7-1 Project Submission

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One of the many unfortunate consequences of the War in Ukraine has been the demonstration of the effectiveness of low-cost, low-flying, single-strike drones in modern warfare. The cost-effective nature of these strike craft, combined with other benefits, has the potential to reshape the modern battlefield, and alter the asymmetric power capabilities of national and non-national actors.

Although the impact of drones on the War in Ukraine has been noteworthy, they are far from the only factor contributing to, or sparking hostilities. The Ukraine war has many attributable causes, some of which are likely yet to be determined or highlighted. However, many agree that some of the major contributing causes were the 2014 Maidan uprising in which the pro-Russian Ukrainian government was ousted, a lack of serious reprisal for Russia in response to the 2014 annexation of the Crimean Peninsula, and Vladimir Putin's desire for a reunification of prior Soviet states and unity amongst the ethnically Russian people (Nye, 2022).

Ultimately, the causes of the war are numerous and under continuing debate. What is clear, however, is that through the conflict, modern drone tactics and technology have been battle-tested and undergone iteration. These weapons are here to stay, and their long-reaching effects on the conflict are still being observed. Although drones and UAVs had humble beginnings, they are quickly revolutionizing the way asymmetric warfare is being fought, representing a low-cost and effective means to strike the enemy without risking a skilled pilot and more easily avoiding detection.

As an example to this effectiveness, on March 12, 2024, Ukraine was able to conduct a successful strike on three Russian oil refineries over 600 miles into Russian territory, beyond the city of Moscow (Picheta, 2024). The successful attack deep in the heart of enemy territory while [Ukraine was] on the backfoot and without air-superiority represents a fundamental shift in wartime capability. Prior to the advent of drones, and without the aid of expensive precision-guided ballistic missiles, this would have been impossible, illustrating the strategic value for asymmetric and guerilla warfare. To further illustrate the effectiveness of this technology, we can look to the Iranian-produced, Russian-purchased Shahed-136. This kamikaze strike drone measures in at 3.5 meters long with a 2.5 meter wingspan, flies at a little over 185 kilometers per hour, has a range as high as 2,000 kilometers, and contains a warhead payload of 30 to 50 kilograms (Wikimedia Foundation, 2024). When compared to an older generation strike craft like the F-16, 600 Shaed-136 could be produced in its place (Hayward, 2023). Additionally, these lowflying, and rather small aircraft have a small cross signature, and thus do not appear easily on radar. The advancing capability of drone strike craft, in the air, on the ground, or in the water, represents a revolutionary technology that is bringing about a fundamental shift in wartime capability.

When contrasting the relative effect of the usage of drones in war, versus public perception, there is a stark disconnect. As the Ukraine conflict is ongoing, there has yet to be much scientific analysis as to the effect drones have played on the two nations. However, we can

look to established evidence in the similar and widespread use of drones by the United States in its war on terror.

The joint report 'Living Under Drones' highlights how the use of UAV in the United States War on Terror terrorized much of the rural population in Pakistan (Woods, 2012). The report claims that the constant presence of American UAVs in the skies above them led to a deeply stressed population, where many have anticipatory anxiety, or the fear they will be attacked constantly. Interviewees report often experiencing emotional breakdowns, running indoors or hiding when drones appear, fainting, suffering nightmares, hyperalertness and hyper-startle behavior, irritability, loss of appetite, and more (Woods, 2012). Compared with the perception by the American public that drones are the 'most legitimate' form of intervention, we see a stark divide (Hanchett, 2022). Lastly, as mentioned in Amber Case's presentation on the use of technology in 'We Are All Androids', the use of technology allows us to create wormholes between our minds, and extend our mental being (Case, 2011). Unfortunately, in this instance, that interaction is violent in nature, and that disconnect has proven detrimental for the mental health of drone pilots. A variety of studies conducted on drone crews have consistently proven a higher incidence of adverse psychiatric symptoms when compared to their manned aircraft counterparts (Saini et al, 2021). Before the widespread adoption of these technologies is complete, it is important to determine the effect it will have on us as individuals and as a society.

