on attack aircrafts. Interviews allow in-depth questions to be asked with long in-depth responses. Some possible participants include engineers and mechanics who work with aircraft and with the military. They will be asked questions such as if they believe ethics has implications on their jobs, if they have ever experienced an ethical dilemma on the job, what they think about creating something that harms others, and more. Additionally, a journal will be kept throughout the progression of the capstone project that will keep notes on certain design choices, how those choices were made, and the effects of them.

It is predicted that this method of research will be conducted over winter break and at the start of the spring semester. It is important especially to have the interviews completed early on because a large part of the thesis will depend on the participants' responses. The interviews will provide insight to how real people view ethics in their jobs, which will further incite the arguments presented in the previously discussed research journals and articles. Hopefully, the interviews will be completed by March to give the author plenty of time to gather and organize the responses for the STS thesis, which will be completed in its entirety by May.

Conclusion

The research conducted and the frameworks considered in this prospectus have provided insight into this ethical dilemma and has served as a proper introduction to the problem at hand. Now that the problem is better understood, the author can move forward to address it and ultimately come up with a conclusion. It is unlikely that solutions will result from a problem as complex as this, but it is hoped that this thesis will give others insight into this dilemma that they may not have realized was even there, and that they will start to understand the role of an engineer and the implications of their actions. It is expected that people will have different ideas on the meaning of ethics and how it applies to designing an attack aircraft, which will result in a broad and open-ended conclusion that will hopefully provoke thought and conversation among those who read it.

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