The Ongoing Tragedy of the 737 MAX

By Chuck Dinerstein, MD, MBA — September 22, 2020

Perhaps it is my longstanding interest in my professional failures or how understanding failure makes my work better and my actions more resilient, but I was drawn, much like a moth to the flame, to the full Congressional report on the 737 MAX. In a week of important news, it was mentioned and then overlooked – that is a mistake.

The full report is quite long, the Executive Summary is 33 pages, and the link to all the primary material is at the end. I have put the tale together in my own way, providing emphasis in bold italics. The report made me increasingly angry, much the way I felt when I discovered that Congress had built itself a bunker against a nuclear war while simultaneously rattling sabers and without mentioning it to the public.

COVID-19 has politicized our government’s response to a novel health crisis. Both sides have argued over disinformation and malfeasance. The report on the 737 MAX does not have that political emotional gist, but it uncovers very distressing behavior motivated not by politics, but by greed and an abrogation of responsibility. It is difficult to reduce a 33-page summary, you need to take the four or five minutes necessary to read it all. It is time to take a deeper dive, it is a matter of life and death, for you, your family, and friends.

- “…the 737 MAX contained a new feature in its flight control computer—the Maneuvering
The new system had the ability to trigger non-pilot-commanded flight control movement that could place the airplane into a dangerous nose-down attitude that challenged the pilots’ ability to control the aircraft. In addition, the MCAS software operated on input from one of the two angle-of-attack (AOA) sensors externally mounted on the fuselage on either side of the airplane.

This new system took control of the plane away from the pilot, the software was in charge. And the software took its information from one, not two, sensors. We have safeguards in place for these new systems, a number of tests, both virtual and real looking for failures, for what are called edge cases.

- “Both Boeing and the FAA failed to appropriately designate MCAS a safety-critical system.”
- “In June 2013, Boeing employees formulated a plan to help avoid increased “cost,” and “greater certification and training impact” for the 737 MAX by describing MCAS as “an addition to [the existing] Speed Trim [system].”
- “In March 2016, the General Manager of Boeing’s 737 MAX program, Keith Leverkuhn, and Michael Teal, the former Chief Project Engineer on the 737 MAX program, both approved a redesign of MCAS to increase its authority to move the aircraft’s stabilizer at low speed, in order to address “stall characteristics” requirements necessary for FAA certification
  - “Michael Teal, acknowledged that when he approved the MCAS redesign in March 2016 he was unaware: 1) that MCAS operated from a single AOA sensor, 2) that MCAS could activate repeatedly, or 3) that Boeing had internal test data showing that one of its own test pilots took more than 10 seconds to react to uncommanded MCAS activation in a flight simulator, and described the results as “catastrophic.”
  - “Mr. Teal defended his lack of awareness of these key attributes on a system he approved saying he relied on the advice of the engineers on the MAX program. ... he did not actually supervise any engineers.”
- “After Boeing redesigned MCAS in 2016 to increase its authority to move the aircraft’s stabilizer at lower speeds, Boeing failed to reevaluate the system or perform single- or multiple-failure analyses of MCAS.”
- “Just hours after the approval for MCAS’s redesign was granted, Boeing sought, and the FAA approved, the removal of references to MCAS from Boeing’s Flight Crew Operations Manual (FCOM) – a document that provides procedures, performance, and systems information to flight crews to enable their safe and efficient operation of the airplane. As a result, 737 MAX pilots were precluded from knowing of the existence of MCAS and its potential effect on aircraft handling without pilot command.”

The angle of attack sensors (AOA) that fed information to MCAS was designed to feed redundant information to MCAS. It makes sense, redundant information improves reliability. Of course, sensors may disagree, one may not be working properly, so again the software has a system to inform the pilot of the disagreement and to make a human choice about what to do. In the 737 MAX, this is done with an AOA Disagreement Alert.

- “In August 2017, five months after the 737 MAX was certified by the FAA and three months
after it entered revenue service, Boeing issued a problem report to its supplier complaining that *the 737 MAX’s AOA Disagree alert was tied to the optional AOA Indicator and therefore was not functioning on the vast majority of the 737 MAX fleet worldwide.* … Rather than immediately informing the FAA and Boeing customers about this issue when it was discovered in August 2017, and advising Boeing to fix the problem via a software update as soon as possible, *a Boeing AR [1] consented to Boeing’s plan to postpone the software update until 2020,* three years later, so it could be done in conjunction with the rollout of Boeing’s planned 737 MAX-10 aircraft.

