A Care Ethics Analysis of the Boeing 737 MAX Crashes

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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 2019, Boeing involuntarily grounded its fleet of 737 MAX aircraft worldwide following the crash of Ethiopian Airlines Flight 302, which killed all 157 people on board (Langewiesche, 2019). This was the second deadly crash of a brand-new MAX aircraft; previously, in October 2018, Lion Air Flight 610 crashed, killing the 189 people on board. Investigations have shown that the Maneuvering Characteristics Augmentation System (MCAS), a new software system intended to prevent a dangerous stall condition, contributed to the crashes by repeatedly forcing the planes into a nose-dive that pilots were unable to override after the system had received faulty angle-of-attack (AoA) measurements from a sensor (Johnston & Harris, 2019). Many are quick to blame the MCAS software itself and the Federal Aviation Administration (F.A.A.), which approved the MAX and MCAS after allowing Boeing to perform much of its own certifications, for the incidents (Sgobba, 2019). However, assessing this case as purely a software problem or regulatory failure neglects the moral responsibilities of engineering companies. The morally irresponsible behaviors exhibited by Boeing in the development of the 737 MAX must be studied in order to understand ethical factors that contributed to the two catastrophic crashes.

By applying the ethical framework of care ethics to the case of the Boeing 737 MAX crashes, I argue that Boeing can be held morally responsible for the accidents in a systematic manner. To do so, I will demonstrate that Boeing failed in each of the four sub-elements of care owed to society according to care ethics theory – attentiveness, responsibility, competence, and responsiveness. Throughout my argument, I will employ the concept of collective responsibility, holding the collective entity of Boeing responsible for the incidents rather than individual engineers.

Literature Review

Much current scholarly research into the causes of the 737 MAX crashes seeks to blame the MCAS software or the antiquated aviation regulations that allowed the software to pass certification. However, this scholarship refrains from considering the significant role Boeing's immoral actions played in the crashes.

In their research, Philip Johnson and Rozi Harris attribute the crashes to the failure of the MCAS software within the larger MAX system, using it as a distressing case study on the importance of harmonizing software and systems engineering, corporate culture, and human relationships (Johnston & Harris, 2019). Ultimately, they highlight four "compounding factors" that contributed to the catastrophic failure of the MCAS in the two crashes; poor documentation and training on the software, a rushed release to compete with Airbus, delayed software updates between the two crashes, and pilots lacking critical information in-flight. The authors conclude that the crashes demonstrate a failure in systems engineering, as Boeing developed the flawed MCAS as a software patch in an attempt to cut training costs, minimize time to market, and fix already existing problems within the larger 737 MAX system.

Tommaso Sgobba in his piece, *Boeing 737 MAX and the Crash of the Regulatory System*, takes a different lesson to be learned from the crashes, using them to illustrate a major failure of regulatory bodies such as the Federal Aviation Administration to effectively asses advancing software-based technologies in their certification procedures. (Sgobba, 2019). He argues that Boeing, allowed by the F.A.A. to perform much of its own safety evaluations on the MAX, under-classified the level of risk associated with the MCAS system because it could not be appropriately assessed under the agency's outdated standards. This allowed the unconventional MCAS software to pass with little thought on the software-human interaction required by pilots

to safely operate the aircraft. Ultimately, Sgobba advocates for the regulatory bodies to move to establish independent supporting organizations with access to experts from industry, academia, and the regulatory bodies themselves to perform independent, peer-reviewed safety certifications free from the usual commercial pressures and timelines.

While this current literature seeks to uncover flaws in the design and certification of the MCAS software to account for the crashes, it refrains from analyzing the morality of the actions of the engineers at Boeing responsible for the design and certification of the 737 MAX and the MCAS. Using a care ethics framework, I will argue that morally irresponsible behavior by Boeing during these processes was a major cause of the catastrophic crashes. To do this, I will examine the specific manners in which Boeing acted without care for the public and with neglect for the power dynamics involved during the development of the 737 MAX.

Conceptual Framework

The theory of care ethics is particularly useful to demonstrate how the immorality of Boeing's actions during the design and certification of the MAX contributed to the crashes because care ethics emphasizes the responsibility of care that Boeing owed its stakeholders such as airline customers, pilots, the F.A.A., and passengers of its aircraft. Care ethics, inspired by the work of Carol Gilligan, differs from normative ethics theories in its belief that the development of morals is not achieved by learning general moral principles or following a set of concrete rules (van de Poel & Royakkers, 2011). Instead, care ethics places an emphasis on relationships and the special moral obligations that arise from them (Vorhoek, 2014). Because of this inherent interconnectedness, an individual (or a company) has a responsibility to act with mutual respect and care for others and to act in a manner that holds the maintenance of the relationship paramount.

