

Analyzing Boeing's 737 MAX Failure Using Care Ethics

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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.

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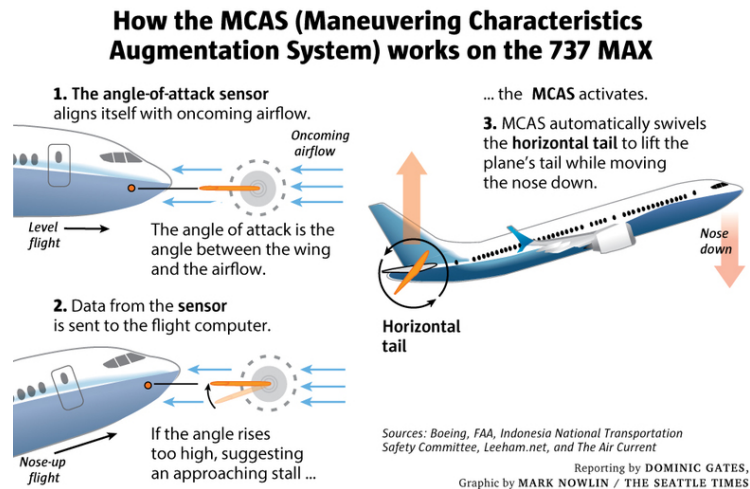
Introduction

In March of 2019, the new Boeing 737 MAX 8 and MAX 9 were grounded internationally due to two fatal crashes that brought travel safety concerns internationally (Johnston & Harris, 2019). A Lion Air aircraft crashed in late 2018 and an Ethiopian Airline crashed in early 2019. Boeing's new MCAS (anti-stall software) is suspected to be the cause for both the crashes. Scholars believe that the software design process of the MCAS had potential flaws and that Boeing's assessment of its safety was incomplete. This flawed process could have been influenced by a lack of a proper software development culture at Boeing. However, the idea that poor software design is a root cause of the Boeing 737 MAX's failure overlooks the moral dimensions of the decisions and actions made by people at Boeing. By neglecting the moral dimensions of software failure, especially of critical systems like passenger airplanes, it is easy to classify the problem as a design, organizational, or technical problem. An analysis of the ethics behind the actions made by Boeing is needed to understand how the crashes occurred from a socio-technical perspective.

This paper explores how Boeing acted immorally with respect to an ethical framework called care ethics. In particular, I examine actions by Boeing (and its employees) and assess whether those actions are in agreement with the four stages of care ethics. By doing so, I emphasize that the crashes were not merely a result of technical problems. Rather, they also demonstrate Boeing's failure to give competent care.

Background

Boeing’s motivation behind the new 737 MAX was to match the fuel efficiency of its competitor, Airbus (Johnston & Harris, 2019). Its new engines were larger in size, and required their positioning to be higher on the wing compared to the predecessor, the 737. During take-off and landing, the new engine position destabilized the aircraft, thus increasing the likelihood of a stall. In order to prevent these stalls, Boeing designed a software called the maneuvering characteristics augmentation system (MCAS) which corrected the airplane’s angle of attack by pushing the nose of the aircraft down. These sensors reported incorrect information which the MCAS did not properly account for. Both the crashes faced the issue of not being able to take manual control of the flight as the MCAS repeatedly forced the airplane to dive down to the ground (Johnston & Harris, 2019). The figure below describes how the MCAS behaves during flight. Angle of attack sensors activate the MCAS which pulls the nose down.



Literature Review

Several scholars have examined the case of the 737 MAX and concluded that its failure stems from flaws in the software development system at Boeing. In particular, it is agreed that

the MCAS software and its design process resulted in the two fatal crashes. These explanations of the crashes fail to consider a different perspective that highlights the immorality of some of the actions taken by Boeing as an engineering and business corporation.