- “Although the AOA Disagree alert was not considered a safety critical component, Boeing knowingly delivered 737 MAX aircraft to its customers with inoperable AOA Disagree alerts that did not conform to the airplane’s amended type certificate. … the FAA has failed to take any measures whatsoever to hold Boeing accountable for knowingly delivering aircraft with non-functioning AOA Disagree alerts to their customer airlines and failing to inform MAX pilots or the FAA that an item that was supposed to be a standard feature in the cockpit was inoperable.”

**Why would this happen? As is often the case, follow the money.**

- “Costs, schedule, and production pressures at Boeing undermined safety of the 737 MAX.”
- “In 2012, in order to lower costs of the 737 MAX program, *Boeing reduced the work hours involved in avionics regression testing* on the 737 MAX by 2,000 hours. It also examined other reductions to save costs”
- “In June 2018, *Ed Pierson, a senior Boeing plant supervisor* at the company’s Renton, Washington 737 MAX production factory, emailed Scott Campbell, the 737 General Manager, requesting a meeting about “safety concerns.”
  - “Mr. Pierson described multiple concerns about production and schedule pressures that were impacting quality control and safety issues. *As a retired Naval Officer and former Squadron Commanding Officer,*” wrote Pierson, “*I know how dangerous even the smallest of defects can be to the safety of an airplane. Frankly right now all my internal warning bells are going off. And for the first time in my life, I’m sorry to say that I’m hesitant about putting my family on a Boeing airplane.*”
  - “In July 2018, … he finally met with Mr. Campbell … he told Mr. Campbell that in the military they would temporarily halt production if they had the kinds of safety problems that Mr. Pierson was seeing on the MAX factory floor. *Mr. Campbell allegedly responded: “The military is not a profit-making organization”….Boeing continued to ramp up production on the 737 MAX”*

The financial concerns run deeper still. Remember, MCAS, was not an addition as Boeing contended, but a new system – one that requires more testing and training.

- “*If we emphasize MCAS is a new function there may be a greater certification and training impact.*” According to the email that summarized the meeting minutes, a Boeing AR concurred with this plan.”
- “*Boeing had tremendous financial incentive to ensure that no regulatory determination requiring pilot simulator training for the 737 MAX was made.*”
Under a contract signed ...with Southwest Airlines, the U.S. launch customer for the 737 MAX, Boeing was financially obligated to have discounted the price of each MAX airplane it delivered to Southwest by at least $1 million if the FAA had required simulator training for pilots transitioning ... to the 737 MAX. ... Southwest had 200 firm orders for the MAX with the option to purchase an additional 191 MAX aircraft. Thus, if Boeing failed to obtain Level B (non-simulator) training requirements or less from the FAA it would have owed Southwest between $200 to nearly $400 million.

- “In November 2012, for instance, it took a Boeing test pilot more than 10 seconds to respond to uncommanded MCAS activation during a flight simulator test, a condition the pilot found to be “catastrophic.” The FAA has provided guidance that pilots should be able to respond to this condition within four seconds. This event should have focused Boeing’s attention on the need for enhanced pilot training for MAX pilots. It didn’t.”
- “…In August 2016, the FAA granted provisional approval for Level B (non-simulator) differences training requirements for pilots transitioning [to] the 737 MAX. In March 2017, the month the 737 MAX was certified by the FAA, Boeing’s 737 Chief Technical Pilot responded to colleagues about the prospects of 737 MAX simulator training, writing: “Boeing will not allow that to happen. We’ll go face to face with any regulator who tries to make that a requirement.”

What about the FAA?

Those Boeing Authorized Representatives, the ARs, are an example of what is called regulatory capture, having the fox guard the henhouse. They failed in their duty to the FAA, and by extension to us. That they were employed at all, is a failure of the FAA and the revolving door between government and industry.

- “Boeing’s Authorized Representatives (ARs) may be impaired from acting independently. ...A 2016 Boeing internal survey of its ARs, found that 39 percent of Boeing ARs that responded perceived “undue pressure” and 29 percent were concerned about consequences if they reported potential “undue pressure.”
- “The Committee has documented four instances in Boeing’s 737 MAX program where Boeing ARs failed to represent the interests of the FAA in carrying out their FAA-delegated functions. In one instance, in 2013, an AR concurred on a decision not to emphasize MCAS as a “new function” [and] ... the Committee found no evidence that any of the four Boeing ARs who knew that Boeing had evidence demonstrating that in 2012 it took a Boeing test pilot more than 10 seconds to respond to uncommanded MCAS activation in a flight simulator, a condition the pilot found to be “catastrophic,” informed the FAA of this critical information.”
- “Not all of these instances violated FAA regulations or guidance. However, every one of them indicates that Boeing ARs are not communicating fundamentally important information about safety, certification or conformity-related issues to the FAA that could drastically enhance the agency’s oversight functions and greatly improve its understanding of potential safety issues on aircraft it is obligated to certify as safe.”
Nor should we leave out the FAA itself

