【欧州】【航空】

Boeing 737 MAX operations' suspension and EASA's way forward regarding software enhancement's approval

Andrea Antolini　Former Researcher JTTRI

【概要：Summary】

The recent accident of Ethiopian Airlines flight ET302 involving a Boeing 737 MAX 8 and the Air Lion accident in October 2018 with the same type of aircraft seem to have some similarities in sequence of occurrences that led to the crash. Although the accident causes in both aircraft crashes have not been fully clarified, yet, at this point of the investigations, the similarities in both crashes leaves no doubt that a technical error, most probably in the aircraft's Manoeuvring Characteristics Augmentation System (MCAS), has at least partially caused the crashes. Meanwhile, there are severe doubts regarding the correct functioning of this aircraft type's software, which consequently led to the suspension of the operation of this aircraft type Boeing 737 MAX 8 and also MAX 9 worldwide.

Furthermore, also the US Federal Aviation Administration (FAA)'s certification of the new aircraft type, the lack of pilot training and the lack of provision of updated software by Boeing after the first crash leave doubts also about the airworthiness of the aircraft. It is therefore not only a matter of eliminating the malfunctioning software, and to introduce a second layer of redundancy. It is also a question of evaluating the certification process and the avoidance of insufficient investigation of the new aircraft. Considering the further way forward, it can be expected that EASA will keep the suspension of the Boeing 737 MAX valid until it has approved itself the safety of the revised software MCAS in order to readmit the aircraft in European airspace. EASA seems to be determined to make its decision on a continuation of the suspension or the re-authorisation of the aircraft in European airspace only after an independent evaluation and irrespective of a previous decision by the FAA.

【記事：Article】

1. Boeing 737 MAX accidents and suspension from operation

Following the tragic accident of a Lion Air Boeing 737 MAX 8 on 29 October 2018 and the second aircraft crash of Ethiopian Airlines flight ET302 involving a Boeing 737 MAX 8 on 10 March 2019, the list of airlines and countries that either stopped flying the Boeing 737 MAX 8 or prohibited them from using their airspace increased quickly. In fact, the Lion Air accident's investigation seemed to indicate that the crash of the aircraft was at least partially caused by the Manoeuvring Characteristics Augmentation System (MCAS), which had been newly introduced in Boeing's 737 MAX aircraft. Due to the suspect that also in the Ethiopian Airlines' crash on 10 March 2019 was caused by a MCAS malfunctioning, many airlines and countries including Ethiopia and Indonesia closed their airspace for Boeing 737 MAX aircraft. More authorities followed on 12 March 2019, when the UK's civil aviation authority (CAA) suspended all Boeing Model 737 MAX 8 and 737 MAX 9 aeroplanes. On the same day, the European Union Aviation Safety Agency (EASA) issued an Airworthiness Directive (AD), mandating the

suspension of all Boeing Model 737 MAX 8 and 737 MAX 9 aeroplanes in Europe "as a precautionary measure" in European airspace, effective as of 19:00 UTC on 12 March 2019 until further notice. In addition, EASA also suspended all commercial flights performed by third-country operators into, within or out of the EU with the Boeing Model 737 MAX 8 and 737 MAX 9.

In contrast, at that point of time, the US and US carriers announced to continue the operation of Boeing Model 737 MAX 8 and the US FAA still stated it was reviewing data and safety performance of the 737 MAX 8 aircraft, but without grounding this aircraft type. However, political pressure to suspend the operation of this aircraft type increased due to the rising evidence that the MCAS system might have played a significant role in the aircraft crashes. It was also revealed that in the US in the past months, pilots of Boeing 737 MAX 8 had been involved in occurrences with this aircraft type, criticizing a lack of training on the new plane and the MCAS, among others.

In the course of 13 March 2019, President Donald Trump finally created facts and signed an emergency order for a provisional flight ban for aircraft of the type 737 MAX 8 and 9, effective immediately. Thereafter, Boeing's recommendation followed to temporary ground the entire worldwide fleet of currently 371 aircraft of the 737-MAX series.