Bergstra and Burgess argue that the software design of the MCAS potentially had flaws affecting the reliability of the software (Bergstra & Burgess, 2020). First, they believe that the MCAS was given a questionable safety classification. Classified as level B, the software was considered a ‘hazardous’ feature compared to a stricter ‘catastrophic’ feature. Therefore, by default, the MCAS was pushed below other components in safety protocol. Second, MCAS’ predecessor Pegasus was underutilized in the development of the MCAS. The design process insufficiently recognized and acknowledged the technology that was already working effectively on previous Boeing models. Finally, they believe that the MCAS algorithm’s intervention in anti-stall is too invasive. Its intervention is too strong to be corrected by a pilot, which points to a flaw in the algorithm itself. This could have been caught earlier with careful requirement specifications. Bergstra and Burgess focus their analysis on the software design process of the MCAS system, which inadequately considers the ethical dimensions and morality of the actions by Boeing during development.

Although similarly motivated by flaws in the software design process, Wendel’s perspective is slightly different. He argues that the Boeing’s approach to assessing safety of the MCAS software was incorrect. When building a technology for safety, one must not evaluate the technology and humans in separation and isolation (Wendel, 2019). One must implement a systems approach in which both the technology and the human are considered as one piece. In the case of the 737 MAX, when Boeing assessed the safety of the MCAS component, it should have mapped the interaction between the pilot and the software component instead of each

separately. The technology that was intended to prevent stalls actually limited the pilot's ability to control the airplane, therefore the interaction was not correctly assessed by Boeing. Again, this argument does not explicitly express whether Boeing's actions are considered immoral.

Both these ideas highlight flaws in the software design process of the MCAS component in the 737 MAX, but they fail to judge the particular actions by Boeing managers and engineers. In my analysis below, I use care ethics as a framework to analyze these actions. I acknowledge the organizational structure of Boeing and identify how hierarchy is a key factor in assigning responsibility for the immoral actions. I further conclude that business corporations such as Boeing have a duty to acknowledge their relationships with their pilots, the aviation industry, their employees, and travelers.

Conceptual Framework

The role of immorality in the failure of the Boeing 737 MAX can be explained through the lens of a normative ethical theory called care ethics. As opposed to utilitarianism and Kantian theory, which rely on the utility principle and the reciprocity principle, care ethics does not suggest actions in a given situation (van de Poel & Royakkers, 2011). Rather, care ethics is centered on relationships between people. One's norms and values originate from the interactions with others instead of a set of moral guidelines. Understanding emotions, vulnerability, power, perspectives, and relationships all allow people to act and respond morally.

The works of psychologist Carol Gilligan and philosopher Nel Noddings in the mid-1980s influenced the development of care ethics (Sander-Staudt, n.d.). Primarily motivated by male bias in society at the time, they proposed that a "voice of care" should be used in order to assess morality. One criticism of care ethics is the ambiguous definition for care, as it is variable

depending on different contexts. A definition that has been accepted widely is that care is what we use to “maintain, continue, and repair our 'world' so that we can live in it as well as possible (Hartout, 1996).” Joan Tronto appends to this definition four stages of care: attentiveness, responsibility, competence, and responsiveness (Sander-Staudt, n.d.). Attentiveness is becoming aware of some need while responsibility is caring for that need. Competence is providing the necessary care successfully, while responsiveness is understanding the power dynamics at work in relationships. It is important to note that in all these stages, the subject doing the caring can either be an individual or a group. For example, after the *Herald of Free Enterprise* disaster in 1987, it was difficult to pinpoint responsibility at an individual level since there were multiple parties involved that contributed to the capsized ship (van de Poel & Royakkers, 2011). Ethicists called this the Problem of Many Hands and collective responsibility. Boeing, a large engineering company with many parties involved, fits into a model similar to collective responsibility.

Using care ethics, I analyze the morality of Boeing engineering in the development of the Boeing 737 MAX. In particular, I define the relationships of interest for Boeing and assess its progression, or lack thereof, through the four stages of care. Further, I examine how Boeing faces collective responsibility and the problem of many hands.