In furtherance, the proliferation of cheap and effective drones has led many to fear the introduction of a state of constant war, at least in the United States. One of the major important questions raised by the increased availability and efficacy of drone capability is whether it dilutes the traditional legal barriers or constraints to the use of military force (Corn, 2017). The United States regularly carries out drone strikes on foreign nations' sovereign territory without a declaration of war, and this is considered somehow different from a piloted jet, or boots-on-the-ground invasion to accomplish the same objective. As such, the Commander in Chief, and powers that be, no longer need to strictly adhere to the constraints imposed upon them in regards to wartime activity. This erosion of the traditional limits of war powers could potentially lead to a state of forever-conflict, where war is never declared, but constantly waged, if not addressed.

Throughout this analysis essay, I will be employing the social science lens to analyze this conflict (SNHU, n.d.). The choice to utilize this lens was a rather easy one, as it is by far the most relevant to the topic of UAV use in the Ukraine war, and best encompasses the method by which I would like to analyze it. As discussed throughout this paper, the topic of the use of drones in the Ukraine war can be critically analyzed from any aspect of this lens. The psychological effects on drone operators as well as those involved on the receiving end of drone attacks could support an entire paper to itself. Likewise, the economic efficiency and increase in power-scaling gained through the use of low-cost strike drones could be explored thoroughly. Finally, the degradation of limits to war powers is a critical issue not just unique to the United States.

Ultimately the social science lenses offer a plethora of intricate and interesting subject matter that will need to be explored before the widespread proliferation of drones has any more impact on the modern battlefield. As we have begun to explore, the advent of low-cost, low-flying strike drones represents a fundamental shift in the modern battlefield with widespread implications regarding the prosperity, security, and balance of power for both individuals and nations alike.

The advent of low-cost kamikaze drones has had a great impact on the war in Ukraine, as well as the institutions waging the war. As touched upon previously, this impact will soon, or is already, spreading its influence beyond the confines of the war. Due to the long-term and long-time use of drones by the United States in its war on terror, we can begin to picture what specific impacts the revolution of low-cost kamikaze drones will have on institutions around the globe. This section will attempt to utilize the social science lens to analyze the impact and implications of drones in war for institutions around the globe.

The first major implication of these low-cost kamikaze drones is the relative cost-effectiveness associated, and the power projection this now allows for. This new capability to cheaply mass produce drone strike-craft has allowed for a tactic-defining wartime occurrence. Ukraine, which due to the annexation of Crimea in 2014, had essentially no Navy at the onset of the war, has operated with no vessels for the majority of the war, and has still managed to sink roughly a third of the Russian Black Sea Fleet. This represents the first time in history in which a power with no navy has inflicted substantial naval losses on an adversary and instituted contested waters without a single naval vessel. In total, reported figures put the losses at roughly 21 warships and one submarine destroyed by Ukraine to this point in the war. Noteworthy Russian naval losses include the Kunikov, Saratov, Gornyak, Minsk, Novocherkassk, and Kunikov landing ships, the Moskva cruiser class, and the Rostov-on-Don kilo class sub (Eckel, 2024). Ukraine accomplished this feat with the use of innovative aquatic drones that are essentially boat hulls equipped with radio operation controls, packed with a large amount of ordinance, welded shut, and piloted toward the enemy. It is estimated that a single aquatic drone costs Ukraine around $200,000 USD to acquire or manufacture (Cheetham, 2023). Meanwhile, the loss of an asset like the Moskva represents a loss upwards of 700 million USD; such an extreme sum that, in this time or war, it has been cast into doubt whether Russia can currently afford to replace it (Landen, 2022). This astronomical material imbalance illustrates how, with the advent of these drones, smaller nations or militant groups can now project power well beyond what was previously possible economically or strategically.

Another major implication of the proliferation of drone warfare and the increase of power projection in asymmetric warfare is the perpetuation of a state of total conflict. As mentioned previously, the United States regularly carries out drone strikes on foreign nations' sovereign territory without a declaration of war. The fear is that the degree by which drone warfare shortens the 'kill-chain' will dilute the traditional legal barriers or constraints to the use of military force (Corn, 2017). This can be seen happening right now, with the joint air campaign

by the US and UK in Yemen, conducting more than 36 strikes in a single day during February of this year (2024) (Copp et al, 2024). Meanwhile, war has not been declared. Although most people do not object to the retaliation of the killing of three American servicemembers, it illustrates the degradation of wartime powers and how, as a nation, the U.S. is almost always engaged in conflict in some way, shape, or form. The rapid expansion in the ability for small actors to wage war effectively, combined with the degradation of wartime powers, casts serious concerns regarding the usage of drones in war.