- “FAA management has **undercut the authority and judgment of its own technical experts** and sided with Boeing on design issues that failed to adequately address safety issues and appear to have violated FAA regulations or guidance, in some instances. These issues go beyond the 737 MAX program.”
- “The agency did not ask enough questions or sufficiently scrutinize Boeing responses regarding critical certification-related issues involving pilot training and technical design.”
  - The FAA has, for instance, **as of the publishing of this report, failed in its duty to hold Boeing accountable for delivering airplanes with non-functioning AOA Disagree alerts that Boeing knew were inoperable.**
  - “Boeing received an FAA exception to allow the company to not install on the 737 MAX an Engine Indicating and Crew Alerting System (EICAS)—a system common in newly type certificated aircraft since 1982 that displays for pilots aircraft system faults and failures and helps pilots prioritize their response to multiple or simultaneous indications, warnings, and alerts. The FAA accepted Boeing’s argument about the impracticality and the economic expense of installing EICAS on the 737 MAX. The 737 family, including the 737 MAX, is the only Boeing commercial aircraft line that does not have an EICAS installed”

- "In December 2019, Ali Bahrami, the FAA’s Associate Administrator for Aviation Safety, seemed unaware of key issues related to the 737 MAX accidents. …He said he was not familiar with the details of FAA’s post Lion Air TARAM analysis that predicted 15 more fatal accidents …He was also unaware of the fact that Boeing had conducted its own tests that showed it took a Boeing test pilot 10 seconds to respond to uncommanded MCAS activation in a flight simulator, …despite the fact that this information had been made public at a high profile Committee hearing”
- “After the Lion Air crash, the FAA’s Boeing Aviation Safety Oversight Office (BASOO) started an internal review of its MCAS certification process on the 737 MAX. The review was the first time FAA performed its own detailed analysis of MCAS and the first time FAA received a complete picture of how MCAS operated. …The FAA review also found that there was nothing discovered that required “corrective action,” although they cited some areas for potential “improvement.” The draft report’s analysis showed that the MAX was compliant with FAA regulations, raising serious questions about the FAA certification process and its oversight of Boeing. …The FAA never finalized this report.”

I’ll end this with the beginning of the Committee report:

“The report reveals several unmistakable facts. The MAX crashes were not the result of a singular failure, technical mistake, or mismanaged event. They were the horrific culmination of a series of faulty technical assumptions by Boeing’s engineers, a lack of transparency on the part of Boeing’s management, and grossly insufficient oversight by the FAA—the pernicious result of regulatory capture on the part of the FAA with respect to its responsibilities to perform robust oversight of Boeing and to ensure the safety of the flying public. The facts laid out in this report document a disturbing pattern of technical miscalculations and troubling management misjudgments made by
Boeing. It also illuminates numerous oversight lapses and accountability gaps by the FAA that played a significant role in the 737 MAX crashes. … that resulted in the tragic and preventable deaths of 346 people.”

The report makes me so angry. These were the people who have been entrusted with the safety of my family. If this type of behavior had occurred in a medical setting, long after my medical malpractice insurance had quickly written a check pleading no contest, I would be looking at charges of criminal negligence.

**Boeing and the FAA repent their wicked past?**

“We have been hard at work strengthening our safety culture and rebuilding trust with our customers, regulators, and the flying public. … As this report recognizes, we have made fundamental changes to our company as a result, and continue to look for ways to improve. Change is always hard and requires daily commitment, but we as a company are dedicated to doing the work.


And from their co-conspirators, the [FAA](https://www.faa.gov/news/updates/?newsId=93206) [3]:

“We are already undertaking important initiatives based on what we have learned from our own internal reviews as well as independent reviews of the Lion Air and Ethiopian Airlines accidents. These initiatives are focused on advancing overall aviation safety by improving our organization, processes, and culture.”

[1] Boeing Authorized Representatives (ARs)—Boeing employees who are granted special permission to represent the interests of the FAA and to act on the agency’s behalf in validating aircraft systems and designs’ compliance with FAA requirements