While care can be considered a virtue, it is most commonly taken as a practice, or action, that includes everything we do to exist as well as possible in our complex and interconnected world, as defined by Tronto and Fischer (Sander-Staudt, n.d.). When taken as a virtue, care lies between selflessness and selfishness; defining care this way emphasizes the importance of what motivates the acts of care in the relationship, such as empathy and compassion towards oneself and others (Vorhoek, 2014).

What actions and attitudes constitute "good care" in a situation is largely dependent on the context of the relationship (van de Poel & Royakkers, 2011). Tronto explains the process of good care by dividing it into four practices: attentiveness, responsibility, competence, and responsiveness (Sander-Staudt, n.d.; Tronto, 2001). A failure in any one of these stages can define an action as immoral under Tronto's care ethics. The first practice of care, attentiveness is the ability to recognize that a need exists, whether it be our own or another's, while the second practice, responsibility, is the commitment to react to and take care of a need that exists. Because of its emphasis on relationships, care ethics can be treated as a social theory of ethics when applied to engineering cases; the applicable social arrangements, such as a design team or a company, can be held accountable for engineering decisions, rather than individual engineers (van de Poel & Royakkers, 2011).

The third stage of care, competence, is the ability to provide appropriate care based on the context of the relationship and the need (Sander-Staudt, n.d.). Lastly, responsiveness is the receiving of and response to care (Tronto, 2001). Responsiveness requires both the caregiver and the care receiver to have empathy for the position of the others in the relationship and to be mindful of potential vulnerabilities (Vorhoek, 2014). Fundamental to this is the recognition of

power dynamics, possibilities for abuse in the relationship, and a consciousness of the level of care owed or expected (van de Poel & Royakkers, 2011).

In the remainder of this paper, I will utilize Tronto's four stages of care to illustrate how the immoral behaviors by Boeing contributed to the deadly crashes of the two 737 MAX aircraft. Drawing on the principle of collective responsibility, I will consider Boeing as a collective entity that is responsible for the unethical decisions regarding the 737 MAX made by its teams of engineers, rather than holding any individual engineer at Boeing accountable (van de Poel & Royakkers, 2011). First, I will establish that Boeing's relationships with its customers, passengers, and the F.A.A. necessitated care. Then, I will use Tronto's four stages of care: attentiveness, responsibility, competence, and responsiveness to reveal that the immoral actions by Boeing during the design and certification of the 737 MAX were a major contributor to the crashes.

Analysis

The two crashes of the 737 MAX aircraft which killed everyone on board display an ethical failure by Boeing to take care of its customers according to each of the four tenants of care – attentiveness, responsibility, competence, and responsiveness. Boeing, in its ethical guidelines, cites the values of "safety," "quality," "integrity," and "trust and respect" as essential in its business mission to "deliver superior value to customers, employees, stakeholders, communities, and partners" (*Ethical Business Conduct Guidelines*, 2020). Boeing and its employees' actions throughout the development and grounding of the 737 MAX show a consistent deficiency in these company values. A clear ethical duty of care was owed to its airlines, their pilots, and the airlines' passengers, whose ability to live and continue to live their best life possible was frighteningly dependent on Boeing through the 737 MAX. A duty of care

was also owed to the F.A.A., Boeing's partner in ensuring that aircrafts released are certified to the standards of safety and quality owed to airline passengers. The two subsequent sections examine actions taken by Boeing that reveal faults in each practice necessary to deliver good care - attentiveness, competence, responsibility, and responsiveness, which ultimately contributed to the two deadly crashes of the 737 MAX.