Thankfully the effect drones have had on our societies and culture is not purely limited to war, and similarly, not every use case for drones, including drones at war, involves committing violence upon another. Drones have seen equal proliferation and impact in the field of medicine and healthcare. As an example of this capability, the UPS Foundation, Zipline, and Gavi recently formed a partnership to deliver blood and vaccines to rural areas in Rwanda (Tucker, 2017). This partnership will revolutionize the speed at which care can be delivered to remote areas in Rwanda, with minimal infrastructure requirements. The team gives the example that "If a child in Rwanda is bitten by a rabid animal, for example, instead of waiting hours to get the necessary vaccine, a UAS can deliver it in about 15 minutes" (Tucker, 2017). By utilizing cost effective solutions like drones to deliver medicine, additional funding can be diverted from transportation to other areas of challenge, like expanded regulatory and social program funding to provide access to more essential medicines and care. When considering domestic rural communities, much research is centered around applying drones in conjunction with telehealth appointments to provide rural patients convenient and easy access to care. With the capability for patients and providers to meet virtually, bolstered by a drone's unmanned delivery capability, much of the barrier to access for domestic rural patients will be mitigated (Tucker, 2017). With the intervention of drones in medicinal delivery, no longer will the burden of healthcare unproportionately fall on rural patients, bolstering incentive and then health outcomes. All of this technology can be, and is being, similarly applied in the Ukraine war to transport much needed medical or wartime supplies across the front lines.

Drones represent a revolutionary method of transportation that is cheap and effective, can be applied both internationally and domestically, and requires very little infrastructure to utilize effectively. In addition to expanding the capability of our species in war, drones can be used to mend health disparity and improve health outcomes, illuminating an interesting perspective and contrast based on the use-case of the technology.

Although UAVs have demonstrated revolutionary capability, the technology is still in its relative infancy, and contains some major tactical and logistic limitations. One major limitation of current drone technology, especially in the use of war, is the lack of true autonomy. All of these drones are still tethered to a human pilot, and require human intervention to operate properly. Many of the military and commercial drones in use can autonomously perform certain tasks, like takeoff and landing, and some have collision-avoidance built-in, but they are far from a true autonomous drone-swarm independent of human intervention. The somewhat terrifying

reality of true autonomous drones may not be a science fiction concept for long, however, as the Pentagon and The Armed Force are already working on this capability. The Navy brought swarms of autonomous air and sea drones to the 2024 Unitas exercise, which were able to automatically coordinate enemy positions between one another and the human operated vessel; this capability, only in its infancy, allowed for a much faster target acquisition and destruction time, demonstrating a small portion of the effectiveness autonomous drones can have (Tucker, 2024). The future of warfare is currently on uncertain ground. Will drones represent a fundamental shift in war strategy, or merely be another marked leap in effectiveness in lethality, like the machine gun? Regardless of the impact, there are multitude ethical and social factors we, as a global community, need to consider before we find ourselves inside of the terrifying reality of autonomous drone swarms.

When considering how to solve the previously stated limitation on UAV technology, the first suggestion or ponderance I would recommend when addressing this topic would be, should we? By this I am referring to the many ethical, moral, and legal quandaries that arise from a fully autonomous drone swarm being used in war. Who decides when it is appropriate for the system to take a life? The programmer, clearly, but how does one ensure they did this correctly, and can you really ever be fully confident? New technology always has errors, except these errors would certainly involve the death of human beings. Additionally, there are many legal considerations in regard to autonomous drone swarms. In an analysis published in 2018 of the usage of autonomous maritime and aerial systems, Johansson illustrates that maritime autonomous systems are unmanned, and so obviously lack a crew or commanding officer, and thus cannot be considered a warship under the eyes of the law (Johansson, 2018). This is just one of the many examples of how truly autonomous swarms can, and likely will, be an ethical and legal nightmare.

