# A Public-Private Partnership Disaster: The Aviation Industry's Reaction to the Boeing 737 MAX Incidents

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Charlie Houghton

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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.

*Charlie Houghton*

*Sociotechnical advisor*: Peter Norton, Department of Engineering and Society

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## Introduction

Soon after the Boeing 737 MAX series was introduced into commercial air travel in 2017, two of the planes crashed, killing 346 people: a Lion Air flight in 2018, and an Ethiopian Airlines flight in 2019. The FAA grounded all 737 MAX planes in March 2019, pending an international, scrupulous investigation by the National Travel Safety Board (NTSB) and the U.S. Department of Transportation (USDOT), among others. With the investigation complete and the 737 MAX back in service (Chappell, 2020), it is important to assess how U.S. airplane manufacturers, airlines, and U.S. aviation governing bodies have balanced profitability and efficiency with safety following the incidents.

NTSB, whose primary objectives include "making transportation safer by conducting independent accident investigations" (NTSB, 2017), found that both 737 MAX incidents were the result of "unintended MCAS operation" (NTSB, 2019). If the 737 MAX maintained a steep angle-of-attack (AoA) during flight, the MCAS system would engage and correct it by pitching down. NTSB (2019) found that, while the MCAS system functioned correctly, "erroneous AoA input," in conjunction with an ill-equipped crew who did not know how to disengage the MCAS system, was the primary cause for both accidents.

Scrutiny by journalists and NTSB also identified systemic oversight issues by FAA and management decisions by Boeing that allowed engineering concerns to go unchecked. NTSB's investigation and USDOT's oversight of FAA have resulted in a safer 737 MAX, but systemic oversight issues, company-wide management issues, and immovable short-term economic

incentives have persisted, allowing and incentivizing the aviation industry to continue prioritizing efficiency over safety. The 737 MAX case is not a unique instance of "organizational shortcomings involving a compromise in commitment to safety" (Englehardt et. al, 2021), and lessons learned from its discussion and resolution may frame future organizational governance beyond aviation and engineering.

**Review of Research**

Boeing claims that the 737 MAX is "one of the most thoroughly scrutinized aircraft in history" (Boeing Communications, 2020) including from researchers. During the approval process of the 737 MAX, FAA "shifted more authority" to Boeing, even allowing them "to choose many of the personnel who oversee tests and vouch for safety," creating an environment where FAA employees would face "retaliation for speaking up" (Robinson et. al, 2019). The Transportation Committee (2020b) identified that this, as well as other "numerous oversight lapses" by FAA, "played a significant role" in the 737 MAX crashes. Leveson (2019) argues that these broader issues necessitate a more robust risk analysis and accident model, that looks beyond incident-specific events as possible causes. Leveson attests that the popular pilot error explanation as "the most consequential factor" (Gates, 2019b) is a result of shortsighted accident modeling, claiming that "human error is a symptom of a system that needs to be redesigned."

Englehardt (2021) identifies four specific "ethical clashes" within Boeing that suppressed engineers' concerns including misaligned corporate culture, ethical "blind spots," "silo mentalities" or tunnel vision, and "organization weakness" in "leadership, loyalty, and whistleblowing." Vaughan (1996) explores similar issues within NASA in the 1980s resulting in the "normalization of deviance" that led up to the 1986 *Challenger* disaster, including safety rule

violations, “competitive pressures and resource scarcity,” and “regulatory ineffectiveness,” also present in the 737 MAX case.

Leveson (2019) speculates that the “past success of Boeing in promoting safety” has led to relaxed oversight by FAA, “essentially turning it into a self-certifying process for Boeing.” Cusumano (2021) argues that increased system complexity may be an explanation. Fang (2020) also favors a new certification process, stating that it “is imperative that FAA and Boeing implement stricter regulations for the 737 MAX and future aircraft” otherwise they risk losing global market share.

**The MCAS System Has Been Patched, but Needs to be Removed**

The primary enhancement of the 737 MAX compared to Boeing’s preceding model, the 737 Next Generation, are the more efficient LEAP-1B engines (CFM International, 2017). Boeing needed a series of hardware and software hacks to accommodate the new engines and Travis (2019) argues that the overreliance on these accommodations compromised the design integrity of the 737 MAX. The new engines were too tall to fit under the wing in the same place, so Boeing moved the engines, and thus the center-of-lift, forward. This created a “dynamically unstable airframe” where the plane approaching a stall has “a tendency to go further into the stall” (Travis, 2019). To deal with this symptom, Boeing introduced MCAS, a software fix. The MCAS system augments pilot input to counter this behavior (Boeing, 2020).