Attentiveness and Competence

Boeing's actions during the development of the 737 MAX are established as immoral by violating the care ethics tenants of attentiveness and competence. According to the theory of care ethics, attentiveness is the act of recognizing the need(s) of others in a relationship while competence is providing successful care for that need (Sander-Staudt, n.d.). To be attentive, the needs of others must motivate one's actions more than one's selfish desires; as acting ignorantly of a need or selfishly both display a failure in the practice of attentiveness (Tronto, 2001). To be competent, one must fully address the need based on the context of the situation. While attentiveness ensures an individual is "caring-for" the other parties in the relationship, competence mandates that good care is effectively provided to them. Boeing, in a race to keep up with its competitor Airbus' new plane the A320neo, failed to act attentively or competently towards its customers in order to push the 737 MAX out the door as quickly as possible (Langewiesche, 2019). To best explain how Boeing acted inattentively and incompetently, some additional background is needed on the engineering design of the 737 MAX.

The Boeing 737 MAX was largely introduced in response to its biggest competitor, Airbus', new A320 aircraft that boasted greater fuel efficiency than Boeing's 737NG (Johnston & Harris, 2019). To optimize the time-to-market and reduce costs, Boeing added larger engines repositioned on its best-selling 737 aircraft to improve fuel efficiency without having to design

an entirely new aircraft (Langewiesche, 2019). As a result of the larger engines, the center of gravity (CG) of the aircraft moved forward, creating more lift in steep pitch situations (such as takeoff) than the previous model, which put the 737 MAX at a greater risk of a dangerous stall situation (Sgobba, 2019). To ameliorate the increased stall risk and to ensure that the plane behaves exactly like the 737, Boeing developed a software solution, the maneuvering characteristics augmentation system (MCAS) (Langewiesche, 2019). The MCAS system automatically commands the aircraft's trim system and points the nose down if it detects an AoA too great. Despite two AoA sensors on the aircraft, the MCAS system relies on data from only one of the sensors (Hatton & Rutkowski, 2019). Even though no software like the MCAS exists on any current commercial planes, Boeing marketed the 737 MAX as an upgrade of the 737 to customers and regulators, refraining from even mentioning the system in the aircraft's manuals, so that pilots already licensed to fly the 737NG would not need costly training or simulator time (Gelles, 2020).

By holding its financial benefits with higher priority than the safety of its customers, Boeing acted selfishly in promoting the 737 MAX without mandating additional simulator training time or properly documenting the MCAS, violating the tenant of attentiveness. During the marketing of the plane in 2011, Boeing sold Southwest airlines a fleet of MAX aircraft with the stipulation of a $1 million discount per plane if additional simulator time was needed to transition from the 737NG to the MAX (Kitroeff & Gelles, 2020). To avoid having to make good on this condition, Boeing's chief technical pilot declared no additional simulator time would be needed, writing, "Boeing will not allow that to happen. We'll go face to face with any regulator who tries to make that a requirement." (*Boeing 737 MAX was "designed by clowns,"* 2020). The confrontational tone of this statement demonstrates the selfish intention behind the

company's decision to not mandate simulator training for pilots on the 737 MAX, despite the new MCAS system. To justify this decision, engineers at Boeing assumed that if the MCAS activated erroneously, as it did in both crashes, pilots would be able to disable the system in less than four seconds (Schaper, 2019). However, Boeing did not inform pilots prior to the Lion Air crash that the MCAS system existed and that there was no way to manually override the system (Matthews & Choi, 2019). Additionally, Boeing knew before the crashes that some pilots would take more than four seconds to react, and reactions upwards of 10 seconds were classified as "catastrophic" (Schaper, 2019). Despite this information signaling the necessity for additional simulator training, Boeing pushed out the MAX with none, requiring only a two hour iPad training course (Langewiesche, 2019). Even if not financially motivated, justifying no simulator training for the MAX on pilots' having adequate reaction time shows a clear failure of competence by Boeing in fulfilling its duty of care. Boeing not only ignored testing data that showed a potentially dangerous reaction time for pilots operating the MAX, but furthermore it chose not to inform pilots of the new MCAS system that could take over its plane with no manual override possible. Based on this information, Boeing's decision not to mandate additional simulator training time displays careless incompetence regardless of its motivation or justification.

