Reusing Materials in the Aerospace Industry – An Analysis of Recycling Methods and Solutions

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Abstract

This research explores the various material recycling methods used by the aerospace industry, particularly in comparison to the reusability of aerospace materials and with the objective to find uses for recycled materials from aircraft, specifically polyetheretherketone (PEEK) and aluminum. Through an analysis of various other material mitigation methods, it is apparent that the physical degradation of materials after they go through recycling processes and the cost of recycling are the most prominent issues holding the aerospace industry back from being able to recycle aircraft up to 100%. From a comparison of physical characteristics of materials after reprocessing, several materials were found to meet industry standards, while still being profitable, like PEEK and aluminum. By using new manufacturing methods, these materials are strong enough to be used as structural components in the aircraft, however, the aerospace industry needs to work towards being consistent with materials and methods.

Introduction

The aerospace industry aims to reduce their emissions and waste to zero over the next few decades, however, the aerospace industry's priority will always need to be safety, so it is difficult to reuse parts and materials within aviation. Most materials, especially those used in structural components, must have high strength, elasticity, toughness, and various other mechanical properties to reduce the risk of structural failure. When reusing materials, they must be reprocessed in some way, degrading the quality of most materials, and therefore making them unusable in the aerospace industry. Industries must also consider the cost and profitability of materials, as they must not be difficult to replace. The objective of this research is to find the need for recycling in aerospace, analyze current methods, and find alternative ways to improve recycling within aerospace.

Salvaging

Salvaging is a common recycling method when an airplane is decommissioned, where parts can be removed to be used on other aircraft. The parts are subject to regulations and the airplane must still be certified when salvaged. The careful removal and inspection of these parts can be costly, as skilled laborers are required, however, salvaging can still be a liability for a company. Salvaged parts can be lost track of in the market and end up being used despite being uncertified. Around $2.5 billion worth of salvaged parts were put onto the market between 2009 and 2011, which includes parts that went overseas [4]. This can be dangerous, since standards and regulations differ around the world. There is also the issue of trade secrets being released, so many parts, especially those from military aircraft, end up being destroyed or never salvaged. An example of this is the 309th Aerospace Maintenance and Regeneration Group's (AMARG) aircraft storage facility, which is the world's largest aircraft boneyard (Figure 1).

Repurposing

One of the most common ways of recycling aircraft is recycling material and repurposing it into another field. Usually, the aircraft components are collectively recycled. Lately, upcycling has become a trend, where artists use aircraft parts to create unique furniture pieces. Traditionally, materials themselves are recycled, such as aluminum and composites, which are broken down and sold as scrap material. This material can be bought by other companies and reprocessed to be sold again as raw material. Electronic components like circuit boards can even be repurposed into new products, like TVs, according to Airbus [1]. Repurposing aircraft components is an effective way of recycling material while also earning a percentage of what was paid for the aircraft back, however, it can still be wasteful. When it comes to collective recycling, especially for composite materials, different materials are not perfectly sorted out. Because of this, the aircraft owners are not able to gain as much money back as they could if a higher quality material could come out of reprocessing.

Figure 1. *AMARG's aircraft boneyard at Davis-Monthan Airforce Base in Arizona [3].*

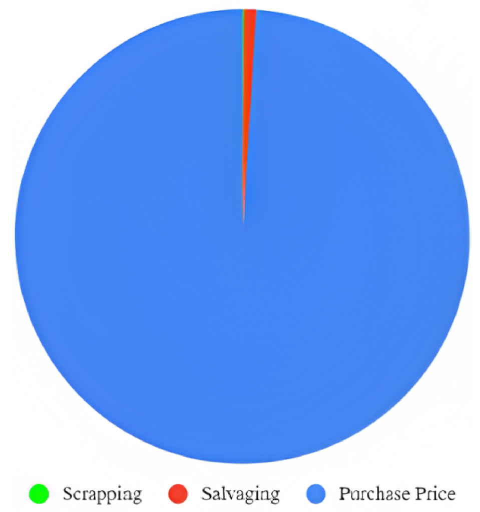

Figure 2. *Chart showing the percentage of a Boeing 747's purchase price made back upon recycling.*

