AELS is specialised in the environmental-friendly disassembly and dismantling of end-of-life aircraft. Its goal is to reduce any possible environmental impacts and acquire a higher recycle rate with each new project. AELS helps the aviation industry with its services to lower its ecological footprint.

As with any other man-made product, an aircraft also reaches an end-of-life. What is done with such an aircraft? How do we deal with the waste that is generated at this stage of an aircraft's life? In this article Brijan Irion, **from Aircraft End-of-Life Solutions, gives insight into this niche market, the developments, and the opportunity the industry has to further improve its ecological footprint.**

End-of-life aircraft management

Aircraft retirements

After about 20-25 years a commercial aircraft, defined as an aircraft with 100 or more seats, reaches the end of its economical life. This means that by then the aircraft is still capable of performing its operational services from a technical point of view. The aircraft, however, is taken out of service because it has become economically unattractive for its operator to keep it in operational service. The predominant factors which contribute to the economical unattractiveness of aircraft ageing beyond 20-25 years are the increasing maintenance, repair and overhaul (MRO) costs and the lure of lower fuel costs with newer aircraft.

Maintenance costs of aircraft ageing beyond 20-25 years are typically more than double that of when they are at five years of age. This creates a situation in which the revenues gained from flying the aircraft do not outweigh the increasing maintenance costs needed for keeping the aircraft operational. The reliability of older aircraft due to more maintenance also has an impact on airliner planning: the older the aircraft, the more unplanned maintenance is required. This disturbance creates extra cost as well as unsatisfied customers that need to wait for a replacement aircraft.

In a time of high fuel prices operators are paying close attention to the fuel efficiency of their aircraft. The acquisition of new or newer, more fuel efficient aircraft becomes attractive for the operator if the acquisition price of the new aircraft does not exceed the cost of keeping the aircraft in operational service. With the current financial crisis this is of less importance, but at the next upturn this will again play a significant role in fleet planning.

Airbus estimates that over the next 20 years 7,000 commercial aircraft will be retired. The majority of these retired aircraft are flown to the south-west region of the United States where they are parked at an aircraft storage facility located in the Arizona desert. Here the aircraft await a possible return to active service. However, a return to active service for these aircraft largely depends on economical and/or market conditions. Older first generation jet aircraft such as the Boeing 727s, early 737s, Airbus A300s and A310s are unlikely candidates for a re-introduction back into active service. This is because these aircraft have the characteristics of being high fuel consumers and are noisy compared to current, more efficient aircraft. Moreover, less than 10 per cent of these older generation aircraft have temporarily returned into active service.

More than 7,000 aircraft could be retired over the next 20 years, with the majority being parked in desert storage facilities.

Historically, aircraft parked for more than two years and aged more than 20 years have a probability of only five per cent of a return into active operational service.

The storage of these aircraft – which are generally carcasses stripped of their valuable components – can be considered as a form of surface level land filling. A potential environmental threat is enclosed in the storage of these old kings and queens of the sky. These aircraft contain heavy metals, asbestos and in some cases still hazardous liquids such as hydraulic fluid. When stored for years the release of these hazardous materials and the leakage of any residual fluids due to, for example, corrosion are an environmental threat.

Besides the strong economical drivers for airline operators there are also environmental considerations for aircraft retirements. Throughout the 20-25 years of the aircraft's operational life cycle the aircraft creates several negative impacts on the environment. These environmental effects follow the natural course of an aircraft's life cycle, such as the disposal of waste generated during the production stage, emissions during its operational life cycle and waste disposal at the end-of-life stage.

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The aviation industry has for years had a reputation of being a major contributor to global warming. The International Air Transport Association (IATA) calculated that the aviation industry is responsible for two per cent of man-made CO_2 emissions. The aviation industry has increased its green awareness as the environmental reputation of companies in all industries becomes more significant in the eyes of the consumer. A strong focus is placed on lowering CO_2 emissions during an aircraft's operational life. Decreasing CO_2 emissions can only be achieved by the retirement of the older, first generation aircraft combined with the introduction of the latest generation, more fuel efficient aircraft. Airbus expects that a total of 13,772 commercial aircraft will be replaced with more eco-efficient aircraft. Of these, a total of 6,459 aircraft will be permanently retired from active service (according to the Airbus global market forecast 2007-2026). The aviation industry has a moral obligation to present an environmentally friendly solution for these end-of-life aircraft.

