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Analysis of the Current Situation and Development Trend of the Aircraft Maintenance Industry

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Abstract

In recent years, China's general aviation industry has developed rapidly. With the continuous progress of modern technology, many aircraft have added many new technologies, new equipment and new materials in the manufacturing process. In the face of the current rapid development of the manufacturing process, it is urgent to innovate the level of maintenance technology, especially for the comprehensive quality of maintenance personnel and the degree of understanding of new technology, new means and new equipment have higher requirements. Based on the principles of general aviation aircraft maintenance, this paper discusses the current situation of the development of general aviation maintenance in China, and analyses and summarises the technology, means and methods related to general aviation aircraft maintenance, in the hope of effectively reducing the probability of aircraft failure, so as to better implement the policy of "decentralisation and management, mainly decentralisation" and promote the development of aviation. It is hoped that this can effectively reduce the probability of aircraft failures, so as to better implement the policy of "decentralisation and management, mainly decentralisation" and promote the development of aviation.

Keywords

Aircraft Maintenance; Maintenance Principles; Maintenance Technology.

1. Introduction

Since the implementation of the reform and opening-up policy, China's economy has developed rapidly and people's living standards have improved significantly, a phenomenon that is particularly evident in the choice of travel modes. While economic development has increased the openness of regional economies, it has also placed higher demands on transport conditions, the basis for accelerating economic circulation within the region. As a result, along with the increase in people's travel requirements, aeroplanes are gradually becoming an unobtainable means of transport for people travelling today. In particular, as air fares have become less daunting in recent years, coupled with the comfort and speed of aeroplanes, more and more people are making them their first choice for travel.

Against the backdrop of such an era, the scale and volume of general aviation in addition to conventional civil aviation has expanded significantly. Compared to the regulated maintenance system of civil aviation, general aviation is faced with a wide range of aircraft types and problems, and some of the faults and problems that arise may not be common, which will seriously restrict the development of general aviation. Therefore, how to grasp the current good development opportunities in the booming general aviation, identify the problems in the general aviation maintenance industry

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and formulate targeted solutions to help the scale and personalised development of general aviation is the primary issue to be considered by those involved in the aviation maintenance sector.

2. Aircraft Maintenance Principles

The late start of aircrafy, the lack of maintenance professionals and the unsound maintenance management system have resulted in the lack of a management core for general aviation maintenance management and the arduous task of maintenance management. As a result, a series of problems have been derived. For example, under what circumstances is it generally necessary to suspend an aircraft's flight duties and start working on maintenance?Are parts that are at the end of their useful life but are in good functional condition and appear to be in working order to be replaced? The answer to these questions lies in the maintenance principles that we have to adhere to, which in part influence the failure rate of an aircraft. In practice, aircraft maintenance staff generally adopt the basic mentality of Murphy's Law. This is an interesting psychological effect, which is simply described as "the more things or places that can go wrong, the more things will go wrong", and is reflected in maintenance work, which means that all factors that can cause aircraft failure must be predetermined in advance, and effective measures must be taken in a timely and rigorous manner to avoid Murphy's Law. This is to avoid Murphy's Law [1].

Compared to air travel, the choice of train or other transport has a relatively stable safety index. Although airplanes have a greater advantage in terms of ease of travel, they are susceptible to weather changes, violent air currents, traffic control, aviation drills and other unstable factors, and once a safety accident occurs, the casualties are more tragic. At the same time, the performance status of the entire aircraft's structural components can also affect the safety of the mission [2]. For example, if one of the tires of a car is damaged, the tire may puncture during the subsequent driving process, but as long as it is not in an extreme coincidence, such as extreme weather, earthquake disasters, landslides, and other situations, it will at the most delay the journey and will not generally cause some major accidents that threaten life and safety. People just need to be prepared with spare tires and jacks, and even if an accident occurs, they can usually cope. But when the same potential for failure occurs in an aircraft, maintenance work must be done well in advance before the mission is carried out, otherwise, there is a high risk of a tragic loss of life and death when the failure occurs.

Modern maintenance concepts require people not only to develop a good aircraft maintenance strategy but also to achieve a level of pre-repair for the overall system and some components of the aircraft, to truly eliminate hidden problems in the bud and the cradle [3]. A further benefit of the 'preventive approach is the control of aircraft maintenance costs. This is because if an aircraft has a problem that affects flight safety, it usually costs more to repair it or even to ground the whole aircraft for a long period, at which point it would cost a lot of money to either purchase a new aircraft or lease the whole aircraft. In this regard, the current civil aviation aircraft maintenance field should adhere to the "prevention-oriented" traditional and modern maintenance principles.

