Boeing 737 MAX Case Study According to Care Ethics

STS Research Paper
Presented to the Faculty of the
School of Engineering and Applied Science
University of Virginia

By

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Feb 27, 2020

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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Boeing 737 Max

Introduction

With the first commercial versions of the Boeing 737 being delivered in 1967 and with over 15,000 orders to date, the Boeing 737 is one of the bestselling commercial airliners in the world (*Boeing commercial orders*, n.d.). In the 50+ years the 737 has been in service, the airframe has been upgraded and rebranded several times – first as the 737-200 which added more powerful engines and the ability to carry more fuel and most recently as the 737 MAX.

The 737 MAX was launched in 2011 as a response to Airbus's announced upgrade to the A320 which yielded 14 percent better fuel economy per seat. In its 2011 annual report, Boeing stated "With development costs and risks far below an all-new airplane, the 737 MAX will provide customers with capabilities they want, at a price they are willing to pay, on a shorter, more certain timeline. This approach is an all-around winner for Boeing. . ." (*2011_annual_report.pdf*, n.d.) In order to compete with Airbus' new offering, the 737 MAX added new engines that were larger and more efficient, structural changes to accommodate the new engines, and a Maneuvering Characteristics Augmentation System (MCAS) function. The launch of the 737 MAX was well received and it became the fastest selling plane in the company's history with about 5,000 orders from more than 100 customers worldwide (*Boeing*, n.d.-a).

By upgrading the 737 platform rather than developing an entirely new plane, Boeing achieved several goals. First, because the 737 MAX was built on the 737 platform, Boeing claimed that the MAX was so similar to the original that pilots already licensed for the 737 would not need additional training or simulator time in order to be qualified to fly the 737 MAX

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(Johnston & Harris, n.d.). The lack of additional training for pilots moving from older 737 models to the 737 MAX made the aircraft significantly more attractive to potential buyers which, in part, explains how the 737 MAX became Boeing's fastest selling aircraft. Additionally, Boeing was able to take advantage of the FAA's changed product rule and ultimately have platform subjected to less scrutiny. Even though the FAA continually updates and amends aircraft design regulations to improve safety and all new aircraft designs are subject to the newest regulations, the FAA's changed product rule allows for changes to previously approved designs to be approved under old regulations (*Final_JATR_Submittal_to_FAA_Oct_2019.pdf*, n.d.).

Unfortunately, all these upgrades to a 50+ year old platform did not come without a cost. The larger engines placed in new positions destabilized the aircraft under certain conditions. The engine housings were designed so that they would not destabilize the aircraft during normal flight, but when the airplane is in a steep pitch (for example during takeoff or an intense turn) the engine housings generate enough lift to potentially cause the plane to stall (Johnston & Harris, n.d.).

Rather than attacking the structural problems with the airframe, Boeing developed a software fix called the MCAS, which was integrated into the flight management computer software. MCAS uses airspeed, altitude and angle of attack (AoA) to determine when the airplane is in danger of stalling. If a risk is detected, the system automatically adjusts the rear stabilizer to lower the nose of the aircraft and push's the pilot's yoke in the downward direction.

On 29 October 2018, a Boeing 737-8 MAX taking off from Jakarta, Indonesia crashed shortly after takeoff killing all 189 people onboard. A few months later in March of 2019,

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another 737 MAX crashed six minutes after taking off from Addis Ababa, Ethiopia. All 157 crew and passengers aboard the aircraft died in the crash (Hawkins, 2019). Both of these crashes were eventually attributed to the MCAS system and the pilots' lack of training and understanding regarding the system.

Current approaches to addressing the problem adopted by scholars, professionals, and other writers generally seek to understand what happened and why it happened on a technical level. While there are some attempts to analyze Boeing's actions from an ethical framework, they generally fall short of analyzing the entire system and focus on just a few individuals. These approaches are flawed because there was no single decision that led to the two 737 MAX crashes, but there was a long string of decisions which, when compounded, led to the deaths of 346 people.

By examining this issue with the theory of care ethics, readers will gain a better understanding of the ethical implications of Boeing's decisions which led to the two 737 MAX crashes. I will show Boeing's the pilots and passengers who died in those crashes were dependent on Boeing, and that Boeing's actions during the marketing of the 737 MAX were not ethical when examined with the theory of care ethics.

Literature Review

Many scholars have examined the events and decisions that led up to the Boeing 737 MAX crashes in Indonesia and Ethiopia. These works tend to examine the technical and business-related factors that led to these tragic accidents and courses of action for related industries to take in order to avoid similar mistakes being made in the future.