Attitudes and responsibility toward end-of-life handling

Company perspective

Both The Boeing Company and Airbus are committing themselves to a more sustainable aviation industry. The two commercial aircraft manufacturers have presented initiatives in designing and

developing best practice standards and codes of conduct for the safe and environmentally-friendly processing of end-of-life aircraft.

In 2005 Airbus, in co-operation with partners, started the PAMELA (Process for Advanced Management of End-of-Life Aircraft) project. This initiative was intended to develop environmentally-friendly aircraft recycling procedures in accordance with environmental, health and safety rules and the aviation safety requirements of the European Aviation Safety Agency (EASA). In line with the life cycle thinking approach, Airbus takes cradle-to-grave responsibility for its products. In June 2007, Airbus announced the birth of TARMAC AEROSAVE. TARMAC stands for: Tarbes Advanced Recycling and Maintenance Aircraft Company. With the establishment of TARMAC, Airbus chose to move on from the experimental PAMELA project toward an industrial-dedicated specialised company for end-of-life aircraft management.

Boeing is involved in an industry initiative called AFRA (Aircraft Fleet Recycling Association). AFRA was launched in June 2006. The objectives of AFRA are to set a standard and develop a code of conduct for end-of-life aircraft handling within the aviation industry. AFRA currently consists of 40 members, and of these members the first are accredited. Their company processes are according to the best standards.

Consumer-passenger perspective

The Dutch company Aircraft End-of-Life Solutions (AELS), also a member of AFRA, in co-operation with the Dutch Erasmus University Rotterdam has researched the opinion of airline passengers. The purpose of this research was to analyse the opinion of airline passengers according to end-of-life handling in relation to the image/-reputation of an airline operator.

The outcome of this research was that 60 per cent of passengers believed that end-of-life handling would influence the reputation and reliability of the specific airliner. Moreover, 48 per cent of the respondents thought that waste treatment is important and will use this for the ticket decision process. The research also indicated that 90 per cent of the respondents thought that the aircraft owner is responsible for the end-of-life handling of the aircraft. These numbers tell the industry that we need to have a good answer for these aircraft as they influence the global perception of customers of environmental friendliness.

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Responsibility from an industry perspective

Currently there is no end-of-life legislation applicable in the aviation industry. However, not obliged by legislation but out of respect for the environment and society both Boeing and Airbus are promoting the environmentally-friendly treatment of their products either through the development of codes of conduct or the establishment of best practices. Their actions are driven out of a feeling of their social corporate responsibility.

End-of-life aircraft management

Many aircraft owners struggle with the question of how to dispose of an end-of-life aircraft and how to do the job. In many cases they are searching for a company who can take care of the entire process ranging from the removal of valuable parts, recycling of the airframe and the management of the re-useable components. AELS is one such company capable of managing the complete process, releasing the aircraft owner from this burden.

The first stage of a typical, sustainable end-of-life aircraft process is disassembly, whereby all valuable parts and components are removed from the aircraft for re-use.

AELS helps aircraft owners worldwide to develop and execute an economical and environmental end-of-life solution for their aircraft. AELS believes that in light of the end-of-life decision there are two options for aircraft owners who have, or are going to, retire their aircraft:

The aircraft can be directly, or after a period of parking, sold to another operator. The aircraft can also be converted from a passenger to a freighter configuration after which it is sold or operated by the same airline. These options are mainly dependent on the economic and/or competitive market conditions.

The valuable parts of the aircraft, such as the engines and avionics, can be disassembled from the aircraft after which these parts and components are sold and re-used on other aircraft. The remaining aircraft fuselage is dismantled for recycling of materials, mainly aluminium.