MCAS critics have advocated for its removal, but regulators have not echoed this sentiment. Travis (2019) argues that the MCAS system violates core design principles of simplicity and predictability and that “the airframe, the hardware, should get it right the first time and not need a lot of added bells and whistles to fly predictably.” Travis calls for the MCAS

system to be "removed altogether." Travis (2019) concedes that "MCAS is certainly much less expensive" than Boeing's alternative of "extensively modifying the airframe." Jim Marko, a Transport Canada aviation safety official, has also advocated for the removal of MCAS. Despite this, "international regulators have given no indication that they will require Boeing to remove MCAS from the Max" (Kitreoff et al., 2019).

Boeing has kept MCAS, but with a series of "enhanced protections." The recertified MCAS system reads from both AoA sensors and "will only be activated if both sensors agree," "only be activated once," and "will never override the pilot's ability to control the airplane using the control column alone" (Boeing, 2020). While Boeing has addressed the chief complaints with MCAS, its continued inclusion is a symbol of rushed engineering and represents Boeing's willingness to violate core engineering principles despite fatal consequences.

**FAA Oversight Processes Have Been Altered, but Remain Problematic**

FAA regulates the manufacture, operation, and maintenance of U.S aircraft (USDOT, 2018) to "provide the safest, most efficient aerospace system in the world" (FAA, 2019a). FAA shares information with the National Travel Safety Board (NTSB) (FAA, 2012). The U.S. Department of Transportation (USDOT) oversees FAA, and its primary objective is to ensure the U.S. "has the safest ... modern transportation system in the world" (USDOT, 2020). The House Committee on Transportation and Infrastructure (Transportation Committee), of which aviation is in its jurisdiction, noted oversight failings: the second of the two 737 MAX incidents occurred "just two years and two days after FAA had certified the new 737 derivative aircraft as safe to fly. Clearly it was not" (Transportation Committee, 2020b).

Much of the airworthiness approval process was delegated to Boeing by FAA for the 737 MAX via a problematic oversight model. Travis (2019) claims that "as airplanes became more complex and the gulf between what the FAA could pay and what an aircraft manufacturer could pay grew larger, more and more of those engineers migrated from the public to the private sector" and "soon the FAA had no in-house ability to determine if a particular airplane's design and manufacture were safe." This necessitated the role of a Designated Engineering Representative (DER), an engineer hired by airplane manufacturers but appointed by FAA to "find that engineering data complies with the appropriate airworthiness standards" and forward that information to their "advisor at the FAA" (FAA, 2020). Gates et al. (2019b) found that many DERs "officially designated to be the FAA's eyes and ears, faced heavy pressure from Boeing managers to limit safety analysis and testing so the company could meet its schedule and keep down costs." This pressure problem worsened when, in 2004, DERs were switched with Authorized Representatives (ARs). Unlike DERs, ARs are not individually certified by FAA. Instead, an organization within Boeing consisting of many ARs, called an Organization Designation Authority (ODA) is collectively certified. ODA ARs "report up the chain to their Boeing managers, not the FAA" allowing Boeing managers, not engineers, to "determine what was presented to the regulatory agency" (Gates, 2019a).

