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# **Boeing’s Fatal Mistake: The Groundings of 737 MAX 8 in 2019**

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Aviation Safety has come through a long journey. Many lives have died out to achieve such a safety and secure aviation systems as we are having these days. Boeing has been an iconic American company since the beginning, gaining reputation and trust worldwide. But in 2018, they made a fatal mistake which resulted in 2 consecutive crashes in 5 months, ending up exposing corporate deception, internal crisis and broken regulatory process with the investigation of the US government and multiple agencies, including the Transportation Department, FBI, NTSB and Inspector General. 346 people were killed. Everything begins with a software system that is “supposed to keep people safe that instead led to their death” (PBS Frontline – Boeing’s Fatal Flaw).

## **I, Two consecutive crashes in 5 months**

### *1, Lion Air Flight 610 – the beginning of the tragedy.*

- Information:

Lion Air Flight 610 (JT610) was a scheduled domestic flight from **Soekarno-Hatta International Airport**, Jakarta to **Depati Amir Airport**, Pinang, Indonesia. On 29th October 2018, the Boeing 737 MAX 8 that was operating the route – crashed into the Java Sea 13 minutes after takeoff, killing all 189 passengers and crew. This was an aircraft introduced in 2017 and the crash was the deadliest accident in Lion Air’s history. The Indonesian government’s search and rescue found the debris and human remains soon after and the first victim was identified two days after the crash. Two black boxes – the Flight Data Recorder (FDR) and the Cockpit Voice Recorder (CVR) were found, but the CVR was heavily destroyed. The fact that something was designed to withstand a disastrous accident like the CVR that instead - completely destroyed in the scenario - showed how severe the accident was. According to PBS Frontline’s Documentary, “…no part of a human remain was bigger than a femur.”

- Aircraft and crew.

+ Aircraft: The aircraft involved in the accident was a Boeing 737 MAX 8, registered PK-LQP, powered by two CFM International LEAP-1B jet engines and made its first flight on July 13th, 2018. At the time of the accident, it had come through 895 flying hours containing 443 cycles of operation.

+ Crew members:

\* Captain **Bhavye Suneja**, who has come through 6,028 hours of flight experience (including 5,176 hours on the Boeing 737)

\* First Officer **Harvino**, who has come through 5,174 hours of flight experience (including 4,286 hours on the Boeing 737).

Many blamed the pilot, including Boeing – the manufacturer of the aircraft. The FDR found on November 1st, 2019 shows severe malfunction in the horizontal stabilizers. The aircraft continuously tried to push the nose down, but the pilot tried to stop the plane from diving into the deep Java Sea. Inside Boeing, they quickly diagnosed the problem but still stood by the MAX as thousands took off from several airports worldwide every day, which led to a series of decisions that kept the plane in the air. And then, another crash occurred.

### *2, Ethiopian Flight 302 – the last straw.*

- Information:

Ethiopian Flight 302 was a scheduled international flight from **Bole International Airport**, Addis Ababa - Ethiopia to **Jomo Kenyatta International Airport**, Nairobi – Kenya. On March 10th, 2019, the aircraft crashed near the town of Bishoftu, Ethiopia just 6 minutes after takeoff, killing all 157 people on board. This is the deadliest accident to date in Ethiopian Airline’s history and the second Boeing 737 MAX 8 accident occurred in less than five months.

- Aircraft and crew:

+ Aircraft: The aircraft was a Boeing 737 MAX 8, registered ET-AVJ and also powered by two CFM International LEAP-1B jet engines. It was manufactured in October 2018 and delivered on November 15th, 2018. It has come through 1,330 hours including 382 cycles of operation at the time of the accident.

+ Crew members:

\* Captain **Yared Getachew** has come through 8,122 flight hours experience (including 4,120 hours on the Boeing 737)

\* First Officer, **Ahmed Nur Mohammod Nur** has come through 361 flight hours (including 207 hours on the Boeing 737). He was a recent graduate from the airline’s academy.

Two aircraft, the same type, same engine, crashed – in less than 5 months. 346 people killed. The Boeing Company’s reputation has tattered. What has Boeing done during the development of the 737 MAX 8?

## **II, The fierce rivalry**

### *1, The story*

Airbus and Boeing have long been the two largest aircraft manufacturers in aviation and they have a “fierce rivalry” (Vox). They have such a competition that, if one of them can offer a better plane, the other could lose a lot of money. And this happened at the 2011 Paris Air Show. Airbus updated their most popular model, a single-aisle aircraft – the A320. They slide in the brand-new CFM International LEAP-1A. which is much larger than its predecessor but it makes the airplane 15% more fuel-efficient. Also, a pilot could walk into the cockpit with minimum additional training and still operate the aircraft just like the one before. It was the A320 NEO (New Engine Option), and it would save the airlines millions of dollars every year. For the first time, Gerard Arpey – the CEO of American Airlines at that time – called Jim McNerney – the CEO of Boeing – to tell their long-time aircraft supplier that they are going to go with the competition. For the first time in history, an American airline decided not to use American aircraft. **“And that is essentially a dagger in the heart of Boeing”**, said atalie Kitroeff, New York Times reporter.

