AIAA Homeland Defense Interceptor Request for Proposal

Exploring the Ethical and Political Ramifications of Remotely and Autonomously Piloted Aircraft Systems in Warfare

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Sciences
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Aerospace Engineering

By
Agha Mohammad Ali

November 12, 2024

Technical Project Team Members: Will Couch, Eric Fryer, Savannah Hafer, Evan Hahn, Matthew Shin, Reid Smith, David Wiles, Nora Wilkerson

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.

ADVISORS

Caitlin D. Wiley, Department of Engineering and Society

Thomas Ward, Department of Mechanical and Aerospace Engineering

I. Introduction

"At a minimum, 134,000 civilians have been killed by war's violence since 2003 in Iraq." (Crawford, 2013, pg. 1) Of these casualties, an unknown number of deaths were a result of cold, impersonal drone warfare. In 2010 in Pakistan, where drone strikes were exclusively used in the fight against the Taliban, there was a nearly 20% civilian casualty rate during strikes (Udeanu et al., 2016). There is an obvious problem here; modern warfare sees far too many civilian casualties. Even with the latest advancements in tracking, targeting, and "killing" technologies, civilian casualty is an unfortunate and prevalent inevitability. My research paper aims to explore the causes and effects of this problem, specifically in the context of America's newest and preferred warfare technology, Remotely and Autonomously Piloted Aircraft (RAPV). In the technical portion of this paper, an emphasis is placed on the shortcomings of current technologies and methodologies in RAPV systems and how they might be improved to develop a more efficient and accurate machine. For the STS topic, I'll look at the disparaging technological differences in modern-day warfare, how they produce civilian casualties, and their resulting impact on civilian populations. In researching both topics, the hope is to develop a better understanding of the capabilities and consequences of RAPV technology. Perhaps with this newfound understanding, better, more ethical steps can be taken in future implementations and iterations of RAPV technology to minimize the issue of civilian casualties in modern warfare.

II. Technical Topic

The United States government plans to retire at least 250 aircraft from its fleet within the next year. This trend is expected to continue throughout the decade as its Air Force looks to free up space and budget in their aircraft programs for newer, more advanced aircraft (Gordon, 2024). The United States aims to replace a large chunk of these retired aircraft with next-gen RAPVs meant to fulfill some of the roles fighter jets historically occupy. However, there is an

overarching problem in that RAPV technologies are limited in their scope of defense applications, cost requirements, and effectiveness in combat situations. In other words, they're expensive and have never been used for defensive or combative purposes. For this reason, the American Institute of Aeronautics and Astronautics (AIAA) has presented a Request for Proposal to develop a highly effective, highly cost-efficient next-gen RAPV Defense Interceptor aircraft. I, along with a team of 8 fellow aerospace engineers, have accepted this call to action, looking to develop the blueprints for an RAPV capable of fulfilling a range of defense applications, while being produced at a mass scale for relatively cheap.

With recent technological innovations, tackling this problem of limitations in RAPV technologies is becoming a reality. "The continued trend of increasingly miniaturized components promises an era of tailored systems for on-demand remote sensing at extraordinary levels of sensor precision and navigational accuracy." (Watts et al., 2012, pg. 1688) These advancements, along with general advancements in aerospace, such as materials processing, manufacturing, and testing, make the development of an accurate and reliable RAPV defense interceptor possible. However, a production-scale supersonic RAPV has yet to be established, so meeting the specifications of a hypersonic combat production aircraft will be an exciting and novel hurdle to cross in the design process. Furthermore, there is a major concern about affordability. As Hobbs mentions in his chapter, promising technologies are being developed, but there is no clear indicator of whether or not these technologies will be produced or implemented in an even remotely affordable manner (Hobbs, 2017). Therefore, it will be a major responsibility of our team to develop this aircraft with affordability in mind, focusing less on developing novel technologies and rather on methods to employ them strategically at a significantly lower cost.