The process

A sustainable end-of-life aircraft process typically follows three stages: disassembly, dismantling and component management.

Stage 1: Disassembly
The first stage involves the removal of all valuable parts and components from the aircraft for re-use. In many cases the disassembling or part-out of valuable parts and components from an end-of-life aircraft can deliver higher revenues than selling the aircraft complete. When the aircraft has been parked for a longer period of time disassembling is often the only solution left. The high costs that have to be paid for parking and maintenance, in combination with the fact that the condition and value of the aircraft decreases during the time of parking, often results in a situation that the aircraft is sold for a lower value than could have been obtained if valuable components were disassembled and sold separately directly after the last flight. The main focus of this stage is to make sure that each component is removed according to aviation safety regulations and OEM directions. It is therefore very important to have a complete history of the aircraft and its components. When the history is incomplete the value of the components can drop to zero.

Stage 2: Dismantling
After the valuable parts are disassembled from the aircraft the next step is to dismantle the remaining airframe after which materials can be recycled. The activities involved at this stage are the drainage of fluids (if not yet removed during disassembly) and the removal of (currently) non-recyclables such as plastics and insulation materials. The removal of heavy metals is also part of this stage.

The second stage (below and top right) involves the dismantling of the remaining airframe after which materials can be recycled.

The value of these metals, such as titanium, is higher when separated from the aluminium stream. Next to that these metals will influence the quality of the aluminium after it is re-melted.

The final step in this stage is the actual scrapping of the carcass and the recycling of its structural materials. These activities are generally executed with industrial cutting equipment. The machines cut the remaining fuselage into transport manageable pieces, after which the materials are transported to a recycling facility where they will be processed. Upon arrival at the recycling facility the aircraft pieces are shredded further into smaller pieces. By using separation techniques, such as eddy current machines, the stream of aluminium is made as pure as possible.

Unfortunately, aircraft dismantling activities are not conducted with the same amount of respect around the globe. This is caused by the absence of global environmental legislation or guidance for aircraft dismantling. Activities are bounded to local environmental legislation and are not regulated by agencies from the aviation industry. Depending on the scrapping location, the final step of this stage usually involves removing the landing gear and leaving the carcass ready to be scrapped. Several locations are known where aircraft are left at this stage for many years.

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The third stage of the process is component management – the re-introduction of removed components from end-of-life aircraft into the aviation industry.

Stage 3: Component Management

The final step is the re-introduction of removed components from end-of-life aircraft into the aviation industry. When done correctly and with the right timing, components can be given the correct certification to be directly re-used in still flying aircraft. When the aircraft has been parked for some time the components cannot be re-used directly and need a shop visit to acquire

the correct paperwork. Of course there are other business processes that need to be done to make all this possible. This includes steps such as packaging, marketing and sales and the logistics of getting the part at the right place at the right time.

When done correctly 90 per cent of the aircraft can be recycled. This means that on an aircraft at end-of-life with a weight of 100 tons, 90 tons can be recycled. These 90 tons consist of components that can be re-used in another aircraft and material that is recycled and used in other products like car engines. The final 10 per cent is disposed of and sometimes used for energy recovery.

Composite recycling

The future challenge for aircraft material recycling will be lightweight composite materials which are used to construct the new generation aircraft such as the A380 and the 787. The use of these composites in new aircraft design is based on the ability of these materials to achieve significant weight savings compared to the most advanced aero aluminium alloys. These weight savings reduce fuel burn, which results in less CO_2 emissions.

Historically, 90 per cent of these composite materials such as carbon fibre reinforced plastics (CFRP) and glass reinforced aluminium (GLARE) have been land-filled or have gone through an incineration process. The U.K.-based composite recycling company Milled Carbon, one of the founding members of AFRA, has collaborated with Nottingham University to improve aerospace composite recycling. Given its expertise in the area of carbon fibre recycling, the company plays a central role in the development of a composite recycling plant in Italy.

At the end of the recycling process an aircraft ends up as nothing more than this large pile of shredder materials.