STAGE II VERSUS STAGE III

Despite increasing maintenance costs and noise concerns, it can often make more sense to keep ageing Stage II aircraft rather than replacing them. Frank Berardino and Earl Bomberger from Gellman Research in Philadelphia examine the fleet planning options for a fictitious Boeing 727 operator.

Despite increased regulatory concerns over their safety, and environmental concerns about the noise they make, ageing commercial jet aircraft remain in most of the world's airline fleets. While airlines must take into account the likely effects of mandated repairs, and the certainty that the aircraft themselves will be banned at many of the airports where they do business, continuing to operate these aircraft makes economic sense.

Airlines often can make more money holding on to their vintage Stage II aircraft, rather than replacing them with new Stage III airliners bristling with new technology, including quieter engines. Given a plausible set of expectations about future economics and the relative performance of Stage II and Stage III aircraft, older and noisier aircraft more than hold their own, according to the Gellman Research Associates Aircraft Evaluation Model.

Consider a replacement decision made by a hypothetical domestic airline operating Boeing 727-200s from a hub in the western part of the United States. Pacific Airlines is a transcontinental carrier with a fleet of 200 aircraft. It maintains hubs on the east and west coasts. From its west coast hub, it operates a fleet of 30 727-200s up and down the coast. The average stage length for the 727-200 fleet is 650 statute miles, and the aircraft average 13 years of age. Pacific has the financial capability to replace the aircraft, although it always has alternative uses for its funds.

The question is, should Pacific choose to replace the 727-200s with new technology, Stage III aircraft? Alternatively, does it make sense to retrofit the 727-200s, with either

TABLE 1: GENERAL BASE CASE VALUES AND EXPECTATIONS

Factors	1990 Value	Future expectations
Real cost of capital (%)	10.5	Equal inflation
Yield ($ per seat mile)	0.189	Equal inflation
Utilisation (hours per year)	3,113	No change
Load factor (%)	64.0	No change
Tax rate (%)	40.0	No change
Aircraft depreciation period (years)	15	No change
Average stage length (statute miles)	650	No change

hush-kits or new engines?

Pacific Airlines exhibits typical US costs and yields for 727-200s operating in 650-mile stage lengths. The carrier has developed a set of base-case values for its decision-making. These reflect current costs and revenues as well as expectations and are summarised in tables.1 and 2. The first table shows a list of general values and expectations about the future that are not aircraft-specific. The cost of capital and yield for Pacific are typical for the US industry, and the airline expects both to rise and fall with inflation.

Pacific expects no changes in any of the other variables shown in Table 1. This means that it expects utilisation for both the Stage II and Stage III aircraft to average approximately 8.5 hours per day and that the load factor will remain at the current level of approximately 64 per cent. It expects no change in effective tax rates, depreciation policies or average stage lengths for the aircraft involved in this decision.

Table 2 summarises the key aircraft-related values and expectations for both Stage II and Stage III aircraft. Both aircraft contain 146 seats, and the airline expects no change in this configuration over the life of either aircraft. It also expects average block times to remain at about 2.1 hours for these routes.

Maintenance costs soar

There are of course substantial differences in operating costs per available seat-mile between the two aircraft – 2.6 cents. The new Stage III aircraft will cost about $35 million. Pacific Airlines expects both airframes to have physical lives of 50 years; this means it does not expect any radical shift in FAA policy with regard to airframe maintenance, or other regulatory changes that would shorten the operable life of the aircraft.

As it looks into the future, and formulates its base case, Pacific Airlines expects aircraft prices to rise in lockstep with inflation. Operating cost increases, however, will exceed inflation due to higher fuel and maintenance costs. Pacific's expectations concerning these critical values relative to expected consumer price increases are illustrated in Chart 1. As the 727-200s age, maintenance costs per operating hour will soar. By 2010, Pacific is projecting that these maintenance costs will have risen more than twice as fast as consumer prices. Pacific also expects that fuel prices (currently at 56 cents per gallon) will rise at a rate 1 per cent higher than consumer prices.

Finally, Pacific has also formulated expectations about the value of the 727-200 aircraft. As these aircraft age, their values will fall from the current levels of approximately $7 million to about $4 million by the year 2000 (in 1990 dollars).

Having collected its current data, and formulated expectations, Pacific Airlines seeks to develop a formal decision rule. Obviously, many factors will enter into the ultimate decision, including the availability of new aircraft, and other competing uses for Pacific's scarce capital. But before getting to these points, the carrier needs to know whether it makes any sense at all to either replace the aircraft, or retrofit them.