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Johnston and Harris focus on lessons that can be extracted from this case study by software organizations. They begin by objectively examining the control logic present in the MCAS system while paying specific attention to the methods by which the system can and cannot be turned off. Notably, they mentioned that if the pilot overrides the MCAS with trim controls, the system will activate again within five seconds after the trim switches are released if there is still an AoA over the allowed threshold detected and that the only way to completely disable the system us using a CUTOUT switch which allows the pilot to take manual control. With the operation of the MCAS system established, Johnston and Harris then provide evidence that it was, in fact, the MCAS system which caused the two 737 MAX crashes. This evidence includes information which shows that directly before the crash of Lion Air flight JT610, the pilots tried to pull up 21 times in response to MCAS pushing the nose of the plane down (Johnston & Harris, n.d.).

Before discussing some of the non-technical problems that contributed to this disaster, Johnston and Harris conclude their technical review by noting that the Lion Air crash had a 20-degree discrepancy in the plane's two AoA sensor readings, but only one of the AoA sensors was referenced in order to determine whether the MCAS system would adjust the trim of the aircraft. This is extremely important because the failure to check both sensors allowed for one sensor with a faulty reading caused the MCAS system to respond to a non-existent emergency.

Having established the technical problems with the MCAS system, Johnston and Harris continue by describing the nontechnical factors that contributed to the crashes. Notably they mention that poor documentation also contributed to a lack of knowledge about the MCAS

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system as black box data from the Lion Air flight shows the pilots desperately searching through manuals to explain what was happening to the aircraft immediately before crashing.

The lessons for software organizations that Johnston and Harris key in on are several. First, they note that people cannot bend complex problems to their will. They argue that Boeing tried to force the 737 platform to fill a gap in its inventory and did not fully appreciate the effects and unintended consequences that result from changes to a complex system. Additionally, they briefly question Boeing's motives and conjecture that keeping up with Airbus was Boeing's top priority during the 737 MAX development and launch. Johnston and Harris also stress the importance of good documentation and keeping humans in the loop. They argue that people must always be able to override or overpower an automated process which, with the increasing prevalence of automated systems, has implications far outside of commercial aviation.

Hatton and Rutkowski focus on the interactions between software, management, and requirements in order to explain both Boeing 737 MAX crashes. Hatton And Rutkowski begin by describing two very different methodologies of software development: the development of safety-critical software and the development of agile technologies. The first category, safety-critical systems, is characterized by higher standards throughout the entire development. Beginning with a rigorous extraction of requirements and ending with "a testing regime that is as rigorous and exhaustive as possible given time and budget constraints." (Hatton & Rutkowski, 2019) The second category, agile systems, is characterized by an attempt reduce costs by creating something of value with as light a development as possible. While these two methodologies normally exist on opposite ends of the software development spectrum, Hatton and Rutkowski note that the two methods of development seem to be converging.

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Hatton and Rutkowski continue by noting that Boeing's design decision to use a single external sensor as an input for the MCAS, a safety-critical software system, as "highly questionable at best." To back up their point, Hatton and Rutkowski point out that reliance on a single sensor in software is a well-documented problem. Driving this point home, they recall that the icing of pitot tubes culminated in a crash of an Airbus 330 in June 2009 which prompted Airbus to issue mandatory service bulletins which fitted the aircraft with additional pitot tubes.

Finally, Hatton and Rutkowski point out that the certification of safety-critical systems is an essential part of their development and that the 737 MAX may have had a questionable certification process. While the certification process is supposed to be completed by an independent body which is not subject to commercial pressures and timelines, the FAA delegated some certification tasks for the 737 MAX to Boeing itself.

While Hatton and Rutkowski's work provides a good look at Boeing's developmental methods and decisions, Johnston and Harris' analysis breaks down many of the specific failures in technical design and in decision making which led to the crashes. However, neither analysis adequately considers the case from a moral perspective. It is essential to consider this case within the context of an ethical framework in order to judge whether the crashes resulted from a series of unfortunate events or from a series of unethical decisions.

Conceptual Framework

The morality of Boeing's actions can be analyzed using the theory of care ethics as it relates to Boeing's decision to market and sell the 737 MAX as a minor upgrade to the 737 platform that did not require significant retraining. Originally inspired by Carol Gilligan, care

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ethics is an ethical theory which is centered around the value of relationships and holds that morals do not come from general moral principles (van de Poel, 2011).

