

# Chapter 11

## Digital Transformation Approaches for Aircraft Maintenance Operations

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### ABSTRACT

*Digital transformation is one of the critical drivers of change in aviation as in many areas. Aviation operations are always aimed to be carried out with a high degree of safety and security standards. Efficient aircraft maintenance management makes a significant contribution to meeting these standards. The digital revolution offers excellent opportunities for safety, reliability, and efficiency advancement for aviation continuing airworthiness. This chapter provides a basic overview of aircraft maintenance processes and highlights some of the maintenance management issues. This chapter addresses some of the industry 4.0 technologies that have been tested for use or currently used in aircraft maintenance operations and discusses the impact of these technologies on current management problems. Consequently, this chapter is expected to present useful information and comments for the aircraft maintenance community, including managers and professionals, and encourage them to think about other possible innovations beneficial to their processes.*

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## INTRODUCTION

The 4th industrial revolution is taking place that will allow people and enterprises to interconnect the real world with the digital world and bring a high level of automation to the daily routine. This transformation, called Industry 4.0, includes significant changes for many business areas. Technological concepts underlying this change are mainly digitizing production systems, and it is quite common to hear about smart manufacturing and factory of future terms. While all industrial revolutions have primarily focused on production systems, the last one is affecting many other areas (Ceruti et al., 2019).

This revolution inevitably affects the aviation industry in which safety and efficiency improvements are considered as the key factors of sustainability. Maintenance 4.0 (Industry 4.0 for maintenance) offers excellent opportunities for safety, reliability, and efficiency advancement in aviation continuing airworthiness. A base maintenance repair and overhaul (MRO) organization may adapt Maintenance 4.0 for resource management optimization, while a line maintenance organization may digitize its operations to achieve fleet operational availability goals. Much more progress can be made in subjects such as predictive maintenance, maintenance training, and maintenance error prevention through the correct and effective use of Industry 4.0 technologies. On the other hand, there are some infrastructural obstacles in front of improvement. Technologies for aircraft (sensors and data transmission) and legacy infrastructures are still in development, difficulties of regulatory framework changes, safety and quality compliances, the adaptation of employees, change of working culture, organizational resources, not knowing how to proceed, and economic issues can be listed as examples (Guyon et al., 2019; World Economic Forum, 2017).

Reducing costs and ensuring flight safety are essential issues in aircraft maintenance management, while aircraft maintenance is a highly complicated and challenging process. These two issues have many sub-factors. However, managers now have the opportunity to use a variety of methods to make progress for many different matters thanks to industry 4.0. Some of these innovative technologies are; robots and drones, virtual/augmented reality, additive manufacturing (AM), the internet of things (IoT), artificial intelligence (AI), machine learning (ML), blockchain, cybersecurity, and big data (Guyon et al., 2019; International Civil Aviation Organization, 2019).

Besides the complexity of the aircraft maintenance process, integrating these new technologies into the system is not easy. However, some of them are already in use, and some other initiatives have already been started by industry leaders (Meissner et al., 2019). For example, airlines use IoT technology to download or upload data to aircraft on the ground, and in this way, they are transforming their daily operations to paperless concepts. They integrate the collected data with their enterprise resource planning (ERP) systems (maintenance software) on a real-time basis. Thus digital thread technique is being used for fleet tracking with several parameters. When the data transmission technologies are further developed for either aircraft or infrastructures, air-ground data transmission will be cheaper and readily available, allowing predictive maintenance to be used more effectively.

Furthermore, flexibility and mobility for maintenance teams will be more obtainable. In this way, maintenance processes may be effectively organized to minimize operational interruptions, since a flight delay costs the airline \$25,000 - \$40,000 in addition to customer dissatisfaction (General Electric, n.d.). These are only a few examples formed by IoT technology. Industry 4.0 is a great driver of change for aircraft maintenance operations, and exciting innovations may come true.

Performing a safe, reliable, and efficient maintenance operation at minimum cost is one of an aircraft maintenance organization's primary purposes. Meanwhile, a proper balance should be maintained between cost and operational availability without any compromise on safety. Maintenance activities can be

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