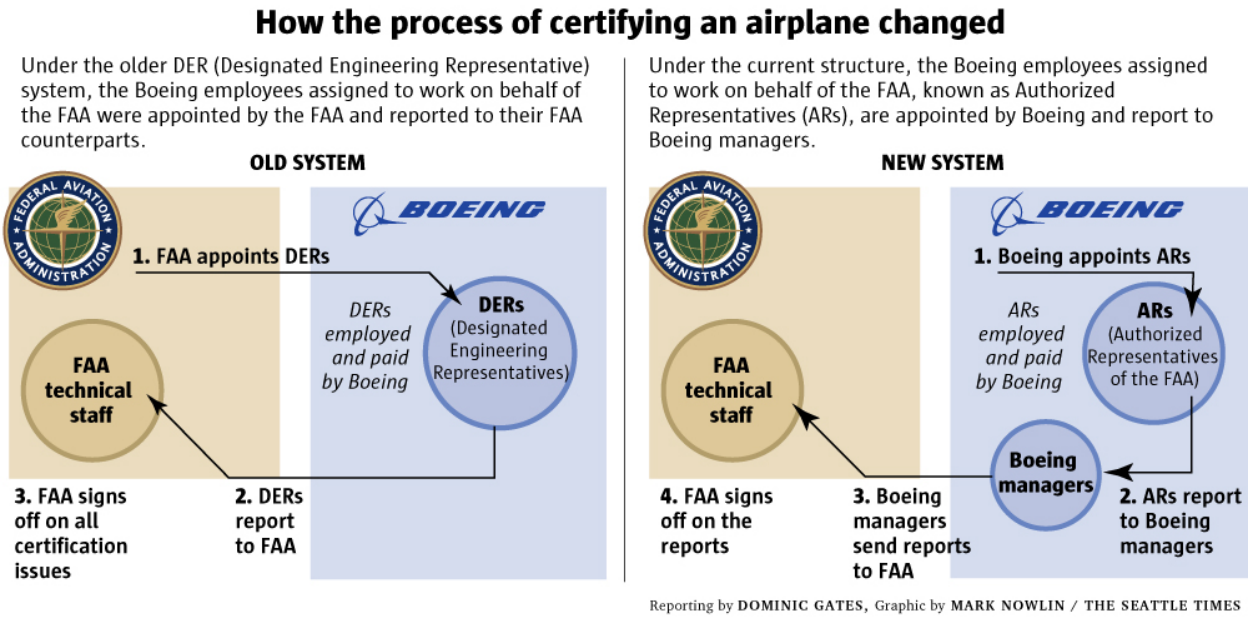


Figure 1. How the process of certifying an airplane changed in 2004 (Gates et al., 2019a)

This new accountability structure (fig. 1) limited FAA oversight, as "these designees now rarely interact with the FAA directly," and directly caused both incidents, as Boeing and FAA "agreed not to inform pilots about MCAS in manuals, even though Boeing's safety analysis expected pilots to be the primary backstop in the event the system went haywire" (Gates, 2019c). Leaked internal emails revealed that Boeing engineers had "no confidence that the FAA is understanding what they are accepting (or rejecting)" (Gelles, 2020).

The MCAS system was not the only 737 MAX system to be insufficiently tested as a result of the limited oversight FAA had via ODAs. In 2016, a Boeing AR "balked at Boeing management demands for less stringent testing of the fire-suppression system around the jet's new LEAP engines" (Gates et al., 2019a). Despite "all certification engineers in his unit" collectively agreeing "with his assessment," Boeing management was hesitant to approve their position, only doing so after intervention from "another senior engineer from outside the MAX program." Following the approval, the safety engineer was removed from the program "before conducting the testing he'd advocated."

Boeing's 787 Dreamliner has been subject to similar criticism. John Barnett, a former Boeing quality control manager, claims that "tests suggest up to a quarter of the oxygen systems could be faulty," and the "faulty parts were deliberately fitted to planes on the production line at one Boeing factory." Barnett was "stonewalled by Boeing managers" after attempting to investigate further and no initial investigation was conducted by FAA, stating that they "could not substantiate that claim, because Boeing had indicated it was working on the issue at the time" (Leggett, 2019).

Congress has stepped in to correct FAA's trajectory. Despite criticism regarding their ODA program, FAA stands by their decision, affirming its necessity and asserting that "FAA has never allowed companies to police themselves or self-certify their aircraft" (Schwellenbach et al., 2019). Internally, some FAA employees disagree with this sentiment. One employee claims that FAA was letting Boeing "certify 96 percent of its own work" (Kitroeff et al., 2019b). Despite continuing to promote the necessity and success of the ODA program, FAA has recognized its oversight limitations through fines levied on Boeing, totalling at least $7.85 million for pressuring "employees to rush inspections" (Aratani et al., 2020) and various other "ODA failures" (Hemmerdinger, 2021). In December 2020, Congress, following "months of debate and legislative wrangling," passed an FAA reform bill, "tightening FAA oversight" (Laris et al., 2020). Congress blamed FAA for "kowtowing to the demands of Boeing managers," and "failing to seek critical safety information," but also recognized Boeing's failure to provide such information. The bill outlines 14 instructions for FAA expressly to "improve safety systems … certification systems … FAA oversight … and compliance," including implementing ODA audits, "protection of whistleblowers," and "the prohibition on certain performance-based incentives." To do this, Congress also provided FAA with an additional "$10,000,000 for each of

fiscal years 2021 through 2030" (116th Congress, 2020). The full effects of the bill will not be known immediately, as some provisions have deadlines in 2022. Time will tell if ODAs, even with extra budget and governance, once again devolve back into the self-certifying processes that allowed the 737 MAX into the air.