3. Aircraft Maintenance Status and Problems

3.1 Insufficient Capital Investment in Maintenance

As an excessively costly means of transport, the overall structure of an aircraft is in a state of complex balance. The aviation industry needs to spend a huge amount of money on the purchase of new aircraft at the early stage of development, and then needs to invest a large amount of money on aircraft maintenance in the process of use. According to a survey, the upper limit of aircraft maintenance costs can reach about 20% of the total cost of civil aviation enterprises, accounting for about 60% of the purchase cost, which shows how heavy the maintenance burden of the aviation industry is. Civil aviation companies need to invest large sums of money in the purchase of maintenance parts if they want to ensure that their aircraft work properly, but more often than not, to keep the immediate short-term benefits, they cut back on the investment in maintenance, making some aircraft parts stock insufficient and making it impossible to replace some parts in time when the whole aircraft is being

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repaired. In some cases, the company has not been able to solve the problem in time, which has caused huge losses in economic benefits and led to problems in the company's capital chain and a shortage of funds for parts, thus forming a vicious circle in the development of civil aviation enterprises.

3.2 Lack of Standards in the Maintenance System

The lack of uniform standards for aircraft maintenance systems has always been an important reason for limiting the development of maintenance [4]. Especially during the development period of China's aviation industry, different maintenance systems are used for different aircraft types generated by different companies, which seriously hinders the healthy development of the maintenance industry. At present, the maintenance system in our country's aviation industry is generally divided into two types: one is to entrust maintenance work to joint ventures for aircraft maintenance management, and the other is to establish a maintenance organization directly in the headquarters of the enterprise, and there are great differences between these two different maintenance management methods(see Fig. 1). However, most companies have not made a unified and standardized adjustment to the maintenance system after the merger and reorganization, resulting in many maintenance staff being unable to adapt to the chaotic and disorganized maintenance system and being forced to jump ship or change careers, with the massive loss of talent undoubtedly adding to the industry's woes.

Fig. 1 Maintenance of SR20

3.3 Lack of High-level Maintenance Personnel

Civil aircraft are very special, both in terms of workplace and work mode, plus they are a kind of high-precision equipment, whose components are not only numerous and complex but also bring a lot of difficulties to the maintenance work (see Fig. 2). In reality, civil aircraft stay on the ramp for a very short period, which usually does not leave much time for the maintenance staff to do a complete inspection of the aircraft [5]. If the maintenance personnel are not good enough, they will have to rely

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on their past maintenance experience to troubleshoot the aircraft, especially if they overlook some minor frictional damage, and will not be able to accurately determine the cause and location of the fault. The absence of a high level of maintenance personnel will not only fail to identify safety hazards quickly and comprehensively but will also inadvertently increase the risk of failure. The industry itself is very short of high-level professional maintenance personnel, requiring companies to invest a lot of human and material resources to excavate and train highly skilled professionals, but the problem still lies in the short-sighted development strategy of many business managers, who over-emphasize the immediate benefits and ignore the long-term healthy development of civil aviation enterprises, resulting in a continuous low level of maintenance personnel, which not only hinders the healthy development of the maintenance industry but also sows many hidden dangers for the safety of the industry. many hidden dangers.

Fig. 2 The avionics Systems of SR20

3.4 Poor Results of Traditional Technologies

According to the statistics of past failure problems, most of them are due to the wear and tear of parts caused by the continuous and uninterrupted flight of the aircraft. As long as the internal parts and equipment of the aircraft can be checked and replaced regularly to ensure that the performance of the aircraft is in a damage-free state, the main work of aircraft maintenance is completed, so the traditional maintenance technology is also seen as a kind of pre-maintenance [6]. However, with the development of modern technology, the structure of aircraft is becoming more and more complex, the frequency and types of problems occurring are becoming more and more frequent, and the cause of failure is no longer the wear and tear of a single part, so it is urgent to update traditional maintenance techniques and improve the application rate of new maintenance methods in the aircraft maintenance industry. The emergence of new maintenance techniques can deal with aircraft failures in a timely and efficient manner, reduce the recurrence of problems and have a strong contribution to the development of the maintenance industry. However, new technology requires new equipment and new theories, all of which are based on the company's capital investment, and the limitation of capital

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investment greatly reduces the application rate of new technology. The traditional-based maintenance operations lead to some fault problems occurring frequently and cannot be cured.

3.5 Poor Maintenance Management

So far, the density of routes, the number of civil aviation maintenance points, and the number of aircraft have long exceeded the capacity of maintenance management and must be combined with modern information technology to achieve more efficient aircraft maintenance management [7]. However, the current management department often lacks advanced management awareness and cannot formulate an effective and scientific management system in time, which to a certain extent hinders the progress and development of aircraft maintenance management level.

4. Trends in New Maintenance Technologies and Methods

4.1 Dynamic Control of Maintenance Intervals

With the rapid development of science and technology, the maintenance technology of aircraft also gradually tends to be intelligent. However, traditional maintenance techniques are still in a basic and important position in the maintenance work. In the early days of aircraft manufacturing, equipment construction was relatively simple compared to today, and failures were mostly caused by long flight times and wear and tear of materials and equipment. The traditional maintenance philosophy applied to the early years of aircraft maintenance, relying on past maintenance experience and technology, and thorough analysis and research of the failure pattern, it was found that the safety and reliability of the aircraft were directly proportional to the length of use of the systems and equipment, thus forming the maintenance habit of "regular maintenance as the mainstay, supplemented by frequent inspection and rework". This has led to the formation of the maintenance habit of "regular maintenance as the mainstay and frequent rework as a supplement", and the conclusion of appropriate control of maintenance intervals to ensure flight safety adjustment measures.