A lack of attentiveness and competence appears again with regards to the warning indicators in the aircraft. Boeing chose to sell this safety feature, which would alert pilots if the two AoA sensors disagreed significantly, as an additional extra to customers rather than as a standard feature in all MAX aircraft (Johnston & Harris, 2019). Both the Lion Air and Ethiopian Airlines aircraft were delivered without this indicator, and malfunctioning AoA readings are implicated in incorrectly triggering the MCAS, which directly caused the crashes as pilots fought

to take control back of the plane (Gelles, 2019a; Hamby, 2019). Attempting to secure an extra profit rather than provide a safety measure to alert pilots of potential incorrect readings shows a selfish motivation by Boeing. Moreover, the design decision to feed readings from only one of the two AoA vanes on the aircraft to the MCAS, resulting in the need for a disagreement indicator, demonstrates a gross disregard for the standard engineering practice of redundancy in systems (Hatton & Rutkowski, 2019). An engineer at Collins Aerospace, a company contracted to develop parts of the MCAS software, said the reliance on one sensor is a "no-go," and pointed out an almost identical situation from 2009 where reliance on data from one altitude sensor triggered an automated system error on a Boeing 737NG, killing 9 people and injuring over 100 more (Hamby, 2019). Making the same design mistake almost a decade later, Boeing failed to competently care for its customers and should have known the importance of redundancy in a safety-critical system.

Responsibility and Responsiveness

Boeing's behaviors during the development of the 737 MAX can be further characterized as immoral by failing to uphold the care ethics tenants of responsibility. Responsibility within Tronto's care ethics framework is defined as accepting the duty to provide care (Sander-Staudt, n.d.). As such, an unwillingness to take care of others or act in the best interest of maintaining the relationship violates this tenant (Tronto, 2001). By taking responsibility for the care owed to others, one becomes morally accountable; however, in engineering practice, who is morally accountable can be unclear.

In the case of the Boeing 737 MAX, the responsibility to take care of its customers rested with the collective company as decisions that were made are easily attributable neither to individual engineers nor to the CEO. However, for the company to act responsibly, the

collective individual employees must accept their roles in ensuring the company does so and sound warning bells within the company as needed. Internal communications during the development of the 737 MAX reveal several employees failed to uphold their part. One employee wrote in 2017, "This airplane is designed by clowns, who in turn are supervised by monkeys" (*Boeing 737 MAX was "designed by clowns,"* 2020; Gelles, 2020). This message shows a damaged company culture in employees at Boeing neither respect nor trust one another. Another Boeing employee asked a colleague in 2018 before the crashes, "Would you put your family on a MAX simulator trained aircraft? I wouldn't;" to which the colleague responded, "No" (Kitroeff, 2020). By acknowledging they would prevent their own families from flying on the MAX, these employees demonstrate they believe the aircraft to be unsafe, yet they take no actions to prevent their customers from flying on the MAX. These communications display Boeing employees' refusal to accept the duty of care owed to their customers to provide a safe product, violating the tenant of responsibility.

Other employees did attempt to take action, voicing concerns internally about the MCAS and conditions in manufacturing facilities; however, their concerns were ignored in the rush to get the MAX to market and avoid additional pilot training (Gelles, 2019a; Gelles & Kitroeff, 2019b; Langewiesche, 2019; Schaper, 2019). While the individuals who raised issues with the MAX displayed a willingness to take care, by shutting down and overriding them Boeing showed a failure to react responsibly. Boeing had knowledge from several employees, including its top test pilot, that the MCAS could be unsafe two years before the deadly crashes but was unwilling to take precautions that would protect its customers (Gelles & Kitroeff, 2019b). The collective responsibility of Boeing in the MAX crashes was underscored by Peter DeFazio, chairman of the House Transportation and Infrastructure Committee, in its investigation of

internal Boeing documents and emails, stating, "Boeing cannot say this is about one person… This is about a cultural failure at Boeing…" (Gelles & Kitroeff, 2019b). The communications of employees throughout the hierarchy of Boeing show an eroded company culture with a pattern of disregard for internal whistleblower's concerns. By neglecting their ethical duty as professional engineers to hold paramount the safety and welfare of the public, the entire workforce of Boeing is responsible for its immoral behaviors in the development of the 737 MAX that ultimately cost 346 individuals their lives.

