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Boeing 737 Max: Air safety, market pressures and cockpit technology

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In just five short months, two Boeing 737 Max 8 airliners crashed, killing a total of 346 passengers and crew members. Both occurred shortly after take-off, and the similarities between the two catastrophes raised fundamental questions about the aircraft's safety. It was grounded by nation after nation, with only Canada and the United States holding out. Finally, they too halted flights on March 13.

A Boeing 737 taxies at Manchester Airport in the United Kingdom.nickyhardinguk/Pixabay

The 737 Max – the fastest-selling airliner ever and the heart of Boeing's business – is now grounded worldwide, a first. A boycott by travellers , cancellation of orders, and demands for compensation by airlines could have disastrous consequences for the Seattle-based manufacturer. It also raises questions about the ever-increasing sophistication of cockpit technology.

Narrow-body jet with a long history

The 737 is a narrow-body, twin-jet airliner with a long history. It entered service in 1968 and over the decades, Boeing has built and sold more than 10,000, making it the best-selling airliner in history. The 737 Max, first delivered in 2017, is the fourth generation and with 370 deliveries and 5,011 more on order, it represents 64% of Boeing's production over the next 14 years. In 2011, the company made the world's biggest ever single sale of commercial aircraft, when Indonesia's Lion Air committed to buying 201 Boeing 737 Max and 29 Boeing 737-900 ER for a total of $22bn.

Boeing started development of what would be the 737 Max after American Airlines, a long-time customer, opted for Airbus in July 2011. To match the energy efficiency of the 737's direct competitor, the A320neo, Boeing decided to improve the design and placement of the 737's engines, increasing their size and positioning them higher and further forward. The new aerodynamics and lighter materials cut fuel consumption by 14%, but also required new stability control systems and other significant changes.

Max efficiency, max reliability, max passenger appeal: Boeing's new 737 Max.

The 737 Max is available in four configurations, the most popular of which are the Max 8 and 9, with 210 and 220 passengers, respectively. To speed getting the aircraft to market and into the air, Boeing's strategy was to make the new versions similar enough to the previous ones that pilots didn't need to be retrained. While this made sense as a commercial strategy, some pilots complained that the new embedded systems made the 737 Max a completely different aircraft to fly.

Separate crashes, similar circumstances

The first fatal 737 Max crash took place on October 29, 2018. Lion Air flight JT610 left Jakarta for Pangkai Pinang under ideal conditions. The plane was brand new and the weather good. After 11 minutes, however, the pilots reported technical problems and attempted to turn back, but in vain. The plane could not gain altitude, nosedived, and plunged into the Java Sea less than 15 minutes after take-off. All 189 passengers and crew died.

The second crash occurred on March 10, 2019. That day, Ethiopian Airlines flight ET302 took off from Addis Ababa, heading for Nairobi. The plane was delivered a year earlier and given a technical check just a month before. The pilot was highly experienced, having flown more than 8,000 hours. Six minutes after take-off, however, he reported technical difficulties and asked to turn back. The request was granted, but the plane disappeared from radar. The death toll was 157, including 35 different nationalities. An entire UN delegation of 19 people perished.

A crew works with an investigative team to clear the crash site of a Boeing 737 Max 8 operated by Ethiopian Airlines. All 8 crew and 149 passengers died in the March 10 accident. Tony Karumba/AFP

Suspicions of sensor and software malfunctions

Given the similarity of the two crashes, aviation experts consider them unlikely to be a coincidence – there had to have been a genuine, serious cause, and one could call into question certain aspects of the 737 Max's design. Indeed, a 2018 report by US Federal Aviation Administration (FAA) indicates that incidence sensors, also called angle of attack (AOA) sensors, designed to avoid a stall, are suspected of being defective on at least 246 737 Max around the globe. The information provided by these sensors, whose purpose is to stabilize the plane, may mistakenly cause it to nosedive.

In fall 2018, US 737 Max pilots registered their concerns in a NASA database about an autopilot anomaly that could cause the plane to nosedive. There were also complaints that the plane's instruction manual was "inadequate and almost criminally insufficient".

In the case of the two 737 Max 8 crashes, the "manoeuvring characteristics augmentation system" (MCAS) is suspected of having failed. The preliminary report on the Lion Air crash states that the pilot was unable to overcome an automatic nose-down command triggered more than 20 times. A similar malfunction happening the day before on the same plane, yet many pilots were unaware that it could occur even when the plane is flown manually. A note issued by Boeing to airlines operating the 737 Max provides guidance in the event of failure of the new safety system – the correct behaviour being simply to disable it. In response to continued concerns, Boeing responded announcing a patch for the MCAS.

On March 11, Boeing CEO Dennis Muilenberg defended the 737 Max and attempted to defuse speculation about its integrity and inherent safety. The following day, the FAA issued a statement asserting that the Max 8 and 9 were both airworthy. Paradoxically, the FAA simultaneously demanded that Boeing make changes to the MCAS by April at the latest. US airlines such as Southwest, United and American initially decided to continue using their 60 Boeing 737 Max, stating their confidence in the plane.

With more than 370 examples in service as of February 2019, tens of thousands of passengers travelled on the 737 Max every day, and many were increasingly concerned. There were reports of travellers attempting to change or cancel trips when they found out they would be flying on one, sometimes refusing to board. Hashtags such as #GroundBoeing737 began to spread on Twitter.

> *Too soon or too late to #GroundBoeing737 #Max8 ?⁦#Boeing737Max https://t.co/j9I2ALFq2V via ⁦@nytimes⁩ ⁦@BoeingAirplanes⁩ #boeing— Graziano Pinna (@graziano_pinna) March 12, 2019*

On Monday, March 11, a number of countries announced that they would immediately ban 737 Max flights, including Ethiopia, Indonesia, and China. India did so the same day, a move that affected at least two carriers with a total of 18 planes. The FAA and the US and Canadian governments continued to assert that there was no evidence of a link between the two fatal events, nor any danger of flying the 737 Max. That changed on Wednesday, March 13, when both countries finally grounded the aircraft.

Distrust and cancelled orders

With the 737 Max now grounded, some operators have demanded compensation, while others with planes on order are considering cancelling. Lion Air, which committed to buy 201 Boeing 737s in 2011, has suspended deliveries and may switch to Airbus.

In addition to the cost in human life, the two 737 Max crashes have seriously damaged Boeing's reputation and could threaten its future. The company cannot wait until investigations establish the cause of the accidents to start to take action, something made clear by the 12% fall in its share price.

The accidents also highlight the increasing presence of technology in today's aircraft. Sophisticated autopilots and even artificial intelligence play a greater and greater role in aircraft design and operation. Compared to the automation-heavy "fly-by-wire" systems used by Airbus, Boeing had long favoured traditional controls and extensive pilot training. But this was before the 737 Max and the race for cost reductions and market share.

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