To answer this question, the carrier should select that alternative which maximises the present value of its net cash flows. These cash flows should be evaluated over the lives of both the 727-200s and the Stage III aircraft that may replace them (Technically, the evaluation is made over an infinite stream of aircraft using a formula embedded in the model). Because the decision must be made on information that must be projected so far forward, expectations play a critical role in the ultimate answer. This also suggests that the carrier would be prudent to look at alternative scenarios, and would be best served by assigning probabilities to each of them. The ultimate decision should be made upon an average net present value weighted by the probabilities assigned by the airline's analysts. Here, we report the base case, and some logical alternatives. We leave it to the reader to assign the probabilities. All currency figures are in 1990 dollars.

The base case

Assuming there are no regulatory changes which require Pacific Airlines to stop flying these 727-200 aircraft at the airports where they now operate, the airline's best move given current expectations and current operating costs and revenues would be to keep the aircraft for an additional 18 years. At that time, they would be 31 years old. Of course, there are important caveats to this conclusion: significant changes in fuel prices, noise regulations or the market for new Stage ▶

TABLE 2: STAGE II AND STAGE III VALUES AND EXPECTATIONS

Factors	Stage II aircraft	Stage III aircraft	Future expectations
Present age (years)	13	0	NA
Seats	146	146	No change
Average block time (hours)	2.1	2.1	No change
Fuel burn (gal/hour)	1,275	900	No change
Cost per ASM (US cents)	9.0	6.4	Exceed inflation*
Operating costs ($ per hour):			
Crew	431	360	Equal inflation
Insurance	15	20	Equal inflation
Taxes	15	20	Equal inflation
Base maintenance	200	160	Exceed inflation
Landing and navigation charges	235	235	Equal inflation
Price new (US$ millions, 1990 $)	13.9	35.0	Equal inflation
Airframe physical life (years)	50	50	No change
Fuel productivity change (% pa)	0	1.0	No change

*Fuel and maintenance costs increases exceed inflation (See Chart 1).

Chart 1: Inflation

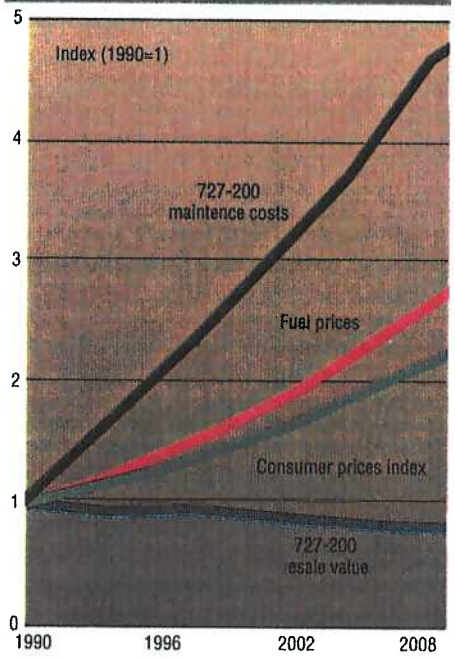
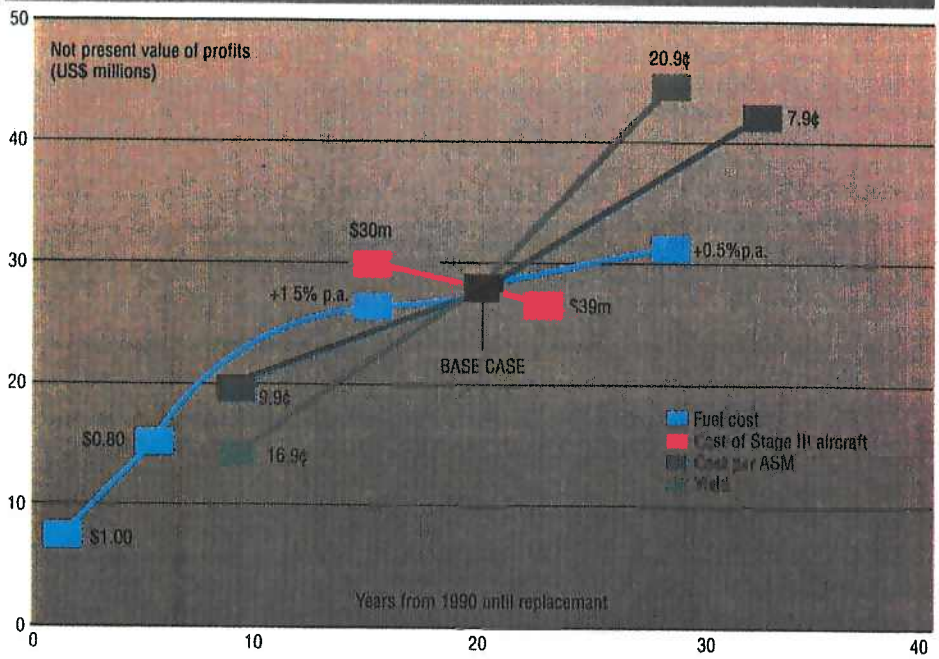


Chart 2 : Base case and alternative scenarios



Left: In the base case, Pacific Airlines may expect 727-200 maintenance costs to rise more than twice as fast as consumer prices, and fuel prices by 1 per cent above the rate of inflation. As a result, 727-200 resale values would fall to $4 million by 2010.