Finally, in designing our aircraft exclusively for defense, we hope to avoid adding to the overarching problem of civilian casualties in warfare.

A host of modeling and computation tools will be used while creating this cheap, novel, and effective aircraft. These include programs such as the ANSYS analytical suite, Solidworks, and OpenVSP, which complete tasks such as 3D modeling, structural stress testing, and aerodynamic computations. Furthermore, research on historical precedents in defense interceptors and fighter jet aircraft, like the F-14 Tomcat or F-35 Lightning, will be a major source of inspiration and guidance in design development. Finally, an emphasis will be placed on utilizing government-developed and furnished technologies to aid in minimizing cost and complexity in design. With these tools and methods, my team and I will develop a working theoretical framework for a next-gen defense interceptor RAPV. Its effectiveness will be judged and determined by the AIAA through a series of real-world mission simulations. In creating this aircraft, we hope to lead the charge in developing accurate, efficient, cost-effective aircraft for the future in homeland defense.

III. STS Topic

Currently, RAPVs are utilized as offensive weapons almost exclusively by the United States and are a greatly debated topic. On the one hand, this technology has been effective in targeting and killing government-recognized terrorists overseas. On the other hand, numerous civilian casualties have come with these campaigns, and even more injuries to boot. Moral and ethical considerations must be made before a precedent in deployment and policy is set and future implementation occurs. “The spread of drones cannot be stopped, but the United States can still influence how they are used. The coming proliferation means that Washington needs to set forth a clear policy now on extrajudicial and extraterritorial killings of terrorists—and stick to

it." (Byman, 2013, pg 41) By questioning the current usage of drone technology, I am striking at the core problem of unethical warfare and asking whether or not current RAPV usage adds to this problem, and how we can prevent it from doing so.

To explore this problem of unethical warfare, however, the framework of ethical warfare must first be defined. For the purposes of my paper, we'll look at RAPV technology in the context of the Just War Theory of "Jus in Bello", meaning "Law in War" in Latin. For context, Just War Theory is a centuries-old philosophical conversation around the topic of ethical warfare, had by great thinkers like Aristotle, Plato, and Socrates, to name a few. Jus in Bello is just one of its two tenets, which focuses on the morality of actions done by parties in warfare. It has played key roles in major ethical trials such as the Nuremberg Trials of 1946 and the war crimes court in Hague, in 1998 (Freiberger, 2013). Throughout this portion of the research paper, arguments will be tied back to this framework to help ground the conversation of whether RAPVs are ethical and how they might be implemented more ethically. All evidence for arguments will come from historical artifacts, both in defense interceptor aircraft and RAPV usage in the Middle East, Yemen, and Pakistan.

There are 2 general ideas I plan to investigate in this STS Topic. First, I'll examine the consequences for civilian populations and the potential precipitate casualties of drone warfare. Beyond the obvious civilian deaths caused by RAPVs, there is an intricate web of socio-political systems being changed and affected by the usage of this novel technology. An excellent example of this is the failed New York Times headquarters bombing incident in New York in 2009. The attempted bomber was a Pakistani Muslim quoted to be motivated by the drone Strikes in Pakistan at the time (Boyle, 2013). This is an extreme example of a US citizen taking up arms due to the strikes, but consider how many more Pakistani or Yemeni citizens were emboldened to

take up arms in their countries and subsequently became or caused more casualties of war. How does this idea of pushing civilian populations into further bloodshed relate to Jus in Bello? Moreover, the current usage of RAPV technologies requires the "instrumentalization of the populations amongst whom wars are fought" (Holmqvist, 2013, pg 541), further entangling civilians in wartime efforts and campaigns. Second, an idea I find most interesting to explore is the historically aggressive transformation of war technologies into killing machines. One need not look much further than the F-14 Tomcat, which was initially designed to be a defense interceptor aircraft, like ours, but became a leading killer in the Iraq War (Holmes, 2012). There's a question to ask about the ethicality of developing a drone fighter jet that far surpasses any enemy combatant's abilities, essentially widening the gap in warfare technology without "just cause", and I plan to dissect it.