Under care ethics, relationships are intimately connected with special responsibilities and moral obligations. As van de Poel points out in his analysis of care ethics, "The solution of moral problems must always be focused on the maintenance of relationships the people have with each other" (van de Poel, 2011). Care ethics emphasizes the importance of caring for those who are dependent and vulnerable. Arguing that caring is the foundation of morality and since the impulse to care is common to all humans, proponents of care ethics contend that the theory is not tightly bound to moral relativism (*Ethics of care | ethics and philosophy*, n.d.).

While "care" seems to have several overlapping definitions including "an ethic defined in opposition to justice, a kind of labor, and a particular relationship" care ethics most often defines "care" as "a practice, value, disposition, or virtue" (Sander-Staudt, n.d.). Joan Tronto expands on this idea by identifying four subelements of care which are: "(1) attentiveness, a proclivity to become aware of need; (2) responsibility, a willingness to respond and take care of need; (3) competence, the skill of providing good and successful care; and (4) responsiveness, consideration of the position of others as they see it and recognition of the potential for abuse in care" (Sander-Staudt, n.d.). In order to be acting ethically under the care ethics framework, an individual or organization must be faithful to all four subelements.

In what follows I will examine the case of the two Boeing 737 MAX using care ethics. First, I will establish a relationship between Boeing and passengers and crew of the 737 MAX planes that crashed. I will use two of Tronto's subelements, specifically attentiveness and responsibility, to show Boeing's failure to act ethically according to the duty of care ethics.

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Having established a moral obligation for Boeing to act as the care giver in the specified relationships, I will show that Boeing failed to act ethically by neglecting to be responsible according to the care ethics subelements discussed earlier.

Analysis

Boeing failed to deliver care to the crew and passengers of the 737 MAX via care ethic's sub-goal of responsibility. Its failure resulted in the deaths of 346 people. I will first establish relationships between Boeing and the 737 MAX crews and passengers, and the vulnerability and dependence experienced by the crews and passengers of the 737 MAX which is inherent to their relationship with Boeing. Having established Boeing's need to act according to care ethics due to the nature of the dependencies, I will analyze Boeing's actions regarding the care ethics subelements of attentiveness and responsibility.

Relationship

Before analyzing whether Boeing acted in good faith according to care ethics, I will first show that care ethics is applicable to this case study by examining the relationships between Boeing and the pilots of the 737 MAX flights and the relationship between Boeing and the passengers of the 737 MAX flights.

As van de Poel points out in his analysis of care ethics, care ethics emphasizes the importance of caring for those who are dependent and vulnerable. Though the pilots' and passengers' vulnerability and dependence on Boeing varies, the dependence and vulnerability are unquestionably present for both relationships.

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The pilots depend on Boeing to create a plane that works reliably and consistently so that they are able to safely operate the aircraft. Because it is not feasible for every pilot to understand and study every component of their aircraft, pilots must depend on airplane manufactures to provide proper training and documentation of all relevant systems. To that end, their reliance on the airplane manufacture to provide accurate and relevant documentation makes them particularly vulnerable to any failure in documentation as, due to the nature of their job, any failures could have life ending consequences for both the pilots and any passengers they may be transporting.

The passengers on a plane are even more vulnerable than the pilots, however, because passengers have no discourse with the airplane manufacturer and are simply along for the ride. While the passengers' dependence is most directly on the pilots, it can be extended to Boeing through the Pilots' dependence and vulnerability.

Attentiveness and Responsibility

Boeing does not seem to have any issues in regards to acknowledging the need to care (attentiveness) for crew and passengers who use its commercial planes; however, Boeing does have some missteps regarding its employment of responsibility.

Beginning with Boeing's attentiveness, I argue the MCAS system, the very system responsible for the two 737 MAX crashes is evidence of Boeing's acknowledgement of a need to care. For the MCAS system is at its core a safety feature as it was designed to stop the aircraft from stalling. Therefore, the inclusion of the MCAS system also shows responsibility – a willingness to respond and take care of a need Additionally, many of Boeing's design decisions on the 737 MAX and other airframes demonstrate its attentiveness. Some of these features

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include twin-engine jets designed to take off and land on only one engine and other redundant systems (*Boeing*, n.d.-b). Further the fact that Boeing provides extensive documentation is an indication of Boeing's attentiveness and of its responsibility. The fact that these items were created and implemented are some ways that Boeing is seen responsibly caring for its airplanes' passengers and crew. Boeing does, however, demonstrate one critical lapse in its responsibility.

Boeing's decision to market the plane as a minor upgrade to the 737 platform and its decision to sell it in such a way that pilots did not have to get recertified or do any additional simulator training is evidence of Boeing not fulfilling its duty to the responsibility subelement. At best, this marketing decision was a failure in communication between the marketing/sales department and the engineering department; at worst, it was an intentionally misleading act which resulted in the deaths of hundreds of people.

