Human Factors Affecting Aircraft Maintenance and the Impact They Have on Flight Safety

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Since 2016, she has served as an AMT Technical Instructor at PhilSCA, now the National Aviation Academy of the Philippines (NAAP), where she plays a vital role in developing competent, safety-conscious, and industry-ready aviation maintenance professionals. Her teaching expertise includes both theoretical instruction and hands-on practical training aligned with current aviation standards and regulatory requirements. Through her guidance, students gain not only technical proficiency but also a strong sense of professionalism, discipline, and adherence to aviation safety practices. Driven by a deep passion for teaching and lifelong learning, Ms. De Joya continuously enhances her technical knowledge and instructional skills to keep pace with advancements in the aviation industry. Her dedication to education, mentorship, and student success reflects her commitment to shaping future aviation maintenance professionals who can excel in a highly demanding, safety-critical field.

Introduction

Aircraft maintenance is a key aspect of flight safety and reliability. In order to accomplish this, skilled aviation maintenance technicians (AMTs) perform inspections, repairs, and maintenance to keep aircraft systems running efficiently. Aircraft maintenance has benefited from significant advances in technology and regulatory standards over the last 50 years. However, human factors continue to contribute to many aviation incidents and accidents. Human factors are defined as the factors associated with the human body, how people think, interact with their environment, and perform maintenance (Olaganathan, 2024). Understanding all human factors is critical to improving the safety of all aviation operations.

Aircraft Maintenance Human Factors result from the combined influence of technicians, tools, aircraft maintenance procedures, and the aircraft maintenance work environment. Aircraft maintenance involves many complex tasks that require accurate component measurement, technical skills, and adherence to numerous rules and procedures. Most maintenance tasks are completed under pressure from the clock, across a variety of environmental conditions, and often across more than one shift. These conditions can lead to human error, compromising aircraft safety if the error is not recognized and appropriately mitigated. Recent research has found that maintenance-related aviation incidents continue to contribute significantly to global aviation incident rates, highlighting the importance of properly managing Human Factors in aviation maintenance systems (Zhang, Li, & Chen, 2024).

The aviation industry widely acknowledges the "***Dirty Dozen,***" a set of twelve common examples of human error associated with aircraft maintenance. These reasons pertain to incidents during maintenance include many of the written above Lack of Communication (Failure to Communicate), Complacency and Proximity to Work (Complacency), High Stress (High Stress) Workloads (High Workloads), and Work Environment Conditions Although the above mentioned reasons do not encompass every crash event in aviation or aerospace they do make up a large portion of recorded aviation incidents related in the Aviation Safety Network B7060 database. Failure to address the above-mentioned human factors can enable incidents during inspection, repair, or assembly processes.

Fatigue (Human Fatigue) is another important human factor impacting maintenance technicians. The workload for the maintenance technician is normally from 65 to 110+ hours per week with irregular hours and oftentimes night shifts. As a result of all of these factors, fatigue reduces cognitive function, including attention and memory capability (not including the ability to make good decisions). There are many studies that show fatigue increases the probability of a mistake. Studies have

concluded that fatigue reduces situational awareness in technicians, leading to increased operational errors during maintenance tasks (Guranda, 2024).

Communication is a very important human factor to have in place during the execution of aircraft maintenance operations, as aircraft maintenance is typically a team operation. The use of effective communication methods is essential for the accurate transfer of information among the maintenance technician, engineer, supervisor, and flight crew. Failure to use good communication practices during shift changes and recordkeeping can create a poor understanding of maintenance tasks and leave a potential defect unresolved. To minimize maintenance-related incidents, it is essential to have effective communication systems and standardized reporting processes (Olaganathan, 2024).

In addition to the above-mentioned factors, training and knowledge are also critical elements to consider to minimize human. Recent changes in the aviation industry have necessitated that technicians remain current with advances in systems, practices, and tools for maintaining aircraft. Technicians who are inadequately trained or lack sufficient knowledge to perform their job duties may commit errors while troubleshooting, incorrectly install components, or fail to recognize system anomalies. Therefore, continuing competency-based and professional development training is an essential component to sustaining high levels of safety within the aviation industry (Tuncal & Altıntaş, 2025).

Organizational culture has a major impact on human performance within the maintenance environment. A strong safety climate permits technicians to report errors, unsafe conditions, and close calls without fear of retribution. By promoting error visibility and learning, organizations establish a climate in which they can effectively implement safety improvements. It has been shown that maintenance organizations with high safety cultures demonstrate increased compliance with safety regulations and experience fewer maintenance-related incidents.

Several environmental variables may adversely affect a technician's performance in a maintenance facility. Maintenance activities may be performed in confined areas, at elevated heights, and/or in extreme weather conditions. Poor lighting, excessive noise, and restricted workspace can cause fatigue and increase the risk of errors. The design of an ergonomic workplace and the provision of adequate environmental resources will enhance technicians' performance while reducing the risk of injuries in the maintenance environment (Guranda, 2024).

Technology is becoming a more integral component of human performance in aircraft maintenance. Technicians are better supported by emerging technologies, including augmented reality (AR), predictive maintenance, and data analytics. These technologies allow technicians to conduct maintenance with greater accuracy and efficiency; facilitate the visualization and understanding of complex systems; enable them to identify potential failures prior to their occurrence; and provide step-by-step guidance when performing maintenance tasks. Collectively, these technologies address the causes of human error and reduce the likelihood of errors contributing to a loss of aviation safety (Olaganathan, 2024).

Despite the many benefits of emerging technology, the contributions of human expertise remain a vital component of aviation safety. Aircraft maintenance technicians must continually interpret complex technical data, troubleshoot faulty systems, and exercise critical judgment when making maintenance decisions. As previously established, a commitment to enhancing awareness of human factors and incorporating the human element into technician training programs will assist in the overall management of safety in aviation systems (Tuncal & Altıntaş, 2025).

The importance of integrating human factors into aviation safety continues to be emphasized by the global regulatory authorities and aviation organizations. To support this directive, many aviation training agencies have implemented human factors modules into their training programs, which provide technicians with information on the risks

associated with human error. The goal of these programs is to increase technicians' ability to recognize situations, work in a team environment, apply critical thinking, and manage stress during maintenance-related tasks (Air Education and Training Command Safety Directorate, 2023).

Finally, human factors play a key role in aircraft maintenance and, therefore, impact the safety of flight operations. Fatigue, ineffective communication, insufficient training, environmental conditions, and organizational culture may directly contribute to maintenance errors if not actively managed. The integration of human factors principles within aviation safety management systems, maintenance training programs, and organizational policies will reduce the aviation industry risks while enhancing operational safety. Finally, ongoing research and technological advancements will continue to encourage the development of safe and reliable practices for maintaining the airworthiness of aircraft, thereby helping ensure the safe travel of aviation passengers to their destinations (Zhang et al., 2024).

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