### *2. Boeing pulled the trigger on releasing the 737 MAX*

The release of A320 NEO placed enormous pressure on Boeing. They have to re-engine their most successful single-aisle aircraft – the 737. 40% of Boeing’s profit is from the 737. They have to make such things that Airbus has done on their A320 NEO: fuel-efficient, minimum pilot training yet still operate the same as its predecessor. They decided to use a similar engine – the CFM International LEAP-1B. But the 737 was a 50-year-old aircraft. It was a completely different design from the A320. So what was the problem when they slide in the new engine?

### *3, CFM International LEAP-1B*

The first challenge arises when it comes to sliding in the new engine. The A320 has a longer gear, which makes it pretty much higher to the ground. Airbus can easily slide in the new engine since there is so much space under the wing. But the 737 was such an old aircraft that the gear was so low to the ground and there wasn’t enough room for the new engine to slide in. This is a challenge for Boeing. They were looking on the 737 MAX program to restore their own credibility after being over budgeted on their 787 program and 747-8 program. So they have to devise a solution that solves the problem – without re-designing their 50-year-old aircraft. Their solution was to move the engine higher and further forward. Also, they have to lengthen the front gear in order to achieve a better position. They have succeeded in sliding in the new engine. But then, another problem…arised.

### *4, A problematic system.*

Moving the engine further forward has a downside: it moves the balance point further backward. When the plane is in full thrust (e.g. during take-off…), the nose will tend to move too far upwards – due to the backward balance point, which would lead to a stall situation. A stall situation occurs when the angle-of-attack (AoA) becomes so high that it exceeds the critical angle-of-attack, thus separating the airflow - resulting in a loss of lift coefficient that would make the aircraft fall out of the sky. This is a real problem for the 737 MAX. So, Boeing had to rely on a system that they previously used on the KC-46 Pegasus – a military tanker. It was designed to smooth out very “unusual” maneuvers of the aircraft, “situation that hopefully the plane would never get in” (Jack Nicas, New York Times reporter). Its name is **Maneuvering Characteristic Augmentation System (MCAS).**

Its mission was to take the data input from the AoA sensors and push the nose down when it believed that the plane might go into a stall. To prevent the nose from getting too high, the system would move the horizontal stabilizer on the back of the plane upward to push the nose back down. However, Boeing has two changes that made MCAS so much more aggressive yet very deadly:

1, It was made much more powerful: It was not until Boeing got into test flight did they realized that they had to expand MCAS. At first, they thought the MAX only needed MCAS at high-speed situation. But it turns out, the aircraft need the system even at low-speed situation. So, MCAS was allowed to make bigger movements of the horizontal stabilizer. This made MCAS a safety-critical system. On an airplane, you can never have a safety-critical system that relies on a single point of failure. But the second change was much more problematic and made the system so deadly.

2, It relies on only ONE Angle-of-attack sensor, instead of two: The angle-of-attack (AoA) sensors, mounted on either side of the fuselage, near the cockpit. Its mission was to measure the angle of attack on an aircraft. And on the MAX, it also has the power to trigger MCAS. But, AoA sensors are known to be faulty. Just a small impact on the sensor (for example, a bird strike) can malfunction the sensor. On the MAX, if that single sensor is damaged or becomes unreliable, it will send a wrong message to MCAS, which triggers the system and makes it try to take over the plane from the pilots. In a coordination sheet, Boeing said: “**With pilot training** to recognize the runaway, a reaction time scenario greater than 10 seconds found the failure to be catastrophic.”

- *“So if you don’t respond in less than 10 seconds to this situation, you can’t recover. 10 seconds, which is ridiculous.”* (Capt. Dan Carey, Netflix’s Documentary “Downfall: The Case Against Boeing”)

- *“So basically, ten seconds, you’re dead.”* (Peter Anthony DeFazio, Netflix’s Documentary “Downfall: The Case Against Boeing”)

These 2 factors showed a very problematic system and revealed Boeing’s internal crisis. But why was it kept concealed from the pilots?

### *5, Concealing became killing*

In an email, Lion Air said “Wouldn’t it be better to have some additional training?”. They have the feeling that something has changed on the MAX. But in a response to the Lion Air email, Boeing said: “There is absolutely no reason to require your pilots to have a MAX simulator to begin flying the MAX.” If Boeing had told the truth about MCAS’ power, worldwide simulator training would be required for the 737 MAX. Boeing has an obsession with simulator training being kept to a minimum. This concealment made the aircraft successful, which soared the company’s profit. They sold over 5,000 MAXes all around the world. Everyone thought that the good times would never end. But it did on October 28th, 2018.

The Lion Air was not being aware of the system due to Boeing’s concealment. They did not know how this system works. They did not even know the name of the system nor the existence of the system on the aircraft.

- *“And the pilot never understood that it was trying to kill them.”* (Capt. Chesley Sullenberger, Netflix’s Documentary “Downfall: The Case Against Boeing”).

## **III, What can we learn from the case?**

This was the deadliest project in the history of Boeing. 346 people were killed, due to the greediness of Boeing’s board and the pressure from Wall Street. This ended up exposing the ruined safety culture that Boeing has been building and wasting several hard-working hours of Boeing’s employees. What we will always have to remember is that whatever we are doing these days, safety is the top priority of every single product. Also, if we want to boost our profit, we have to be very careful of every single decision that we make and always be truthful about every single problem that arises during the development of any products.

- *“It was their greed. Are the profits more important than the human life?”* (Garima Sethi, Bhavye Suneja’s wife, Netflix’s Documentary “Downfall: The Case Against Boeing”).

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