13 Fleet Planning: The Aircraft Selection Process

Introduction Factors in Fleet Planning Design and Development—The Manufacturer's Viewpoint The Fleet-Planning Process The Decision to Upgrade or Replace Appendix: Fleet Planning at American Airlines

Chapter Checklist • You Should Be Able To:

- Understand the importance of fleet planning, and describe its long-range implications
- Describe the industry changes since deregulation that have affected the fleet-planning process including new aircraft technology
- Discuss the major factors an aircraft manufacturer must take into consideration in designing and developing a new jetliner
- Identify the four inputs in the fleet-planning process and explain what each one means
- Define *system constraints* and *constrained operating plan*
- Discuss the five areas that must be considered by an individual carrier in evaluating a particular aircraft

INTRODUCTION

One of the most difficult decisions airline managements must make is whether to buy new or used aircraft and what type. Alternatively, they must consider whether it makes better financial sense to modernize older aircraft already in their fleet or to acquire aircraft from the outside. Many additional factors, including the costs associated with engineering and maintenance, must be weighed. The factors are constantly changing, and their relative importance at each airline depends on the carrier's individual situation.

FACTORS IN FLEET PLANNING

Purchasers of new aircraft can generally get by for 7 to 10 years without having to make any major structural repairs. Furthermore, maintenance costs as a percentage of total costs have been steadily decreasing since the 1960s. However, percentages do not necessarily present a true picture. If one set of costs, such as for maintenance, rises less steeply than others, its percentage of the total may drop although the cost in absolute dollars may be rising. In this context, a set of figures from American Airlines is worth noting. Over the 20-year life of a 707, American found that maintenance costs rose 10 percent but that improvements in reliability more than compensated for the rise. This was in terms of current dollars. When translated into constant dollars, which take inflation into account, the situation was even better: maintenance costs actually dropped.

It would be quite simple if maintenance were the only, or the most important, factor to consider in fleet decisions. But besides maintenance costs, many other factors must be balanced against one another: the price of fuel; the availability and price of used aircraft; resale value; the price of new aircraft; terms of purchase; cash flow; debt/equity ratio; the availability of money from lenders; the receptivity of Wall Street to the issuance of stocks, bonds, and debentures; interest rates; route structure; competitive situation; strategy; and labor costs. All are even more important than before in today's deregulated environment.

The Prederegulation Era

Before deregulation, the airlines constituted a fairly stable business, and fleet decisions were much simpler, usually based on technical considerations. The airframe and engine manufacturers came up with improved models, and the airlines bought them on about a five-year re-equipment cycle. In the prederegulation world, the carriers would buy up the new aircraft coming on the market despite their high prices. The highly efficient and reliable engines, digital avionic cockpits, outstanding performance, and improved maintainability of these aircraft seemed to make them irresistible. But that simply hasn't been the case.

In the old days, overall costs could be predicted with some degree of confidence. Traffic kept growing, and routes were protected by the CAB. Lenders were secure in the knowledge that loans would be repaid on time. Even the weaker carriers could get the financing they needed, because under the "failing carrier" doctrine, the CAB would, if necessary, find them a stronger airline as a merger partner. Northeast Airlines was merged into Delta under this doctrine in the early 1970s when the former ran into financial difficulty.

Before deregulation, there were excellent technical reasons for massive replacement of aircraft. The advent in the 1960s of the turbine engine and in the 1970s of the widebody airframe permitted quantum jumps in productivity. Technical progress since then, although impressive, has been more in the nature of step-by-step advances. Today, there has to be a much more careful analysis of costs versus benefits before fleet decisions can be made.

Deregulation changed the rules of the game. New nonunion carriers, usually flying relatively inexpensive used aircraft, invaded traditional markets with low fares. Other low-cost carriers, such as Southwest Airlines, expanded their systems into new markets. To make matters worse, the price of fuel soared to over \$1 a gallon. The old, established trunk carriers, whose fleet philosophy had been to prepare themselves to meet peak demands, were stuck with fleets of three- and four-engine aircraft flown by cockpit crews of three or four and with power plants designed at a time when a gallon of fuel cost only 10 to 15 cents. The new carriers, on the other hand, flew twin-engine aircraft with only two pilots in the cockpit.

With deregulation, the established airlines had to find ways to reduce the operating costs associated with aircraft already in their inventory that were not as efficient as the newer generation of equipment. The incumbent carriers began to focus on new equipment that generated the lowest operating costs and were available in sufficient quantities and at the right times to meet their fleet and market-planning requirements. The strong market for used aircraft enabled many of the incumbent carriers to upgrade their fleets more rapidly and, even with higher labor costs, to compete successfully with the start-ups.

The Hub-and-Spoke System

In the quest to achieve the lowest possible unit cost, U.S. airlines have come to stress huband-spoke route systems where practical. This, too, has had a profound influence on new aircraft requirements. Lift capacity has tended to be greater in smaller aircraft with shorter full-payload ranges, such as American's MD-80s, United's fleet of 737s of various models, and US Airways' ERJs and CRJs.

Hub-and-spoke networks have influenced airlines in other ways. Although the air carrier community has long recognized economies of scale (as reflected in the preference for a large number of identical aircraft), it has also come to appreciate that, with deregulation, economies of scope are perhaps as important as economies of scale. This has led carriers to serve not only more city-pair markets but more varied markets than ever before. This, in turn, has caused the largest airlines to require a wider variety of aircraft than ever before. Indeed, the range of attributes embodied in such aircraft appears to be broadening as economies of scope are pursued, partially through airline consolidation.