**FAA Continues to Prioritize Efficiency Over Safety**

FAA developed ODAs to save money and to compete with EASA. FAA claims authority delegation via ODAs is important to maintaining a "level playing field with foreign competitors" in the global aviation market (FAA, 2021). The European equivalent airworthiness certification authority is the European Union Aviation Safety Agency (EASA). EASA has an ODA corollary, a Design Organisations Approvals (DOA). Like a DER, a DOA-certified engineer is individually certified, but like an ODA member, they do not report directly to EASA, instead "a DOA holder can … have compliance documents accepted by the Agency without further verification" and "perform activities independently from the Agency" (EASA, 2021a). Yang (2011) recognizes that "it is more effective to manage the designation organization," like FAA's ODA, "rather than the designation individuals," like FAA's DER and EASA's DOA, "because the designation organization could perform the self-audit" and this reduces "the workload of the authority." Gönenç (2001) recognized a "growing consensus that unnecessarily restrictive regulations may have led to significant losses of economic efficiency" and "recognising these shortcomings, several OECD governments have initiated reforms in the past two decades" to "improve efficiency … by increasing competition, … and enhancing airline governance." FAA estimated that DOAs would save the U.S. government "$24.9 million between 2006 and 2015" (FAA, 2005a), 0.18% of FAA's total budget in 2006 (FAA, 2005b**)**.

FAA and EASA work closely together via bilateral agreements to advance efficiency. In 2011, EASA signed an agreement "on cooperation in the regulation of civil aviation safety" with FAA (EASA, 2013), both parties believing "they should make the best use of scarce available resources to produce rules, and that cooperation in this field can be furthered without affecting their independence" (FAA, EASA, 2013). The agreement should "not relieve FAA, EASA's … statutory responsibilities to make findings of compliance with regulations" and provides "an alternative means for the authorities to make their findings, using the system of the other signatory country to the maximum extent practicable" (FAA, EASA, 2011). Historically, the EASA has approved "FAA's decisions without requiring further tests and certifications" (Johnson et al., 2020).

EASA distanced from FAA following the 737 MAX incidents. EASA pledged "no delegation to FAA" while they began recertification (Nair, 2019). The EASA required four conditions to be met by Boeing. Upon recertification, EASA asserted that "the two accidents" were "deemed sufficiently understood," "design changes proposed by Boeing to address the issues highlighted by the accidents" were "EASA approved and their embodiment is mandated, an independent extended design review has been completed by EASA, and Boeing 737 MAX flight crews have been adequately trained" (EASA, 2021b). EASA recertified the 737 MAX in January 2021, a month after FAA, working with FAA and Boeing only to request information to "draw [their] own conclusions" (EASA, 2021c). Recognizing oversight shortcomings by FAA, EASA committed themselves to a more thorough, independent investigation and a review of "systemic issues that may have contributed to the accidents so as to identify improvements that will contribute to a more resilient European and international certification framework" (EASA, 2020).

FAA's certification process was unchanged and oversight issues persisted. For the recertification of the 737 MAX, FAA (2020a) continued "to follow a robust certification process," giving no indication that it had been modified despite inviting "any changes that would improve our certification activities" (FAA, 2019b) and stating that they will "take steps to enhance our aircraft certification processes" (FAA, 2020b). The Transportation Committee found that FAA continued "to retaliate against whistleblowers instead of welcoming their disclosures in the interest of safety" and "FAA senior leaders may have obstructed Department of Transportation Office of Inspector General review of the 737 MAX crashes." The Transportation Committee affirms that "FAA senior managers have not been held accountable for the failure … despite repeated findings of deficiencies over several decades" (Transportation Committee, 2020a).

**Fierce Market Competition Continues to Push Boeing to Overpromise and Cut Corners**

Boeing is the second-largest airplane manufacturer in the world by market share, just behind their European competitor, Airbus (Morrison, 2020). As a publicly traded corporation, Boeing has a legal obligation to seek profit. Following the two 2018 and 2019 737 MAX accidents, Boeing's market share suffered, allowing Airbus and "non-Western manufacturers to fill the gap" (Fang, 2020). Some of the 737 MAX missteps can be attributed to Boeing's rushed production of the airplane to compete with Airbus's A320neo, which resulted in "extensive efforts to cut costs, maintain the 737 MAX program schedule, and avoid slowing the 737 MAX production line" (Transportation Committee, 2020c). In that effort, Boeing promoted the plane as being similar to the existing Next-Generation 737 model "minimizing MAX pilot transition

training," which "was an important cost saving for Boeing's airline customers"' and "a key selling point for the jet," leading to more than 5,000 orders (Gates, 2019c).