2. The MCAS problem and software enhancement

After new information of satellite-tracking data showed similar flight profiles before the crashes of the two aircraft, which supported the US government's decision to grounding the Boeing 737 MAX fleet, the Federal Aviation Administration (FAA) explained that there was a "possibility of a shared cause" for the accidents. The first preliminary investigations seem to support the thesis that the Manoeuvring Characteristics Augmentation System (MCAS). The MCAS was developed for the 737 MAX to prevent stalls of the aircraft, in flaps-retracted, low-speed, nose-up flight. The MCAS automatically trims the MAX's horizontal stabilizers nose-down when it detects the angle of attack is too high. The MCAS uses airspeed, altitude and angle of attack (AOA) sensor data to evaluate the situation when a dangerous condition has developed and then trims the aircraft nose down. The system receives input from only one of the two AOA sensors. During the certification of the aircraft, the Boeing and the FAA decided that the MCAS' AOA reading and AOA-disagree alert features were not critical for safe operation and could be considered optional. Furthermore, being considered not safety relevant, Boeing charged extra for these additional alerts. Accordingly, not all airlines ordered the aircraft with the extra AOA reading and AOA-disagree alert features.

3. Investigation in the causes of Boeing 737 MAX accidents and FAA's certification process

While the MCAS seems to be at least partially responsible for the two accidents with Boeing 737 MAX aircraft, a further cause of the accidents is seen in the fact that the pilots at least of the Lion Air's aircraft were not aware of the existence of the MCAS and that the pilots of both, the Ethiopian Airlines and the Lion Air aircraft, lacked sufficient training on the device MCAS. This system had been newly introduced into the 737 MAX, but further mentioning or training had not been deemed necessary according to Boeing and FAA. Consequently, pilots were not aware of the MCAS specifications and were not trained to disable the MCAS and operate the plane manually in case of an occurrence and malfunction of the MCAS. The FAA certified the aircraft without further questioning or investigating in the safety relevance and functionality of the new device.

Therefore, meanwhile, the US Department of Transportation (DOT)'s Inspector General has started investigations in FAA's certification process for Boeing 737 MAX models. The probe focuses on potential failures in the FAA's safety-review and certification process. The DOT investigation is also focusing on a FAA office responsible for certifying the new Boeing aircraft, and a second FAA office, which is responsible for setting training requirements and approvals of fleet-wide training programs.

Furthermore, the US House Transportation and Infrastructure Committee chairman Rep. Peter DeFazio (D-Oregon) stated he intends to hold hearings to answer questions about how the Boeing 737 MAX aircraft were certified as safe, as well as why additional pilot training for the MCAS was deemed unnecessary by Boeing and FAA.

In a Senate hearing on 27 March 2019, FAA acting administrator Dan Elwell stated that FAA retained oversight of the Boeing 737 MAX's MCAS early on in the aircraft's certification process, but later delegated it to Boeing. However, FAA engineers and flight test pilots were involved in the MCAS operational evaluation flight test and 133 of the 297 MAX certification flight tests. Furthermore, the MCAS was not flagged to pilots as a relevant change from the previous aircraft model 737NG during certification. This was the primary reason that more information on MCAS was not provided to pilots.

Meanwhile, the Ethiopian transport minister Dagmawit Moges announced the results of an interim report regarding the Ethiopian Airlines Boeing 737 MAX 8 crash, confirming that the flight crew followed proper procedures in response to the aircraft's un-commanded nose-down flight, but they could not stop the aircraft from crashing. This indicates that the malfunctioning of the MCAS software was at least partially responsible for the crash.

Soon after the Ethiopian Airlines accident, Boeing announced it would submit a software update to the aircraft operators "in the coming weeks". However now, Boeing is considering it might take more time to deliver the software update, also because additional software problems seem to have arisen. Therefore, more time is needed for releasing a properly functioning update, which will be essential for regaining the permission to fly Boeing 737 MAX. Boeing's announcement of the extended timeline marks a significant shift compared to the previously planned procedures, as Boeing also held already an all-operators' briefing, presenting details of the system changes to pilot groups. However, now an internal Boeing review of the software enhancement has forced the aircraft manufacturer to delay the software submission.

