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MAE 4300 Final Report - Boeing Analysis

I. Introduction

Throughout the course of MAE 4300, we've learned the ethical analysis behind the Boeing 737 Max incident. Engineering decisions do not exist in isolation; it takes many people and many systems shaped by economic pressures, organizational structures, and regulatory frameworks to make a decision. The Boeing 737 Max crisis proves that ethical failures can occur, but it is through this class that we analyzed all the different parties partially responsible. The development of the Maneuvering Characteristics Augmentation System (MCAS) shows how prioritizing cost reduction and competitive advantage will put hundreds of people in grave danger. This case demonstrates that engineers have an ethical obligation to protect the public.

II. Background and Context

The Boeing 737 Max was built in an effort to gain competitive advantage over Airbus. Airbus has already developed a more fuel efficient aircraft which led Boeing to modify the existing 737. The thought behind this decision was to avoid making a new aircraft from scratch. All that was necessary was installing larger engines and altering some of the aerodynamics. However, as simple as it may sound, these kinds of changes to an aircraft require many teams of engineers and constant design reviews to ensure the safety. The changes made by Boeing altered the aerodynamics of the plane and increased the risk of nose up conditions. To fix this, Boeing created the MCAS which was a software system that would push the nose of the airplane down. Unfortunately, MCAS relied solely on data from the Angle of Attack sensor (AOA sensor) which created a single point of failure in a safety critical system.

III. Identification of Core Ethical Issues

Several ethical issues arise from this design choice. The first concern is how engineers should respond to pressures from management. From the outside perspective, it seems easy, but as per the Boeing incident, it is clear that companies can do a better job supporting their employees and making management readily available. In the case of the 737 Max, Boeing executives wanted to minimize pilot training. This meant that they needed to avoid a complete redesign because the Max seemed like an update rather than a new model. The lack of transparency truly caused several issues. It seems that engineers were not able to voice their concerns to management and pilots/airlines were left in the dark. The reliance on a single sensor contradicts everything engineers are taught in school, which means that concerns should have been voiced and a design review should have been conducted.

Another ethical issue involves transparency. MCAS was not fully mentioned in the pilot flight training manuals so many pilots were completely unaware of the MCAS system. During the failures of the MCAS system, the pilots were unaware of how to respond to the malfunction.

This raises several questions about the engineers' responsibilities to voice these concerns and the managements' responsibility to disclose new system updates to the airlines and pilots. Ethical engineering practices require that safety critical information should be communicated clearly. By presenting MCAS as a smaller modification, Boeing completely limited the pilots' ability to understand and respond effectively during emergencies.

Lastly, whistleblowing remains a key ethical concern. Engineers working on MCAS might have recognized the risks with the MCAS system or inadequate pilot training, however, organizational culture and pressures from management might have discouraged the engineers from voicing concerns. Engineers might have feared job loss or professional consequences if they challenged management. While whistleblowing is ethically justified when public safety is threatened, it often occurs when institutional protection is weak.

IV. Stakeholders Affected

The Boeing 737 MAX crisis affected a wide range of stakeholders across individual, organizational, and societal levels. The most directly impacted stakeholders were passengers and flight crews, whose safety was placed at risk due to flaws in the MCAS system and insufficient training. Pilots were particularly affected because they were not fully informed about the system's existence or how to respond to its malfunction, limiting their ability to act effectively during emergencies. Secondary stakeholders included airlines operating the aircraft, families of crash victims, Boeing engineers, shareholders, and the general public.

V. Relevant Ethical Principles

Several core engineering ethical principles are directly relevant to this case as per the ASME Code of Ethics. Canon 1 discusses holding engineers responsible for the safety of the public as design and communication decisions compromise public safety. Canon 3 emphasizes honesty and transparency in professional communications, a principle violated by the limited disclosure of MCAS functionality to pilots and airlines. Canon 4, which calls for engineers to act as faithful agents of their employers, must be interpreted in balance with public safety obligations. Loyalty to an employer does not ethically justify decisions that place lives at risk.

VI. Conclusion

In conclusion, the Boeing 737 MAX crisis illustrates how engineering decisions can have profound societal consequences. The case underscores the importance of ethical vigilance in environments shaped by economic and organizational pressure. Engineers serve as critical guardians of public safety, and their responsibility does not end with technical competence or regulatory compliance. Upholding ethical principles, even when difficult, is essential to maintaining trust in engineering and protecting the societies that depend on it.