Boeing's immoral practices during the certification of the 737 MAX by the F.A.A demonstrate a lack of responsiveness. Tronto's last sub-element of care, responsiveness, requires one to be cognizant of power dynamics or potential vulnerabilities that could be exploited in the relationship (Tronto, 2001). Boeing, in its deceitful behaviors to get the MAX certified quickly by the F.A.A., abused its position of power over the F.A.A. and its customers, who trusted Boeing would deliver a safe airplane through honest regulatory measures. Scrutiny into the approval of the MCAS system by the F.A.A. has revealed that Boeing did not fully explain the system to regulators, downplaying its significance and risk, and even going as far as to intentionally mislead regulators (*Boeing 737 MAX was "designed by clowns,"* 2020). Mark Forkner, the chief technical pilot for the MAX and responsible for working with the F.A.A. on how pilots would be trained, wrote in a 2016 email he was "Jedi-mind tricking regulators into accepting the training" (Gelles & Kitroeff, 2019b). In using the Star Wars phrase, "jedi-mind tricking", Mr. Forkner is boasting that he is exerting influence over the F.A.A. regulators he views as weak-minded and susceptible to his, and Boeing's, control. This email came after Mr. Forkner secured approval form the F.A.A. to remove mention of the MCAS from the pilot's manual, despite himself having raised internal concerns weeks earlier that the MCAS was acting

"egregiously unpredictable" in a flight simulator. Mr. Forkner was not alone in exploiting Boeing's power to commandeer certification on its own terms, referencing a 2016 meeting to discuss training requirements for the plane where one Boeing employee described regulators as "dogs watching TV," while another employee wrote: "There is no confidence the F.A.A is understanding what they are accepting" (Gelles, 2020). Boeing, which has since apologized to the F.A.A. and customers for the internal messages, but did not reveal the messages to the F.A.A. until Mr. Muilenburg was scheduled to testify in front of Congress (Kitroeff, 2020). The rampant intent to mislead regulators into approving certification of the MCAS and training procedures for pilots displays a blatant abuse of power by Boeing over both the F.A.A and its customers, which violates the tenant of responsiveness. By treating the regulators as an obstacle on its path to profit, Boeing disregarded the role of the F.A.A. in the relationship and sacrificed the public's safety through its unethical actions.

While a care ethics analysis of the 737 MAX certification holds Boeing morally culpable for the crashes that followed, some may argue that the F.A.A. is at fault for flawed oversight of the 737 MAX certification in which it allowed Boeing to perform much of its own certifications (Gelles & Kitroeff, 2019a). However, this viewpoint overlooks the fact that Boeing employees went out of their way to sell the MCAS as an insignificant system that would only activate in rare situations to persuade the F.A.A. the MAX did not require simulator training (*Boeing 737 MAX was "designed by clowns,"* 2020; Gelles, 2020; Gelles & Kitroeff, 2019b). One such example of this can be seen late in the development of the MAX, when Boeing radically increased the power of the MCAS, yet never submitted an updated safety assessment to the regulators who still believed the system to be insignificant (Kitroeff et al., 2019). Furthermore, delegating oversight to companies and their technical experts so that the F.A.A. can prioritize

resources on the most safety-critical systems is a long-standing practice, recently expanded under the F.A.A. Reauthorization Act of 2018 (Kitroeff & Gelles, 2019). However, this practice cannot work when companies such as Boeing lack the responsiveness and responsibility to truthfully and impartially assess the safety of their aircraft. Boeing, abusing its power by hiding the intricacies of the MCAS, left the F.A.A. naïve to the fact that the MCAS should have been classified as one of the safety-critical systems under its oversight. By violating the principle of responsiveness, Boeing exploited not only the F.A.A. but also its defenseless customers who trusted Boeing with their lives by flying on the 737 MAX.

Conclusion

Examining the crashes of the two Boeing 737 MAX airplanes using a care ethics framework reveals that Boeing's immoral behaviors in the development of the MAX directly contributed to the catastrophic incidents that killed 346 individuals. Boeing as a company failed in each practice of care it owed society – attentiveness, responsibility, competence, and responsiveness. By prioritizing profits over safety in the development and certification of the MAX, Boeing neglected the moral duties it had to its customers, passengers, and the F.A.A. With the direct financial repercussions to Boeing exceeding $8 billion so far and over half of American flyers unwilling to fly on the MAX if it returns, Boeing employees are beginning to understand the consequence of their moral obligations as engineers, with former C.E.O. Muilenburg stating, "…the personal element of this, and the impact it's had on families – you know, it's reminded me of the importance of the work we do... And that's going to stick with me forever" (Gelles, 2019b; Kitroeff, 2019; Yaffe-Bellany, 2019).

This ethical analysis of the two catastrophic MAX crashes demonstrates the difficult dilemma companies face when balancing business interests versus customer safety. In the

future, using care ethics as a guideline, engineering companies can better harmonize their best interests and their stakeholder's best interests in order to uphold their moral responsibilities to society as they design and certify their products.

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