Analysis

According to Joan Tronto, caring has ethical dimensions which help people know how to live a good life (Holstein, 2001). In order to maintain and repair the world that we live in, all four phases of care must be accounted for. If any one of these four requirements are not met, then the action is morally flawed and unethical. Using this framework, I explore how Boeing acted

immorally by improperly documenting the MCAS software, rushing the release of the 737 MAX, and by inadequately reviewing the software.

Before elaborating the primary actions by Boeing, I clarify what question each stage of care ethics answers. The first, attentiveness, exposes whether the need for care was recognized. Did someone at Boeing or Boeing as a corporation acknowledge the existence of a need? Being able to comprehend the needs of others and self is a moral quality in the world of care ethics (Holstein, 2001). The second, responsibility, examines whether someone took the initiative to organize the necessary resources to ensure the care is given. Did Boeing gather resources to give the necessary care? The third, competence, assesses the level to which the care was given. This is the critical caregiving portion of care ethics. Did Boeing show competence in its caregiving? By giving incompetent care, one is considered to have acted immorally. The final component, responsiveness, entails how the care receivers responded to the caregiving. It evaluates whether the needs were met successfully, how the receiving party responded to the given care, and whether Boeing recognized the vulnerability of the care receiver. Did Boeing's care, if it provided any, meet the intended needs addressed in the first phase and were the care receivers satisfied? By combining these phases, care ethics provides a method of assessing the morality of Boeing's actions. This method is utilized below for several Boeing's actions that potentially led to the disastrous 737 MAX.

Improper Documentation and Training

Boeing's inability to provide adequate documentation and training for pilots is immoral according to care ethics because it did not provide competent care to pilots. Many pilots had expressed concerns about the MCAS system and their lack of expertise with 737 MAX (Aviation

Safety Reporting System [ASRS], 2018). In one account (ACN 1593017), a pilot expressed that the entire MCAS software system is not mentioned in neither the 737 Flight Manual nor the Boeing FCOM. The pilot was concerned that the manual for the error prone and “highly complex” software system is “criminally insufficient.” Another pilot (ACN 1555013) expressed that he/she lacked the knowledge required to safely operate the airplane (ASRS, 2018). The instrumentation was different from previous models and the lack of expertise with the new ND (Navigation Display) and ADI (Attitude Director Indicator) degraded the pilot’s efficiency and confidence. The pilot was unable to traverse systems pages and information effectively. Additionally, the Lion Air black box revealed that pilots were struggling to find a solution in the provided manuals during their deadly descent into the ground (Johnston & Harris, 2019). Evidently, the lack of robust manuals and training was a key factor for the failure of the 737 MAX.

Through care ethics, I analyze how Boeing acted immorally. The first stage of care ethics is attentiveness, the ability to recognize the need for robust manuals, training, and documentation. Although pilots weren’t able to find them easily, Boeing actually provided the necessary instructions to take manual control of the flight in the manuals (Bergstra & Burgess, 2019). Therefore, Boeing recognized that there was need for documentation to allow pilots to safely maneuver out of a dangerous system failure. The second stage is responsibility, the ability to take initiative in providing documentation. Since these instructions to take manual control were provided, some documenting body at Boeing took the initiative to provide them. The stage in which Boeing acts immorally is the competence phase.

Competence requires that Boeing provided sufficient and robust documentation for the pilots. Although Boeing provided the minimum instructions, the pilots were still unable to locate

and navigate the manuals given the lack of training (ASRS, 2018). The MCAS was mentioned only in a small part of the manual and the Boeing chief technical pilot even requested the FAA to remove it from the manual (Nicas, Kitroeff, Gelles, Glanz, et al., 2019). Boeing failed to clearly warn against the previous method and took the assumption that robust documentation for all systems was unnecessary due to pilots' familiarity to previous models (Johnston & Harris, 2019). In the past, when the automatic stabilizer repeatedly trimmed downward due to a suspected high angle of attack, the pilots reacted to the situation by yoke handling and taking manual control of the flight. In the predecessor of the 737 MAX, this is what pilots did to take manual control of the flight and bring it back to safety (Bergstra & Burgess, 2019). However, the MAX was designed so that yoke handling was restricted and the pilot had to follow a unique set of instructions from the manual. As previously highlighted by the pilots' accounts from the ASRS, the instructions and training that Boeing did provide were not sufficient enough. The pilots' lack of knowledge and training for this emphasizes the incompetence of Boeing's documentation and the problem with assuming familiarity. Boeing acted immorally by not providing competent care for the pilots, failing to meet the third requirement of care ethics.