Right: Pacific could keep its 727-200s for 18 more years in the base case. But sharp increases in fuel costs or general seat-mile costs, or decreases in yield, would make earlier replacement advisable. Changes in the cost of new Stage III aircraft would have little effect.

III aircraft could affect the results. Pacific would be well advised to run alternative scenarios.

Since 1987, there has been a considerable increase in the prices paid by airlines for new narrowbody aircraft in the 150-seat range. While it is always difficult to nail down exact prices, which depend on many conditions, the average increase in price in only two years was about $5 to $6 million per aircraft ordered.

Swings in prices

In the present case, the impacts of such large swings in aircraft prices do not have substantial effects on the replacement decision. Chart 2 graphs the net present value of each option on the vertical axis against the number of years until the 727-200s would be replaced. If the Stage III aircraft price in 1990 fell to $30 million, the model suggests that the 727-200 aircraft be replaced in 15 years instead of in the 18 years reported in the base case. Alternatively, if 1990 prices for Stage III aircraft were to rise to $39 million, replacement would take place 21 years from now. These replacement times are so far into the future that they have no material effect on the carrier's current plans.

Because of discounting, the prospect of buying a more or less expensive Stage III aircraft 15 or 20 years from now does not matter that much in the calculation of expected net cash flows.

With fuel prices, it's a different story. In December 1989 and January 1990, jet fuel prices spiked in the United States. Some carriers were paying in excess of $1 per gallon for a short period of time. This contrasts with Pacific's current jet fuel price of 56 cents per gallon. Permanent changes in fuel prices, or more rapid run-ups in fuel prices than are assumed in the base case, represent another important possibility that Pacific must consider. The results are again shown in Chart 2. If fuel prices were to rise to $1 per gallon and then increase at a rate which exceeds the consumer price index by one percentage point per year, then the model suggests that the 727-200 aircraft be replaced in 1991.

Such a run up in fuel prices also has a dramatic effect on the net cash flows that the carrier can expect (assuming an inability to pass on any of the fuel prices increases to customers; in the long run, some pass through would be almost inevitable, however). Instead of producing net cash flows (in 1990 dollars) of $29.5 million as reported in the base case, each aircraft would produce only $8.1 million in net discounted cash.

Eighty-cents-per-gallon fuel would have a similar dramatic effect. Replacement would take place in only four years, and the cash flow prospects of the carrier would be reduced from base case levels. The reason for these dramatic effects is that we have assumed that the run-up in fuel prices occurs immediately and that the fuel prices themselves remain at a high level and grow faster than inflation.

Sensitive to fuel

Alternatively, if fuel prices grew only slightly faster than the 1 per cent in excess of inflation assumed in the base case, the effects would be far less dramatic. If fuel prices were to increase only 1.5 per cent faster than the CPI, then replacement would take place in 15 years instead of in the 18 years reported in the base case. If instead, fuel prices increased only 0.5 per cent faster than the CPI (a rate slower than assumed in the base case), replacement would take place in 27 years, by which time the aircraft would be 40 years old.

Clearly, the replacement decision is very sensitive to fuel prices. Of course, when ▶

projecting so far into the future, Pacific would be well served if it explored alternative scenarios which made different assumptions about the ability of the carrier to pass fuel price increases on to customers in the future.

Chart 2 also illustrates the effects of alternative operating circumstances for Pacific Airlines. If yields were 2 cents higher than assumed in the base case, Pacific would choose to replace the aircraft in 27 years instead of in the 18 years shown in the base case. If instead yields fell by 2 cents, then the carrier would choose to replace the aircraft in only nine years.

Similar sensitivities with regard to seat-mile costs are shown in Chart 2. A reduction in operating cost of 1.1 cents per ASM would increase the remaining life of the 727-200s to 33 years, from the 18 years reported in the base case. An increase in operating cost of 0.9 cents per ASM would cause Pacific to replace the 727-200s in only nine years.

Clearly yields and operating costs also have a dramatic effect on the replacement decision. As is the case with fuel prices, if an alternative condition takes effect on the carrier in the very near term, the replacement decision will be more dramatically changed.

Hush kits

There are any number of companies in the business of providing hush kits for Stage II aircraft. For example, Federal Express has a programme in place for modifying its 727s and those of its customers to meet Stage III noise requirements. In evaluating this alternative, it must be borne in mind that most of these hush kits have no beneficial effect on the operating costs of the aircraft; while they may increase the opportunities to use them at different airports, the fundamental operating economics remain unchanged.