4.2 Adopting Intelligent Modern Technology

Advanced technology is an effective cornerstone for the smooth implementation of maintenance work. Compared to the traditional, modern technology maintenance means more involvement in information technology, intelligence and other elements, the fault also from single mechanical wear and tear into a combination of mechanical and electrical, electronic and digital technology and other factors into a complex type, but also promote aircraft maintenance technology to a higher level of development. In maintenance work, new equipment, materials and techniques must be used appropriately to improve the effectiveness of maintenance. To date, the main maintenance technologies that are widely used are digital technology and computer technology, but the prerequisite is that maintenance personnel are fully aware of and familiar with the operation of new technologies and equipment [8]. For example, the main civil aviation aircraft currently in use are equipped with the function of monitoring and diagnosing flight conditions, which can be used as a pre-maintenance function, but there must be staff familiar with this technology to carry out troubleshooting and maintenance, without understanding the operating principles of this technology there is no way to carry out timely and adequate maintenance in the event of a fault.

4.3 Seasonal Maintenance

When the seasons change, it is also a time when aircraft breakdowns occur. Generally speaking, the change of seasons is accompanied by a change in airflow and temperature. Aircraft flying in an unstable environment are prone to component damage. Therefore, during the seasonal maintenance period, it is not only necessary to carry out seasonal inspections, but also to replace parts and equipment promptly to ensure the safety and stability of the aircraft. For example, in the northern weather, taking into account the low-temperature factor in winter, it is necessary to regularly clean the air intake of the aircraft engine using potion for the following reasons: firstly, it is necessary to carry out routine maintenance of the system; secondly, it reduces the probability of oil leakage caused by low temperature and improves the smoothness of the engine air intake; thirdly, it reduces the

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chance of snow entering the aircraft from the air intake; fourthly, based on different The fourth is to facilitate regular de-icing based on different aircraft types and specifications. It is also important that the aircraft is systematically inspected around March each year and that the landing gear is warmed up before the flight.

4.4 Fault Database

The establishment of a fault database is an important cornerstone for improving maintenance levels and doing a good job of maintenance. Especially for some typical faults that often occur, a good collection of problems can help a lot in analyzing and investigating the causes of faults, and can also lead to improvements in the performance of the aircraft. The advantages of establishing a fault database are as follows: firstly, the fault data collected and collated can be used as training material for maintenance personnel, providing corresponding maintenance measures for various fault data; secondly, the database can be used to analyze the various influencing factors causing flight delays, supplemented by cause-effect diagrams and Pareto diagrams, and to analyze the proportion of the five types of factors: human, machine, material, law and environment. Furthermore, the collation of fault data is also a process of evaluating the current maintenance work and the ability of maintenance personnel to make appropriate adjustments to the subsequent maintenance plan.

4.5 Maintenance Skills and Review of Work

The professional level of the maintenance staff can directly affect the safety and stability of the whole aircraft flight. Therefore, every year, civil aviation enterprises have to carry out occasional training courses for maintenance staff. The training courses include the updating of maintenance techniques, the operation principles and usage of new technical equipment and the cultivation of comprehensive qualities such as mental health, to ensure the improvement of the maintenance staff's skill level.

In reality, to improve the effectiveness of maintenance work, a general review of the day's maintenance is carried out after the daily maintenance work has been completed. The review is summarized as follows:

Firstly, check the content of the day's maintenance work to check for gaps;

Secondly, review the day's maintenance work process and whether the handover of tools and equipment was in place;

Thirdly, carefully consider whether every detail of the maintenance finishing work was omitted.

By relying on this kind of review to improve the whole maintenance work, and forming the habit of summarising and thinking hard, the whole maintenance work can be effectively improved.

5. Conclusion

Earlier aircraft were relatively simple in structure and relatively easy to maintain compared to today. However, with the widespread use of modern computer and digital intelligence technologies in the field of aviation technology, many aircraft use many new materials and equipment processes in the manufacturing process, and the cost and difficulty of aircraft maintenance have increased. For convenience reasons, modern aircraft manufacturing technology incorporates some highly sophisticated technological achievements. In order to avoid breakdowns and to improve the stability and safety of aircraft flight, maintenance personnel must always maintain a humble and cautious attitude and constantly improve their overall quality and skills.

In this regard, aircraft maintenance occupies an important position in the development of the aviation industry, and we need to increase our efforts in the study of maintenance technology, based on traditional experience, in line with modern technology, adhere to the "prevention-oriented" maintenance concept, seriously do a good job of daily inspection, regular maintenance, timely and accurate troubleshooting, to ensure maximum flight safety We will also promote the stable and healthy development of the aviation industry.

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