Rushed Release

Through the lens of care ethics, Boeing also acted immorally by rushing the production of the MAX because Boeing managers did not take initiative to improve factory conditions. A former senior engineer at Boeing's 737 factory, Ed Pierson, revealed many issues with the production of the MAX in a testimony before the House Transportation and Infrastructure Committee (Pierson, 2019). He accounts that in early 2018, Boeing had a long backlog for the production of the 737 and that its "roll out on time" percentage had dropped to less than 10%. To

meet higher production demand, Boeing prioritized time over quality (Pierson, 2019). In order to compensate, employees faced excessive overtime and structural breakdowns with managers. Regular processes were being rushed and were not done chronologically in order to save time (Pierson, 2019). In addition to this, it was reported that Boeing was months behind its major competitor Airbus, which released the new A320neo (Johnston & Harris, 2019).

With respect to care ethics, Boeing acted immorally in the responsibility stage.

Attentiveness (first stage) requires that Boeing recognized rushing the production would affect the quality of the model and the well-being of the employees. Boeing's website lists quality and work life as important pillars of their principles (Boeing, n.d). Consequently, Boeing cares about its employees and recognizes the need for a healthy work environment. When Ed Pierson emailed a 737 executive expressing concern that factory conditions are affecting the quality of production, he responded by saying that safety and quality is a top priority (Pierson, 2019). Therefore, the executive recognizes that proper work conditions and quality are needed, meeting the attentiveness stage. However, he did not take the initiative to change the conditions in the factory. He didn't take responsibility in ensuring that the MAX was a quality product and that Boeing's employees were in effective working conditions. Even after the two deadly crashes, Ed Pierson repeatedly contacted Boeing officials to review the production process, factory conditions, and employee health because he was afraid those factors might have caused the crashes. The officials once again showed no interest in investigating that. Boeing officials and managers acted immorally because they did not take the responsibility to properly address the factory conditions and quality (Pierson, 2019). Even when Ed Pierson took the initiative after the crashes, nothing was done by the executives which further highlights the lack of care for proper production and safety.

Improper Reviews

Boeing acted immorally by improperly testing and reviewing the safety of the MAX because it did not recognize how the review process compromised safety. Although improperly testing and reviewing might have been caused by the poor working conditions mentioned in the previous section, this is slightly different because of the relationship of care. Previously, I focused on the employer-employee relationship. The relationship in focus here is between Boeing engineering and the aviation industry's code of conduct.

In an investigative report by the House Committee on Transportation and Infrastructure, it was revealed that there was a conflicted representation of the FAA in Boeing's review process (House of Transportation And Infrastructure Committee, 2020). The FAA (Federal Aviation Agency) acts as the reviewer of an aircraft model before signing it off (Johnston & Harris, 2019). However, the FAA allows specially selected Boeing employees to do validation on its behalf (House of Transportation And Infrastructure Committee, 2019). Due to the production demand, these authorized representatives failed to mirror proper review practice and take "appropriate actions to represent the interests of the FAA and the public good." There were cases when proper FAA reviewers brought up issues of the MAX, but Boeing's influence over the FAA overruled such issues (House of Transportation And Infrastructure Committee, 2019).

