Thesis Project Portfolio

AIAA HDI-25 Aircraft Design

Unmanned Homeland Defense Interceptor Critical Design

(Technical Report)

Analyzing the Capabilities of UAV Technology in Humanitarian Disaster Relief and the Implications of Their Shortfalls

(STS Research Paper)

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Sociotechnical Synthesis

In this paper, I synthesize two closely related projects involving unmanned aerial vehicles, or UAVs. One is a technical project designing the HDI 25 (Homeland Defense Interceptor, made in 2025) for national security. The other is a research paper analyzing how UAVs are used in humanitarian disaster relief and where they fall short. While one focuses on military defense and the other on emergency response, both raise important questions about how technology is used and who it benefits. Using ideas from Science, Technology, and Society Studies (STS), this paper explores how ethics and social responsibility should guide engineering decisions, especially when building systems that can act without direct human control.

The HDI 25 is a small, efficient, unmanned aircraft designed to protect U.S. airspace. It is meant to be cheaper and more powerful than traditional fighter jets while still being powerful. It includes remote piloting and autonomous targeting systems, which raised ethical concerns during its development. The aircraft uses advanced radar, tracking systems, and secure communications to meet the requirements of the AIAA Request for Proposal (RFP) performance specifications. However, it does not involve a human operator in launching weapons. This brings up serious questions about accountability if the system were to cause harm or make an error. The STS research paper focused on how UAVs were used in two disaster situations: the 2021 earthquake in Haiti and the wildfires in California in 2022 and 2025. In both cases, drones were used to collect data, assess damage, and help guide rescue and recovery efforts. The paper showed that while UAVs were helpful, the benefits were not shared equally, most often disadvantaging marginalized communities. Communities that were low-income and women-led often received less support, even though they faced the worst outcomes. Wealthier areas had better access to UAV support and received faster, higher-quality responses from relief teams. The paper used an intersectional STS approach to explain how factors like race, class, and gender affected those who received aid.

The main connection between these two projects is the idea that technology is never neutral. Engineers may focus on how well a system works, but those systems always have a substantial effect on people's lives. UAVs, whether used in defense or disaster relief, raise questions about fairness and responsibility. These are not just political or academic concerns. They are engineering concerns because engineers play a key role in how these systems are built and how they are used. In the HDI 25 project, the team assumed that the targeting system would be accurate and reliable. They also followed existing military guidelines that allowed for full autonomy in operations. But without a human making the final decision, it is harder to know who would be accountable if something went wrong. The STS research shows why this is a problem. In disaster zones, drones can sometimes fail to collect the right data or can miss the needs of groups that are already at risk. If engineers do not think about who might be left out, their work can unintentionally cause harm, even if their goals are good. Engineers are expected to protect public safety and act with responsibility. That includes asking important questions about what will happen once technology is in use. The HDI 25 report did mention risks like cybersecurity and automation failures. But it could have learned more from the disaster relief case studies. For example, involving communities, planning for what can go wrong, and thinking about long-term effects would have made the project more ethical and more prepared for real-world situations.

Both the HDI 25 and the UAV disaster relief case studies show that engineering is shaped by values and social systems. Engineers often work under pressure to stay on schedule, reduce costs, or solve technical problems. But these pressures should not keep them from thinking about the bigger picture. Whether designing a defense aircraft or using drones for humanitarian aid, engineers have the undeniable responsibility to understand how their technology affects society.

In conclusion, the HDI-25 and UAV disaster relief case studies show how important it is to think about ethics and equity in engineering. Both projects deal with powerful tools that can save lives but also cause harm if not handled equitably. It is crucial to consider the impact that UAV technology can have on the vast number of complex communities in which it will be used; their input is the most valuable asset for any given rescue team, military drone operator, or engineer.