A common throughline in all 3 ideas is the difficulty in finding accurate data. "The public is routinely assured that a high percentage of those extrajudicially killed are militants, but victims are often unnamed and deaths rarely investigated." (Hudson et al., 2011, pg 122) Tracking the number of civilians killed or injured is neigh impossible with the current levels of information and transparency around the topic. Despite this, a conscious and focused effort will be made to find the overarching trends in usage and deaths despite lacking consistent and reliable data. This will be achieved by referencing multiple reputable journals and articles exploring any of the three aforementioned ideas from multiple perspectives and backgrounds. In doing so, I may hopefully establish an argument for the current ethicality of RAPV and how it may be improved.

IV. Conclusion

Tackling the problem of excessive civilian deaths in warfare is a large and daunting endeavor. Collateral in war is as old as war itself, but that does not mean it should be a standard. By focusing on the impact and development of new wartime technology, specifically RAPVs, I hope to chip away at one area of warfare where excessive civilian casualties are observed. By the end of this Capstone Research Paper's development, two main goals should be achieved. First, the design and potential production of an efficient, affordable defense interceptor RAPV meant to bolster the United States' air defense fleet and capabilities, protecting American civilians while avoiding any contact with enemy civilians. Second, the understanding of the impacts and fallout of implementing RAPV technologies in warfare on affected civilian populations. By exploring both topics, a holistic viewpoint of the issue from the developers of this technology and those affected by it can be established. In doing so, the goal is to gain a better understanding of all interested and affected parties, and hopefully to produce a solution to further implement RAPV technologies while reducing, if not eliminating, civilian casualties caused by it.

V. References

Byman, Daniel. (2013). Why drones work: the case for Washington's weapon of choice. *Foreign Affairs, 92(4),* 32-43.

Boyle, M. J. (2013). The costs and consequences of drone warfare. *International Affairs*, *89*(1), 1–29. https://doi.org/10.1111/1468-2346.12002

Crawford, N. C. (2013). Civilian death and injury in the Iraq war, 2003-2013. *Cost of War*.

Freiberger, E. (2013). Just war theory and the ethics of drone warfare. *E-International Relations*, 1-7.

Gordon, C. (2024, March 11). Air Force plans to divest 250 aircraft in 2025, shrinking fleet to new low. *Air & Space Forces Magazine*. Retrieved 2024, from https://www.airandspaceforces.com/air-force-divest-fleet-2025/.

Hobbs, A. (2017). Remotely Piloted Aircraft. In *Handbook of Human Factors in Air Transportation Systems.* (1st ed., pp. 379-395). CRC Press.

Holmes, T. (2012). *US Navy F-14 Tomcat units of operation Iraqi freedom* (Vol. 52). Bloomsbury Publishing.

Holmqvist, C. (2013). Undoing War: War Ontologies and the Materiality of Drone Warfare. Millennium, 41(3), 535-552. https://doi.org/10.1177/0305829813483350

Hudson, L., Owens, C. S., & Flannes, M. (2011). Drone Warfare: Blowback from the New American Way of War. *Middle East Policy*, *18*(3), 122–132 https://doi.org/10.1111/mepo.2011.18.issue-3

Mégret, F. (2013). The humanitarian problem with drones. *Utah L. Rev.*, 1283 - 1320.

Udeanu, G., Dobrescu, A., & Oltean, M. (2016). Unmanned aerial vehicle in military operations. *SCIENTIFIC RESEARCH AND EDUCATION IN THE AIR FORCE*, *18*(1), 199–206. https://doi.org/10.19062/2247-3173.2016.18.1.26

Watts, Adam C., Vincent G. Ambrosia, and Everette A. Hinkley. 2012. "Unmanned Aircraft Systems in Remote Sensing and Scientific Research: Classification and Considerations of Use" *Remote Sensing* 4, no. 6: 1671-1692. https://doi.org/10.3390/rs4061671