Aircraft Replacement Strategy
Mathematical Model And Analysis For Fleet Acquisitions And Replacements

For carriers to plan optimal strategic fleet acquisitions and retirements, planners must diligently compile and study all related cost data. This analysis reviews the required data and involves two U.S.-based airlines with distinctly different business models.

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Most aviation regulatory entities and aircraft manufacturers foresee demand for air transport rising during the next 20 years, and airlines are seeking to strategically position themselves to meet this anticipated rise in demand.

Aircraft replacement strategies involve critical decisions that impact all processes related to planning and operations within airlines. They revolve directly around how many aircraft of different types to purchase, lease and retire — as well as precisely when — within an airline’s planning horizon.

These decisions must support and fully reflect a carrier’s short- and long-term intent and strategy, fundamentally affecting its financial, operational and competitive performance.

For airlines trying to make these strategic decisions, the following mathematical approach can help construct their fleet replacement strategy.

**Mathematical Model**

We developed a mathematical model to help with these critical airline decisions.

The mathematical model attempts to identify the number of aircraft to buy, lease or sell while minimizing total discounted costs within the planning horizon. We refer interested readers to Bazargan and Hartman (sabreairlinesolutions.com/ACReplacement) for details of this mathematical model.

**Model Parameters**

The model requires some data that airlines themselves do not have — or do not choose to disclose. Therefore, an alternative search was initiated. The following discusses the data needed for the model and how they were compiled:

- Aircraft values — including purchase and salvage prices for each fleet — were compiled from Collateral Verification (2010) and Airfinance Journal (2010) databases. These databases provide both the aircraft book and market values with respect to individual aircraft ages. A series of regression analyses was used to identify the relationships between aircraft market values and their ages for each fleet.

- Aircraft annual lease prices — They vary depending on the leasing company and the airline’s network. Again, Collateral Verification (2010) was used to determine lease payments. A logarithmic equation provides a good estimate for annual aircraft lease prices with respect to their market values.

- Operating and maintenance costs — These estimates were obtained from the Airline Monitor (2010). The operating cost of a fleet tends to remain stable and does not depend on the age of the aircraft. For maintenance costs, we used the analyses and model reported by The RAND Corp. They have conducted research on maintenance costs for more than 1,000 aircraft for both commercial and military aircraft as the aircraft age. Their research categorizes the maintenance costs into three aircraft age brackets — namely new, mature and aging. They propose models for each age bracket.

- Cost of introducing new fleet — In our study, we adopted Conklin and Decker’s 2010 analysis to determine the cost associated with introducing a new fleet.

- Fleet sizes — We relied on U.S. Bureau of Transportation statistics for current fleet sizes, and derived a nominal discount factor based on statistics from the International Air Transport Association (IATA).

Planning horizon: Aircraft Researcher Paul Clark in 2007 indicated that major technological change in aircraft manufacturing occurs every decade. In accordance with this assumption, we set the planning factor in a period from 2011 to 2020.

**Research And Application Analysis**

To test our model, we examined AirTran Airways and Continental Airlines (prior to their mergers).

The rationale for selecting these two airlines was to investigate whether the carriers’ aircraft replacement strategies vary with fleet diversity, network size and/or business model and philosophical business approach.

In 2010, AirTran Airways operated a fleet of just two types of narrow-body aircraft, using 138 aircraft on more than 600 daily flights.

Meanwhile, Continental Airlines operated more than 10 types of narrow- and wide-body aircraft, with a total of 352 aircraft on more than 2,200 daily short- and long-haul flights.

We used the model to derive the aircraft replacement for both airlines.

Figures 1 and 2 present the solutions for the aircraft replacement strategies for the two airlines between 2011 and 2020. Discounted costs over the 10 years are US$3.45 billion and US$53.5 billion, for AirTran Airways and Continental, respectively.

These figures illustrate the fleet type as well as the number of aircraft to buy, lease and sell.