Therefore, it should be no surprise that Pacific would install hush kits only if it expected regulatory changes that would adversely effect its ability to operate at airports on its route system. If a hush kit costs $2 million to $3 million per aircraft, it will have no effect on the year that the airline chooses to replace the aircraft. Using base case values, it would install the hush kit as far into the future as it could without running foul of noise regulations, and then retire the aircraft 18 years from now.

Some carriers have found it attractive to re-engine their aircraft. Pacific Airlines' 727-200s are relatively young. The airframes may have as much as 37 more years of life. Therefore, re-engining may make good economic sense.

As part of its evaluation of alternatives, Pacific has chosen to examine the Valsan re-engining programme. This programme involves replacing the two outboard engines with JT8D-217C engines, and acoustically treating the centre engine. The list price for this option in 1990 dollars is $8.6 million. Valsan also claims a 5 per cent increase in aircraft utilisation and a 16 per cent improvement in fuel consumption. Obviously, realising these additional benefits depends on airline-specific circumstances. However, re-engining carries with it one other important benefit. it significantly reduces aircraft maintenance costs. We have assumed for this analysis that the Valsan option would effectively zero-time two engines, which would have the effect of reducing maintenance costs by 25 per cent in 1990.

At Pacific Airlines, management can foresee no improvements in utilisation. Therefore, the Valsan option must stand or fall on its ability to improve fuel consumption while providing Stage III performance. The analysis of this option is presented in Chart 3. The horizontal axis on the chart shows the fuel savings due to the Valsan package, while the vertical axis reports the present values of net cash flows for various options. The horizontal line inside the chart represents the results for the base case. The other line shows the results for the Valsan option. Where the two lines intersect represents the trade-off point between installing Valsan engines and not installing them. Given Pacific's base case operating circumstances, fuel consumption improvements (shown on the horizontal axis) must be on the order of 7.5 per cent in order to justify installation.

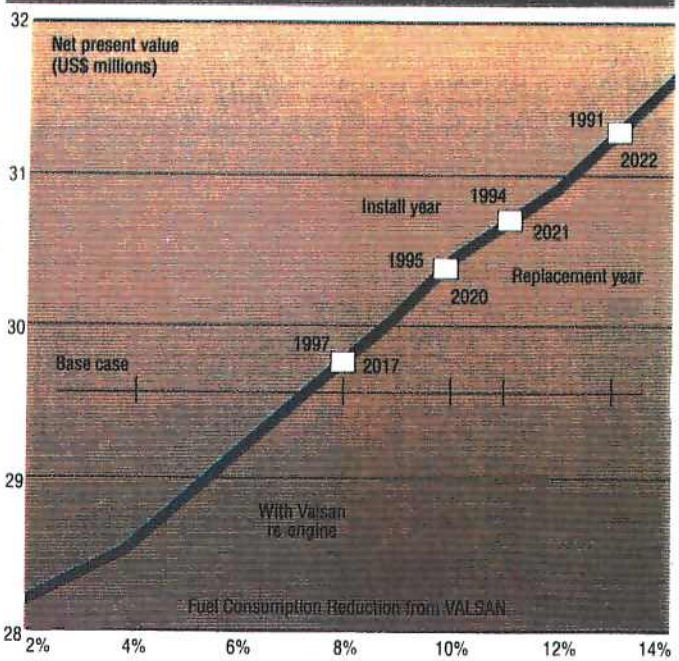
Re-engining attractive

The figures to the left of the Valsan line are the years when the new engines would be installed assuming fuel consumption improvements of 8, 10, 11 and 13 per cent. The numbers to the right of the line are the years when re-engined aircraft would be replaced. The greater the fuel reduction benefit, the sooner the new engines would be installed, and the longer the aircraft would be maintained in Pacific's fleet.

If Pacific was willing to place all its chips on the base case, it would choose to do nothing about its 727-200s in the near future. The model projects that it should not replace the aircraft for another 18 years. But placing all its chips on the base case could be dangerous. If fuel prices permanently increase 20 cents above the levels assumed in the base case, Pacific would prefer to replace these same aircraft in only four years. Fuel at $1 per gallon would make the need for replacement even more critical. Pacific also faces the high probability that Stage II aircraft will be banned at one or more airports where it operates on the West Coast.

Pacific's management will have to assign probabilities to the various scenarios; it might even ask its finance department to run a few more. Given the uncertainty, however, re-engining looks to be a very attractive alternative because it extends the life of the aircraft fleet, and may improve fuel efficiency significantly. ■

Chart 3: The Valsan re-engine option



For Pacific, Valsan re-engining is worthwhile if it improves fuel consumption by more than 7.5 per cent, assuming no increase in utilisation is possible.