In terms of actual solutions to drone independence, I do not have the technical expertise to solve the problem of truly autonomous drone swarms nor is it within the scope of this paper. However, the minds within the U.S. Armed Forces are already fast at work on this issue. The U.S. Air Force has been in development and testing of its "loyal wingman" autonomous craft that will accompany manned pilots as wingment (Col G. Lage Dyndal, 2017). Another example comes in the recently tested PERDIX nano drones system, where 100 drones were dropped from an F-18 'mother aircraft' and observed to operate with a high degree of autonomy (Col G. Lage Dyndal, 2017). Ultimately the U.S. Armed Forces have had a long and colored history with drone use; it is no surprise that they are on the forefront of new technologies and are striving for truly autonomous drones and the ridiculous subsequent power projection capabilities.

When seriously considering such systems as fully autonomous drones in reality, we must understand the asymmetric perspective of the technology this can create, especially when engaging in analysis of the topic. One of the first major factors that would impact how individuals understand the role of drones in the Ukraine war, for example, is if they were directly

a part of the war or not. Although this is rather obvious, it would have an immense impact on someone's outlook toward the relevant technology, especially when compared with someone like me, for example, analyzing the event from different perspectives, with stakes much less visceral. We can see evidence to this in the prior exploration of the psychological impact drone usage has demonstrated on those being attacked. Conversly, a variety of studies conducted on drone crews have consistently proven a higher incidence of adverse psychiatric symptoms when compared to their manned aircraft counterparts (Saini et al, 2021). Ultimately, lived experience with the technology will have a drastic effect on one's perspective of it, and cannot be ignored when analyzing the event.

Another major perspective that will affect an individual's outlook on the technology would be if they think UAV use in war is ethical, or if war is ethical to begin with. This point is not to attempt to disparage anyone who feels this way, but rather to illustrate the fact that having a certain outlook on war or UAVs and their ethical use will color one's opinion. Discussing the usage of a revolutionary technology like drones in a scenario like war is not easy. The amazing capability has many applications beyond the scope of the war, but it would be foolish to ignore the impact that the technology has had on the event, and likewise foolish to ignore the impact this has had on us as individuals, regardless of and including multiple perspectives. UAVs revolutionary capability represents an existential capability that needs to be discussed, from a variety of different angles, to ensure the path we are going down aligns with who and what we are as a society.

As we have seen through the complexity offered by such a topic as UAV in war, there are many challenges in critically analyzing anything, including technology in society. There are many perspectives and outlooks individuals can have on the usage of drones and UAVs in war, and this will color the perspective with which they approach the topic. One of the greatest challenges to critically analyzing is remaining as impartial as possible, while also being aware of the bias one does possess. Especially with charged topics like war, it can be hard to maintain a professional and poised demeanor, but is essential for thorough and impartial analysis. Although critical analysis of technology in society can be difficult, there are many advantages to engaging in the practice. By understanding the way in which technology helps to shape and drive us and our society, one can better contextualize the society in which they live, as well as their place within it.

In terms of my specific profession, this practice can better allow me to understand why certain technologies are successful and relied upon, what they provide their users that they need, and how I could potentially replicate this in my work going forward. Critical analysis is an important aspect to contextualization and should be exercised regularly to maintain a present and relevant understanding. Rather obviously the most important aspect to critical analysis is to remain critical. It is all too easy to allow one's biases and perspectives to color their outlook and analysis of a topic, and as such, it is essential to remain cognisant of our own thoughts and contrast with those of others. By being aware of this fact, one can ensure they provide the most

impartial and thorough analysis possible, considerate of multiple perspectives. Once this has been achieved, critical analysis, as mentioned earlier, can provide invaluable context about a situation or field. As an example, if I were to try and make a video game, critical analysis of what has been successful, and why, would be an essential aspect to a successful development. By providing invaluable context, critical analysis can help steer an individual towards their goal in an efficient and wholesome manner.

Ultimately practicing critical analysis is an important part to distinguishing oneself as a cognisant and thoughtful individual who has the peace of mind and foresight to make careful considerations before taking action.