Furthermore, before all the grounded Boeing 737 MAX aircraft will receive the software enhancement, the FAA will have to test and approve the new software update. The FAA has pointed out it would only approve the software for installation after the agency has carried out a "vigorous safety review". Since the FAA has been criticised for appearing to initially resisting the grounding of the aircraft out of favouritism for a US company, and for questionable procedures during the certification process for the Boeing 737 MAX aircraft, the FAA will have to act cautiously in the reauthorisation process for the aircraft. It can be expected that the FAA will be especially attentive in the approval process of the Boeing 737 MAX's software enhancement.

4. EASA's approach and way forward

While the FAA is expecting to receive Boeing's final package of the 737 MAX's MCAS software enhancement in the next weeks, also the European Aviation Safety Agency (EASA) has commented it would not allow the Boeing 737 MAX aircraft to fly again unless the MCAS software updates are installed. While EASA is in contact with both, the FAA and Boeing regarding the review of the 737 MAX, EASA has also pointed out, that before re-authorising the aircraft to fly in European airspace, it would carry out a close investigation of the software update.

After the experiences with the FAA's initial inaction regarding the grounding of the Boeing 737 MAX aircraft, and in contrast to the usual procedures between the FAA and EASA to decide on safety issues in a coordinated manner, EASA can be expected to be cautious and will closely investigate the software enhancement itself before it readmits Boeing 737 MAX aircraft in European airspace.

Furthermore, it seems that US and European aviation agencies knew before the Lion Air crash that the usual method for controlling the Boeing 737 MAX noise nose angle might not work in conditions similar to those in two recent disasters. When the EASA certified the

plane, it stated the plane was safe in part because it mentioned additional procedures and training would “clearly explain” to pilots the “unusual” situations in which they would need to manipulate a rarely used manual wheel to control, or “trim,” the plane’s angle. However, EASA and the US FAA ultimately determined that the set-up was safe enough for the plane to be certified, with the European agency citing training plans and the relative rarity of conditions requiring the utilisation of the trim wheel in the cockpit’s center console.

On 18 March 2019, the European Parliament’s Transport and Tourism committee (TRAN committee) had invited the EASA executive director Patrick Ky for an exchange of views on the Boeing 737 MAX case. Ky stated that EASA would look ″very deeply″ at Boeing’s software updates and study all the failure modes of the Boeing 737 MAX. At the meeting with the TRAN committee, Ky emphasised that EASA would not allow the aircraft to fly if EASA has not found acceptable answers to all questions related to the Boeing 737 MAX software update. This includes that EASA would have an in-depth look into the proposed changes that may include design and training aspects. However, the FAA is the primary responsible certification authority for the aircraft and the EASA’s overall involvement will be confined by the existing EU-US bilateral aviation safety agreement. Nevertheless, Ky also pointed out that EU decisions regarding the reauthorisation of Boeing 737 MAX aircraft in European airspace would be made irrespective of what the US FAA would decide on the case.

5. Conclusion

The major impact of the two Boeing 737 MAX aircraft accidents is that the credibility of Boeing and the FAA as certification institution is now compromised. Boeing is under investigation due to the fact that the MCAS was not properly introduced to airlines’ pilots including training of pilots, besides the malfunctioning of the MCAS. Furthermore, the FAA is under investigation for the fact that the agency certified the new aircraft as airworthy in 2017 without considering the necessity of a mandatory training of pilots for the new MCAS system.

However, a lot of US airlines rely on the early return of the Boeing 737 MAX to service, as they are now suffering a substantial capacity lack and network impacts, as well as increased costs, as they have to substitute the grounded planes with other aircraft. Every day that passes with the Boeing 737 MAX grounded is a financial loss for those airlines. Therefore, the FAA is also under pressure to approve the software update as soon as possible.