The Aviation Safety Reporting System, which is run by NASA, allows pilots to confidentially report safety issues without risking their careers. While there are many reports regarding the 737 MAX in the system, one in particular shows the level of comfort some pilots had with the 737 MAX. Report (ACN: 155501) submitted to the Aviation Safety Reporting system in June of 2018 said:

> I had my first flight on the Max… We found out we were scheduled to fly the aircraft on the way to the airport in the limo. We had little time [to] review the essentials in the car. Otherwise we would have walked onto the plane cold. My post flight evaluation is that we lacked the knowledge to operate the aircraft in all weather and aircraft states safely. The instrumentation is completely different – My scan was degraded, slow and labored

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> having had no experience w/ the new ND (Navigation Display) and ADI (Attitude Director Indicator)… (*ASRS Database Online—Results Display*, n.d.)

Report (ACN: 155501) is clear evidence that the preparation required of pilots transitioning to the 737 MAX from older 737 models was completely inadequate. This pilot's assertion that the instrumentation "is completely different" and that he or she "lacked the knowledge to operate the aircraft in all weather and aircraft states safely" shows that pilots were not being adequately prepared to fly the aircraft. It is especially important to note that this report was filed *before* the first 737 MAX crash. It is entirely possible, and likely, the pilot making these assertions did not even know about the introduction of the novel MCAS system introduced on the 737 MAX.

While it could be argued that it was the responsibility of the airlines, not of Boeing, to ensure proper training of their pilots, this is a flawed argument. Before airlines were even able to purchase the 737 MAX, the plane was certified as safe and reliable by both Boeing and the Federal Administration of Aviation (FAA). The airlines were buying an aircraft from a large company with a long, reputable history in the commercial aviation sector; therefore, there was no reason to question the training requirements approved by the FAA.

Evidence of Boeing's marketing strategy for the airframe is shown when Ed Wilson, Boeing's chief 737 Max pilot, promotes the aircraft. In a video which features Wilson sitting in the 737 MAX cockpit, Wilson states, "A pilot can walk into here, and he will be able to find everything... Just like he can in the NG. The FAA approved this for two and a half hours of computer-based training for the transition between the two aircraft." (*FlightGlobal talks to Boeing's Keith Leverkuhn about 737 Max certification progress*, n.d.) Wilson's claims about the

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ease of transition between the two aircraft are completely contradicted by many anonymous reports filed with the Aviation Safety Reporting System.

Report (ACN: 155501) stands in stark contrast with the claims made by Ed Wilson. It shows that Boeing was not willing to respond and take care of the pilots' need to be instructed on the new features of the 737 MAX when compared to the 737 NG. Further, some of the statements in Boeing's 2011 Annual Report give a glimpse into the company's motivation for these decisions. Discussing the decision to update the 737 platform rather than build an entirely new aircraft, the report states, "With development costs and risks far below an all-new airplane, the 737 MAX will provide customers the capabilities they want, at a price they are willing to pay…" (*2011 Annual Report*, n.d.) Because retraining pilots is part of the cost incurred by airlines when adopting a new aircraft, this statement shows that Boeing marketed the plane as requiring minimal retraining for financial reasons, not because the plane was so similar to its predecessor.

As the responsiveness part of the care ethics contract requires that the 'care giver' respond and take care of a need, it is clear that in this way Boeing acts unethically. As fly by wire systems are a widely accepted and expected feature in commercial aircraft, the decision to add larger engines to the 737 platform and knowingly create an unstable aircraft isn't inherently unethical because the problem could, in theory, be corrected with good software. However, the decision to make the plane more marketable to customers by eliminating any training costs or time for pilots is a failure in care ethics. Because of the vulnerability and dependence of the passengers and crew that would be onboard Boeing's 737 MAX, the company had a duty to care

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for them and failed to do so in order to make a more marketable aircraft. The introduction of the novel MCAS system required additional training, as is evidenced by the two 737 MAX crashes.

Conclusion

Care ethics shows that Boeing is morally responsible for the deaths that resulted from the 737 MAX crashes in Indonesia and Ethiopia. A special relationship existed between Boeing and all who died in those crashes – a relationship defined by dependence and vulnerability that morally obligated Boeing to care for them. However, Boeing ultimately failed under care ethics to demonstrate the responsibility required. Boeing's failure under care ethics is most clearly demonstrated by its decision to market the 737 MAX as a minor upgrade which required no additional training for pilots to fly.

Word count: 3009

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