A care ethics analysis reveals that Boeing acted immorally in the attentiveness stage of care. Boeing did not recognize the need for a proper review of an aircraft model. Although Boeing participated in reviewing the model, they failed to recognize that having its own representatives review could potentially lead to inadequate and biased validation. Even if there was proper

review practice, Boeing's ability to overturn proper FAA findings is threatening to the safety protocol of the aviation industry. Therefore, Boeing would also be acting immorally in the competence stage of care because it does not protect the code of conduct sufficiently.

Relationships & Vulnerability

The three actions above demonstrate that Boeing acted immorally by not meeting all the phases of care. Each scenario is centered on a relationship that Boeing failed to maintain and repair. By improperly documenting the MCAS software, Boeing didn't maintain the standard that pilots were accustomed to. Pilots placed trust in Boeing to provide the necessary tools to help them do their job and protect the passengers. They are vulnerable to the quality of help that Boeing provides to them during unsafe conditions, therefore Boeing had a duty of obligation to show that they cared about providing the right resources. It is immoral to not fulfill this duty. Next, by rushing the release of the aircraft model, Boeing failed to maintain a healthy relationship with its employees. The engineers under the MCAS project were vulnerable to the pressure placed by management, so Boeing had a duty to intervene and fix work conditions to keep its employees content. Finally, Boeing's failure to properly follow the traditional review process highlights its ignorance of its relationship to the aviation industry and quality. The quality of the 737 MAX in combination with people's trust in the aviation industry were vulnerable to Boeing's reviews. Boeing has a duty to respect the correct methods in the industry, which it failed to do. A common relationship in all these scenarios is the Boeing-passenger relationship. Travelers around the world put trust in manufacturers like Boeing to build a quality product that will get them safely from one destination to another. Therefore, Boeing also has a duty to think about the people who face the consequences of a flaw in their aircraft. Since the

disasters could have been prevented through proper moral decisions, it is fair to say that Boeing failed to respect and care for all the travelers around the world.

The Problem of Many Hands

In complex organizations, assessing responsibility at an individual level is difficult. This is referred to as the Problem of Many Hands (Thompson, 1980). However, Boeing is a hierarchical corporation where many decisions pass through higher levels, as exemplified by Ed Pierson (Pierson, 2019). Therefore, hierarchical responsibility is a better model to analyze Boeing's actions. The responsibility must land on individuals with the higher authority (van de Poel & Royakkers, 2011). In Boeing, this includes the senior engineers, managers, and executives.

One could argue that it is not fair to assign complete responsibility on the higher authorities. The engineer level individuals also have a duty to act morally when they see incompetent care. This model in which everyone is equally responsible is referred to as collective responsibility. The organization as a whole is at fault for some immoral action.

This argument, however, overlooks unfairly assigning responsibility to people with less power. An engineer's ability to make an impact in a large issue is very minimal in a hierarchical organization. Currently, Boeing engineers report to business leaders who are adamant on production over safety (Kimball, 2019). For example, when Boeing engineers like Ed Pierson attempted to point out flaws in the production system, the managers and executives did nothing to change the issues that were pointed out (Pierson, 2019). Therefore, placing responsibility on an individual who is limited by the organizational structure is illogical. At Boeing, the CEO and the business leaders have a duty to respect the vulnerability of its engineers and employees.

Conclusion

I have argued that the failure of the new Boeing's 737 MAX is not simply a technical design issue or a software process flaw. Using care ethics, I expand beyond this view and suggest that Boeing's immoral actions caused the disastrous ending of a promising aircraft model. By failing to provide robust documentation and training, Boeing's relationship of care for their pilots was not maintained. By rushing the release of the model, Boeing's relationship with employee engineers was not cared for. By modifying the review process to fit the schedule of Boeing, its relationship of care with the aviation industry and code of conduct was not continued. The common denominator in all of these is the relationship between Boeing and the people around the world who trust its product and bear all the consequences. Boeing failed to recognize others' vulnerability in all the actions mentioned, thereby acting immorally. This argument that immorality is what caused the 737 MAX to be grounded can hopefully allow other technological failures to be analyzed without being limited to the technical deficiencies.

Word Count: 3645

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