Returning to the topic at hand, specifically, critically analyzing the usage of UAV in the Ukraine war has offered a surprising amount of insight and perspective across many lenses of study, some of which I did not anticipate. With an issue as contentious as a war, and the evolution of a technology throughout that war (which implies increased effectiveness at killing), there are a few obvious avenues of exploration when analyzing the topic, including the psychological and societal impact faced by each side from the perspective of attacker and attackee, as well as the effect this will have on institutions responsible for waging war globally. However, I did not expect the 'well' to 'run so deep', as it were, with the implications of UAVs' evolution throughout the war being far more nuanced and expansive than previously anticipated.

A good example of this can be seen in the previous discussion of the degradation of traditional limits on wartime powers seen with UAV usage in the United States war on terror, and how the public's perception furthers this degradation. When initially delving into the topic, I could not have anticipated such a complicated and important consideration of the technology. To further this point, prior to the advent of the war, it had been inconceivable for a non-state power or a state power with no naval capacity to enact a naval blockade. This revolution in capability has caused many to wonder if the hulking and vastly expensive warships are a relic of the past. Similarly, the demonstrated effectiveness of this technology has influenced leading institutions, such as the U.S. Armed Forces, to zealously invest in truly autonomous drone swarms. Although this has been a staple of science fiction for decades, prior to my foray into this research, I had figured development of this technology was decades out from completion. Instead, active prototypes are being tested by the Navy. In combination with the degradation of wartime powers already observed in usage of UAV, this capability brings about a frightening possibility of a dangerous and Orwellian future. All of this is to say that, much like life in general, the topic of UAVs in the Ukraine war is much more nuanced and complicated than at first glance, with unforeseeable insights lying within analysis. This exploration of the topic serves as an important reminder to myself to not rest on my first assumption, and to actively push myself to consider any topic from multiple avenues of consideration and perspectives. This ability enforces thoughtfulness and attention to detail, important aspects to a wholesome and worldly framework of perception.

Similar to the surprising depth of consideration found in a topic like UAV use in war, a topic like this can provide substantial practice recognizing, examining, and understanding bias. Examining bias, especially within technology and the usage of it, has had a marked impact on how I personally view and engage with technology. Specifically, as someone pursuing a degree in computer science, and the increasing relevance of the field overall, it is extremely important to not only be aware of the personal biases I hold, but also of the biases present within the area, culture, society, nation, and species I belong to. This concept was made overtly apparent when analyzing how training materials can have very real impacts on the AI systems trained on them. An example of an incident where poor analysis of bias in training materials occurred when Amazon attempted to deploy an AI resume-screening tool to perform a first-pass at resumes. Unfortunately, the data this system had been trained on had largely been resumes submitted by men (Heilweil, 2020). This had the unintended effect of teaching the system to discriminate against women, to the extent that the system learned to consider and judge proxy factors, such as an individual attending an all women's college. Obviously this was not intended, but it serves to highlight how, left unchecked, our biases can have a marked impact on the performance of intelligent systems, including ourselves.

In an era where technology plays an increasingly integral role in business and everyday life, the imperative to address bias in technology and AI systems remains steadfast. The principles discussed previously provide a solid foundation to understanding why mitigating bias present in technological systems is so important. It is paramount to instill ethical considerations from the inception of development and to rigorously scrutinize the data used to create systems, ensuring it remains free from bias. Therefore, through the analysis of the role of technology in society, it is apparent that the onus lies with us, the developers, to ensure systems are created with thoughtfulness, care, and fulfill a need or expectation of the public. These systems, if mishandled, have the potential to inflict tangible harm, substantial damage, and significant injustice. Thus, it is our responsibility to garner the knowledge and dedication necessary through analysis to prevent the ramifications that can result from instilling bias in intelligent systems. This becomes increasingly relevant when applied to the potential autonomous drone swarms of the future.

Part of the process of garnering said knowledge involves utilizing the various educational lenses to analyze the same topic, which can offer unique insights and alternate perspectives. This not only informs a more wholesome understanding of the topic, but also provides invaluable context to provide validity and evidence to an opinion or argument. I primarily focused on the social sciences lens for the majority of my work, purposefully analyzing the societal, cultural, and individual changes as a result of the technology (SNHU, 2024). However, I could have easily approached this topic from a humanities or historical perspective. Using the example of history, I could have taken the angle of analyzing the historic effectiveness of UAVs in war, and how only recently they have shown remarkable adoption and widespread use, as well as why this is. This would allow me to paint the perspective of the shifting focus, effectiveness, and threat

posed by the technology compared to UAVs' surprisingly long history. Although this angle would be less obvious in its focus on individuals, analyzing the changing impact, investment into, and adoption of the technology throughout history for the use of war could provide invaluable understanding into the current climate, and where we, as people, may take the technology in the future. Utilizing alternate lenses is important to develop a more informed opinion and provide stronger evidence and validity for an argument.