These solutions also include current airlines’ orders for owned and leased aircraft to be delivered between 2011 and 2020 as reported through U.S. Bureau of Transportation statistics.

To avoid clutter, the figures do not present the ages of the aircraft to buy, sell or lease.

Solutions for both airlines favor brand-new aircraft for both buying and leasing; short-term leases; selling older aircraft ages 12 and older; discouraging fleet diversity; and leasing aircraft over buying.

**Figure 1: Aircraft Replacement Strategy For AirTran Airways**

Significant Savings Over a 10-year period, from 2011 through 2020, AirTran Airways would save US$3.45 billion as a result of an aircraft replacement strategy that follows the outlined mathematical model.
These recommendations are similar for both airlines, regardless of their different network sizes and fleet diversity.

Other notable studies have also revealed an expanding interest among airlines for leasing over buying. Based on the solutions reached in our study, Figure 3 presents the percentage of leased aircraft among total aircraft in the two airlines’ networks from 2010 to 2020.

Sensitivity Analysis

As part of our study, we explored the sensitivity of the solutions presented in the previous section. Of particular interest, we examined how the strategies of lease/buy are affected as prices vary, and we identified the roles of major cost drivers.

To determine how sensitive the solutions are to lease/buy prices, we let the prices fluctuate between minus 50 percent and plus 50 percent of their current values.

The strategy only starts to favor “buy” over “lease” when lease prices rise 30 percent and purchase prices are reduced by 40 percent — neither of which is a likely circumstance.

Also, we have varied the conditions by inserting fluctuations in other parameters such as annual demand and planning horizon. The indicated strategy using those factors, however, continues to favor “lease” over “buy.”

The solutions in the previous section illustrate the total discounted costs for the two airlines over 10 years. These include purchase, lease, operations, maintenance and depreciation costs — minus revenue generated from sales of aircraft. Figure 4 presents the percentages of each of these cost components over a 10-year period for each airline.

As this figure suggests, the major cost drivers are operations and maintenance costs. These two components make up more than 90 percent of incurred costs over the 10-year planning horizon. Furthermore, operational and maintenance costs have to be assumed by the airline regardless of its choice to buy or lease the planes. In fact, as the figure shows, the lease/purchase costs seem rather insignificant compared to operating and maintenance costs.

Figure 5 provides a comparison between lease/buy and operations and maintenance costs. This figure presents the aircraft market value and cumulative operating and maintenance costs for a sample fleet during a 10-year period. As the figure illustrates, the airlines spend more on operating and maintenance costs during the first years of operating
this new aircraft than what the aircraft is worth at the end of three years.

Further analyses with other fleet have also confirmed that no aircraft is worth more than what was spent on it within its first four years of operation.

**Research Conclusions**

This mathematical study has introduced a model to highlight major factors in aircraft replacement strategy for airlines of varying sizes and operating philosophies.

The model attempts to minimize the total discounted cost of purchasing, leasing, operations and maintenance by identifying the number of aircraft to lease, buy and sell over a typical planning horizon.

The suggested strategy favors new aircraft to be leased over short-term periods. Short-term leases provide fleet flexibility to adjust capacity and respond to changes in the marketplace, if needed. The strategy also discourages fleet diversity. Having a less-diverse fleet will minimize overall operating costs because cockpit and cabin crew can be cross-trained and utilized. This provides flexibility to the operation, giving the ability to respond to irregular operations, increase maintenance efficiency, reduce costs and boost productivity.

Various sensitivity analyses tend to strongly imply that leasing aircraft is preferred to buying. An additional advantage of leasing versus buying is the reduction of risk associated with fleet impairment charges. It is common that airlines have aircraft sitting on their books with a higher book value than the market value. When these planes are taken out of the fleet, a special charge is incurred. This risk is higher if the fleet associated is not desirable by the marketplace due to its economics. An example is the Airbus A340-500 fleet type.

The analyses also suggest that airlines will benefit from operating more-efficient fleet, even if the acquisition cost of that enhanced efficiency is either somewhat or substantially greater.

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