In respect of the Boeing 737 MAX suspension of service in Europe, which was decided independently from the US FAA, which at that point did not intend to declare a suspension for the US airspace, is one of the very few cases of unilateral action on the European side. Usually, the EU and US aviation agencies take decisions on aviation safety in a coordinated, cooperative manner. EASA took the decision to ground Boeing 737 MAX aircraft independently from the FAA, but in parallel with around 40 authorities in other countries, including China. This left the US Federal Aviation Administration isolated. Therefore, this case represents an exception in decades of coordinated aviation safety decisions and leadership of the FAA in questions of aviation safety.

Considering the way forward, besides the considerations of other countries’ authorities, which can be expected to conduct their own analysis, the EASA could play an influential role in determining how long and complicated the review of the Boeing 737 MAX could be. EASA’s investigation and decision in this case of re-authorising the Boeing 737 MAX in European airspace could prove to be important as it could investigate into the Boeing 737 MAX software update independently. The EASA decision could have a particular weight, due to concerns regarding the neutrality and independence of a decision-making of the FAA in this case. The FAA’s decision might be received with concerns as a re-authorisation could be granted hastily, due to economic pressure and the fact that the US is Boeing’s home market and the majority of the suspended aircraft are grounded in the US. The

break between FAA and overseas authorities on the initial decision to suspend Boeing 737 MAX from airspace, combined with the US DOT's investigation into the FAA's certification process for the Boeing 737 MAX could ultimately also have an impact on the resumption of the aircraft's operations outside the US.

References:

https://atwonline.com/safety/faa-details-boeing-737-max-mcas-oversight-handover

https://atwonline.com/safety/boeing-extends-timeline-max-software-upgrade-weeks, Apr 1, 2019

https://atwonline.com/safety/easa-grounds-boeing-737-max, Mar 12, 2019

https://en.wikipedia.org/wiki/Boeing_737_MAX_groundings

https://interestingengineering.com/boeing-737-max-8-software-fix-delayed-after-review, April, 02nd 2019

https://news.airwise.com/story/more-airlines-halt-boeing-737-max-8-flights, March 12, 2019

https://uk.reuters.com/article/uk-ethiopia-airplane/u-s-will-not-suspend-boeing-737-max-planes-discussion-on-black-box-analysis-idUKKBN1QT12C

https://uk.reuters.com/article/us-ethiopia-airplane-eu-boeing/eu-to-study-boeing-software-updates-before-allowing-flights-to-resume-idUKKCN1R01XR

https://www.aero.de/news-31353/FAA-Update-der-Boeing-737-Max-Software-dauert-noch-Wochen.html, 2.4.2019

https://www.easa.europa.eu/newsroom-and-events/press-releases/easa-suspends-all-boeing-737-max-operations-europe

https://www.easa.europa.eu/newsroom-and-events/news/easa-suspends-all-boeing-737-max-operations-europe, 12 MAR 2019

https:/www.easa.europa.eu/newsroom-and-events/press-releases/easa-suspends-all-boeing-737-max-operations-europe

https:/www.euractiv.com/section/aviation/news/deadly-crash-starts-to-ground-boeings-as-europe-watches-on/

https:/www.euronews.com/2019/03/19/eu-to-study-boeing-software-updates-before-allowing-flights-to-resume, 19/03/2019

http:/www.europarl.europa.eu/committees/en/tran/home.html, 19-03-2019

http:/www.europarl.europa.eu/committees/en/tran/home.html

http://www.europarl.europa.eu/cmsdata/162141/TRAN%20Newsletter%20March%202019.pdf

https://www.faa.gov/news/updates/?newsId=93206

https://www.ft.com/content/a2b6c6ec-54bd-11e9-91f9-b6515a54c5b1

https://www.latimes.com/business/la-fi-737-max-boeing-eu-20190331-story.html, Mar 31, 2019

https://www.nytimes.com/2019/03/13/world/africa/boeing-ethiopian-airlines-plane-crash.html, 13 March 2019

https://www.politico.eu/article/us-increasingly-isolated-as-europe-grounds-boeing-max-jets/, 3/12/19

http://www.spiegel.de/wirtschaft/unternehmen/boeing-737-max-trump-kuendigt-flugverbot-an-a-1257708.html, 13.03.2019