Airlines, including privately owned Lion Air and state-owned Ethiopian Airlines, are also profit-seeking. Airlines adopted the 737 MAX into their fleets because they were "better, lighter, and cheaper to fuel and maintain" than previous models (Topham, 2019). Profit-seeking behavior may also come in the form of safety assurances. One such example comes from Lion Air in 2017, when they asked Boeing for additional training resources for the 737 MAX, to which Boeing employees internally rebuked seeing the request as unnecessary (Gelles, 2020).

Pressure from American Airlines caused Boeing to overcommit to an airplane they could not robustly manufacture. In 2011, American Airlines, "an exclusive Boeing customer for more than a decade, was ready to place an order for hundreds of new" jets from Airbus. To maintain their presence in American Airlines' fleet, "Boeing ditched the idea of developing a new passenger plane, which would take a decade," instead, deciding "to update its workhorse 737, promising the plane would be done in six years" (Gelles et al., 2019). In July 2011, American Airlines finalized the $38 billion deal, ordering a total of 460 planes from Airbus and Boeing. American Airlines also intended to "order 100 of Boeing's expected new evolution of the 737NG, with a new engine that would offer even more significant fuel-efficiency gains over today's models," which became the 737 MAX (American Airlines, 2011). Financial incentives forced Boeing's hand, as "losing the American account would have been gutting, costing the manufacturer billions in lost sales and potentially thousands of jobs" (Gelles et al., 2019).

Following the 737 MAX recertification, Boeing has been "trying to sell canceled 737 MAX orders" (Boon, 2020), which has drawn the attention of low-cost airlines including Ryanair and Southwest Airlines. In December 2020, Ryanair ordered 75 737 MAX planes (Ryanair,

2020), likely with “discounts in excess of 50% of list prices” (Johnson, 2020). In March 2021, Southwest Airlines, Boeing’s “biggest customer of the 737,” placed the “biggest Boeing 737 Max order since it was grounded,” ordering 100, also likely at “a big discount on the planes” (Josephs, 2021).

Airline pressures on Boeing have persisted, even from Boeing’s historically most loyal customers. Despite being historically Boeing-only airlines (Southwest Airlines, 2019; Ryanair, 2021), Ryanair and Southwest Airlines have considered incorporating Airbus into their fleets, exerting similar pressure on Boeing as American Airlines did in 2011. Before finalizing the deal with Boeing, Southwest Airlines was “evaluating the Airbus A220-300 against the Boeing 737 MAX7,” potentially complicating “the Southwest relationship,” which “meant billions of dollars in sales of aircraft, spare parts, upgrades, training, and other services” for Boeing (Goldstein, 2021). Ryanair exclusively flew Boeing aircraft until the acquisition of Lauda Airlines in 2018 (Reddan et al., 2018). In March 2019, Michael O’Leary, the CEO of Ryanair, was in “early talks with Airbus about an order for 100 A321s and that Ryanair wanted to have a dual Boeing-Airbus fleet.” Despite planning on increasing Lauda Airlines’ fleet with 15 more Airbus A320s, Airbus negotiations fell-through, and Ryanair “will cancel almost all” Airbus deliveries over the next 12 months (Humphries, 2020).

**Conclusion**

The 737 MAX case is a lesson in oversight and how systemic degradation of it can have disastrous but avoidable consequences. Airplane manufacturers, airline companies, and aviation regulatory authorities will continue to operate as cost-efficiently as possible. It is the responsibility of regulatory authorities to alter incentive structures if free market forces fail to

incentivize appropriate firm behavior. In this case, regulation must make the pursuit of safety more efficient, profitable, or justifiable than knowingly compromising it, as Boeing has continued to do by opting for patch fixes rather than an expensive redesign. Any regulatory agency in a safety-critical domain must constantly reevaluate imposed incentives on firms, especially if that agency is relaxing oversight for the sake of efficiency, like FAA. If problematic systems become well established, they become difficult or expensive to remove, demonstrated by Boeing's MCAS system and FAA's ODAs. FAA and Boeing have continued to compromise safety in pursuit of efficiency and until these priorities are corrected and underlying systems are significantly reworked or removed, either by legislation or by revaluation of long term costs, the aviation industry will be no safer than before the incidents.

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