As the benefits of analyzing a topic from multiple perspectives are vast, I will focus on three main boons associated with analysis that will better inform interactions with those of different opinions. The necessity for analysis in bolstering an opinion or argument, the necessity of perspective for empathy, and the necessity of informing oneself to promote behavioral change or action.

It is not unreasonable to say that this subject is rather charged, and there are myriad perspectives by which to approach the topic and thus myriad opinions a single person can hold regarding the event. As this is the case, exploring the issue not through a single perspective, but multiple, while comparing and contrasting with similar events throughout history, provided me the ability to much better inform myself of the nuances of the event, and the history leading to the widespread adoption of UAVs in the Ukraine war. These nuances and understanding allowed me to find and utilize primary and secondary sources to support my argument. Although it is rather obvious, analysis, in this case analyzing the role of UAVs in the Ukraine war, provided me with the validity to make my argument and disseminate my opinion via written work. Often, papers and publications are not written for those that agree with the study or findings already, but rather to be peer-reviewed by dissenters and proven right or wrong. As such, analysis is necessary to bolster one's opinion in written works, and better allows for the 'communication' of their opinion to others through their work.

The second benefit in facilitating interactions of those of a different opinion seen in analysis of the technology is the benefit that knowledge brings in empathy. While it is by no means impossible to empathize with people while not having specific information about their situation, this can take the form of more theoretical empathy. When provided with specifics of an individual, their story, and how it affected them, we as individuals can better relate and empathize. Through my analysis of this topic, I encountered studies and tales describing the psychological impact of drone usage on the operator, and those living 'underneath' them, so to speak. As we saw in the joint report 'Living Under Drones', the constant presence of American UAVs in the skies above rural Pakistan led to a deeply stressed population, interviewees reported often experiencing emotional breakdowns, running indoors or hiding when drones appear, fainting, suffering nightmares, hyperalertness and hyper-startle behavior, irritability, loss of appetite, and more (Woods, 2012). Similarly, a variety of studies conducted on drone crews have consistently proven a higher incidence of adverse psychiatric symptoms when compared to their manned aircraft counterparts (Saini et al, 2021). These specific examples provided me with real, contextual information on people's lives and how they were affected by the technology. This type

of individual exposure is most relatable in terms of empathizing, illustrating the power that informing oneself can have on empathizing with differing sides of a charged topic like armed conflict. This empathy generated will go a long way in relating, understanding, and further studying UAVs in war, for instance, and will better inform one on communicating the complexities of the event as well as the role the technology plays in this.

Lastly, in conjunction with the prior two benefits of analysis, analysis is an important key in promoting individual behavior change. The accepted paradigm of behavioral change follows precontemplation, or lack of acknowledgement, contemplation, or active acknowledgement, preparation/determination, action/willpower, and maintenance (Loma Linda University, 2024). Analysis and the information it provides is essential in the first three steps of change, and as an example, during my study of this topic I came across a very interesting paper on the degradation of traditional wartime powers seen with the usage of drones (Corn, 2017). This information, which was entirely new to me, spurred contemplation and eventual determination for me, personally, regarding my opinions of the use of UAVs and eventually autonomous drones in war. By proxy of analysis, my own opinion has changed, which will in turn, after promoting action in me, cause me to attempt to change the opinions of others, and directly inform interactions with those of different viewpoints, as it has throughout the creation of this essay.

Ultimately, the analysis of the usage of UAVs in the Ukraine war, the implications this has, and the potential future it can create has provided me with much more perspective, insight, and contemplations than I imagined at the beginning of this essay. This entire process has served to show that through the conscious use of analysis, from multiple lenses and perspectives, one can better situate themselves to engage in valuable contemplation of a topic, or engage in thoughtful discourse with any individual, regardless of viewpoint, culture, or perspective.

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