Cost Analysis

Using a spar as an example, the cost of using more recyclable materials and structures can be calculated. Based on the dimensions of a plane the size of a Boeing 737 Dreamliner or Airbus A320, the total cost of materials was calculated in Table 1, being $3,733.24. The cost of a wing spar alone for a Piper PA-38 Tomahawk, a significantly smaller aircraft, would be $5,540 (before labor costs are factored in) [4]. The labor costs would also lessen, as composite materials have expensive fabrication costs due to the specialized labor needed. By simplifying the materials used and way of constructing components, manufacturing cost could significantly lessen. This method is much more profitable when compared with other recycling methods. In Figure 2, it can be seen that current methods, like salvaging and repurposing only pays back a small percentage of the original cost of an aircraft.

Table 1 Cost of wing spare made from PEEK and Aluminum

Material	Weight (lb.)	Cost (per lb.)	Total Cost
Aluminum 2024-T3	199.5	$7.35	$1466.34
PEEK Filament	80.99	$27.99	$2266.91
		Total Cost:	$3733.24

Conclusion

The most prominent issue in sustainability is the willingness of different companies and sectors within aerospace to communicate and create a uniform system that yields the best results. Instead of changing recycling methods, aerospace companies could instead consider the materials being used and how they will be disposed of or recycled in the long run. Glass fiber and seats are a great example of this, since glass fiber does not recycle well, and seats are made with flame retardant chemicals that cannot be recycled.

Besides the issue of material waste, the environmental effect of disposing of materials made from high-risk chemicals should be considered when it comes to recycling. For instance, state governments and regulatory bodies have been tightening their hold on "forever chemicals" like perfluoroalkyl and polyfluoroalkyl (PFAS) substances. These chemicals do not break down and are being found to have a very significant impact on the environment, humans, and will continue to do so. In aerospace, PFAS chemicals are commonly used to make materials flame retardant, such as in seats. Although this is an important quality in the case of an emergency, these chemicals will not be able to be used in manufacturing anymore. PEEK is already a preferred plastic within the aerospace industry, but so are PFAS plastics.

To increase the recyclable material yield of aircraft, the change needs to start within aerospace manufacturers. Many companies are already pushing for this goal, but the aerospace industry would need to be willing to change and adapt with each other. The amount of aircraft being decommissioned will continue to rise (Figure 3), and the aviation industry will only find itself with more waste.

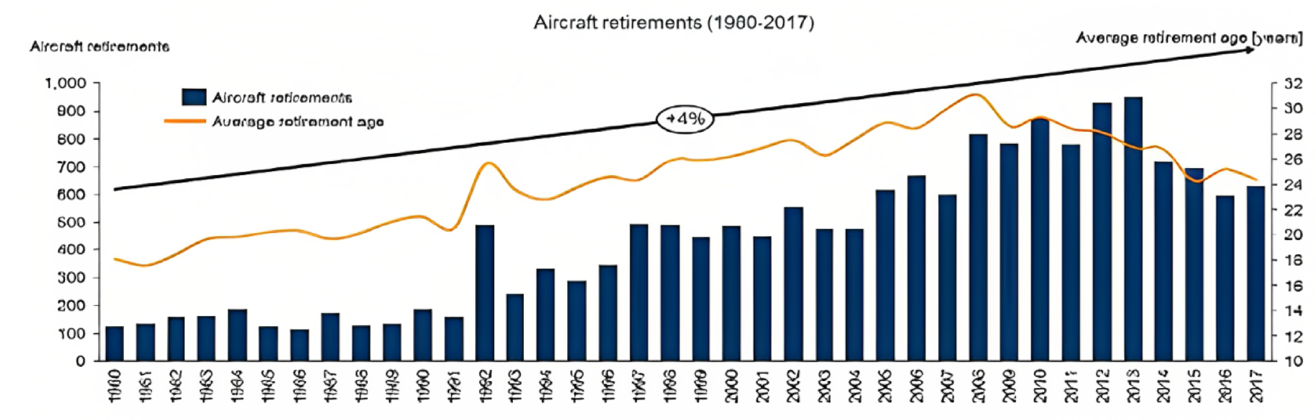

Figure 3. *Graph showing the change in historical aircraft retirements from 1980 to 2017 [2].*

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