Point Merge: Increasing Human-System Integration in Air Traffic Management

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SUMMARY

Through consideration of human-system integration (HSI) during airspace design, ATCOs who operate in a Point Merge environment can benefit from increased situational awareness, reduced workload and increased performance levels (Eurocontrol, 2021). This short paper outlines the advantages of implementing Point Merge operations to increase ATM safety, by considering the role of the ATCO and the importance of HSI when implementing air traffic control procedures.

KEYWORDS

Point Merge, Air Traffic Control, Human Factors

Introduction

Point Merge provides a framework which reduces the requirement for aircraft to enter 'traditional' holding patterns when approaching busy aerodromes. Aircraft arriving on standard arrival routes (STARs) via point merge at an airport do so without the need for radar vectors, and instead fly on a circular 'sequence arc' around the Intermediate Fix (IF), before being routed by an Air Traffic Control Officer (ATCO) to the IF for commencement of an instrument approach. This design supports the human operator by aiding the development and maintenance of ATCO situational awareness, increasing automation, and reducing controller workload. Additionally, the benefits of Point Merge operations are in line with the objectives of SESAR, which include increased safety, reduced ATM costs and increased airspace capacity (SESAR Consortium, 2009).

Case Study: Point Merge vs Traditional Approach Procedures

An ATC simulation was conducted using COOPANS software to compare the frequency occupation time and number of instructions issued to two aircraft operating in Point Merge and non-Point Merge environments. The aircraft in both environments performed approaches to the same runway at a busy European airport under moderate-busy traffic levels (approx. 40 runway movements per hour) and entered the airspace from the same entry point. The aircraft operating under non-Point Merge operations was required to complete approximately one round of the hold, before being vectored for an approach. While the aircraft operating under Point-Merge operations was not required to hold, it completed approximately half of the sequence arc before being issued with a turn to the IF. Both aircraft entered the airspace and reached the IF at the same approximate time.

The simulation demonstrated that aircraft travelling along the Point Merge framework (Figure 1) receive one third less instructions compared to non-Point Merge procedures (Figure 2). In the Point Merge environment, the aircraft was issued a total of eight instructions as it passed through the approach ATCO's sector, while an aircraft operating during non-Point Merge conditions received a total of twelve instructions. Frequency occupation times are also demonstrated as being larger during non-Point Merge procedures. While the frequency occupation time between an ATCO and one aircraft was recorded as 84 seconds during non-point merge operations, this time increases to 89 seconds, once the time taken to coordinate available levels in the hold with adjacent sectors is added. This is 30 seconds more than the total frequency occupation time for Point Merge procedures, which was recorded as being 59 seconds.

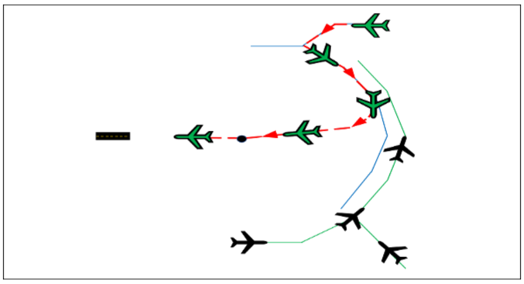

Figure 1: Aircraft routing via Point Merge

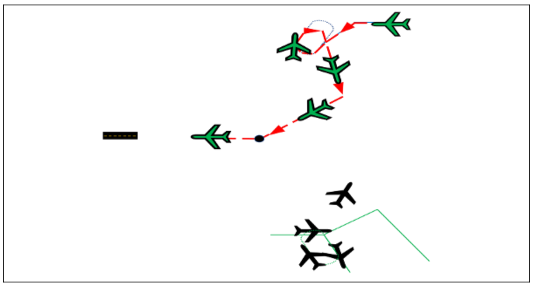

Figure 2: Aircraft routing via non-Point Merge

Discussion

During moderate-busy non-Point Merge operations, an ATCO's cognitive resources are tasked with generating vectors and/or point clearances to aircraft leaving the hold when routing aircraft towards the airport. During this type of operation, the ATCO is also required to coordinate available levels in a hold, correctly update a list of holding aircraft and issue aircraft with track miles to touchdown, while also safely and efficiently managing traffic located away from the hold. This differs from a Point Merge environment, whereby the ATCO is largely concerned with monitoring traffic states, and so increased mental capacity is available for proactively predicting potential future conflicts and achieving desired spacings between landing aircraft. ATCO workload during Point Merge operations is therefore reduced by limiting the necessity to issue radar vectors, coordinate levels in a hold and separate aircraft on conflicting tracks. Instead, an aircraft's instructed route along a sequence arc is managed by the flight crew without the need for regular ATC instructions, and so the ATCO can allocate increased resources to scanning, monitoring traffic, and identifying potential conflicts. By considering HSI during the procedural design phase, the task of predicting future traffic scenarios is also further supported by an airspace layout which largely restricts aircraft label clutter along a predictable and established route. Thus, ATCO scanning time is reduced and deviations from ATC clearances can be quickly identified. Point merge is therefore an effective example of applying 'safety by design' to implement a human-centred initiative in ATM, as recommended by Eurocontrol (2019).

Conclusion

Frequency occupancy time and number of clearance instructions issued are reduced under Point Merge operations, when compared to traditional approach holding procedures. This reduces the workload of the controller, who can then assign additional cognitive resources for scanning, monitoring traffic, and predicting future conflicts. This shift in task resource allocation benefits the development and maintenance of an ATCO's situational awareness, so that potential conflicts can be identified and solved proactively to increase ATM efficiency and safety.

References

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