Hubs have also influenced carriers' decisions with regard to larger aircraft, such as the Boeing 767 and Airbus A330. As the hubs become increasingly congested and slot limitations more constraining, there is a natural tendency to schedule larger aircraft rather than smaller ones through the hub, especially during periods of peak activity. This, too, has led to a proliferation of certain types of aircraft in the fleets of the larger carriers reliant on hub-and-spoke networks. Here, also, there has been a happy conjunction of events: changes in the so-called two-engine rule have increasingly enabled airlines to operate larger twin-engine aircraft intercontinentally and internationally as well as on shorter hauls.

Technical Aspects

During the early years following deregulation, most major carriers were reducing, and even liquidating, whole staff departments, including, in some cases, all their engineering personnel. Under such circumstances, the physical aspects of aircraft to be acquired have been left increasingly in the hands of the manufacturers of aircraft, engines, and associated equipment. Indeed, with the economics of aircraft having become the most critical issue, not surprisingly, the aircraft purchasing decision has become simpler again. Typically, an air carrier's senior executive concerned with financial and market performance of the airline dominates the aircraft acquisition decision process, and those engineering personnel that remain, as well as the operating staff (including pilots), play a much more reactive than proactive role.

In part, this can be seen by the relative ease with which the heavily innovative Airbus A320 is being sold to major airlines. Here is an aircraft that embodies a number of truly innovative concepts and much new hardware and software. In a former age, this would have given pause to most airline engineering departments, which would have preferred to see much more incremental technological steps because of their typically conservative approach to fundamental changes in aircraft technology.

For example, the total fly-by-wire concept in the A320, together with its sidestick controls, represents a substantial departure from past practice, and surely most airline engineering departments would caution their managements to go somewhat slower. This is not to suggest that the A320 is an unwise choice or poses any threat to safety. But the aircraft is being acquired primarily because it promises lower-cost production of the airline product, not because of its inherent differences—which most passengers will not recognize in any case.

Until the mid-1990s, the A320 was originally purchased with little airline engineering input. This was best reflected in the fact that the A320 incorporated components in its vital avionics system that were supplied by manufacturers with little or no previous success in the air transport market. Given the nature of the A320 (and a growing number of modern aircraft types such as the Boeing 777), avionics installations are integral to the aircraft. The fact that many airlines purchased the A320 with critical components from suppliers with whom they had never previously done business showed strong support for the contention that airline engineering departments were substantially out of the loop so far as decisions to purchase new aircraft were concerned. Today, the A320 is an aircraft with a proven history, and airline engineering departments are able to provide important input in the fleet-planning process.

Fleet Rationalization

Consolidation of the industry during the 1980s as a result of mergers has led to a proliferation of specific aircraft types operated by any particular carrier. No doubt, much of this proliferation will be reduced as fleet rationalization becomes both practical and possible. Although fleet rationalization may well be a first order of business for consolidated airlines, such carriers still need to acquire new aircraft not only to address new markets but also to enable them to enjoy the benefits of maximum practical fleet commonality in the long run. What will influence the acquisition process involving new aircraft is the economic organization of the airline industry as consolidation proceeds. The issue is the behavior of the airline industry under conditions of oligopoly. Economic theory suggests that as airlines become fewer in number, there will be tacit understanding with regard to fare levels and structures, even though no formal or strictly illegal agreements are reached. Cost minimization will not be completely disregarded. However, with greater price stability and with the behavior of competitors reflecting their own acquisition of a greater measure of monopoly power, product differentiation through service rather than price will certainly become more important.

With aircraft once more playing a greater role in determining a carrier's market share, coupled with the mild relaxation of cost-cutting pressures that consolidation will induce, airlines can be expected to add staff, especially as consolidation increases and the scale of individual airlines supports specialization of function within the organization. Under such conditions, airlines capable of acquiring significant blocks of new aircraft are likely once more to move in the direction of formalizing the fleet decision-making process. Although that process will necessarily be more concerned with the economies of the aircraft than it was under comprehensive economic regulation, engineering considerations will once again matter.

Consolidation also increases the interdependence between mega-carriers on the one hand and the manufacturers of aircraft and engines on the other. Whether such interdependence will be as great as in the period between 1933 and 1960 remains to be seen, but it will be an important factor. For example, with fewer airlines to serve as sponsors and launch customers for a new aircraft type, and with such airlines having requirements for a very large number of such aircraft, these carriers may seek to sew up the production capabilities of a given manufacturer by receiving initial delivery of a large number of aircraft—if not at the beginning of the production run, then somewhat later. The manufacturer, on the other hand, has every incentive to spread deliveries among as many air carriers as possible. As the number of airlines capable of placing launch orders and of becoming sponsors of new aircraft types diminishes with consolidation, the manufacturers will also experience added pressure to lower prices.

Still another anticipated effect of consolidation and subsequent fleet rationalization is that aircraft will tend to stay in the fleets even longer. This gives rise to the possibility of far longer depreciation periods than are now being experienced. This will result in the replacement cycles for new aircraft being extended and manufacturers becoming less able to market innovative types of aircraft as frequently as in the past. But if, as expected, airline consolidation does lead to heightened pressure to reduce aircraft prices and to a diminished willingness of the carriers to acquire innovative new aircraft so frequently, this may well serve at least the short-term interests of the manufacturers as well as of the air carriers.

But there is another side to this coin. Specifically, manufacturers of aircraft and their components, as well as the airlines, have benefited materially from the ability and willingness of most such enterprises to accept innovation. Were technological change to become less highly prized, there is a real question as to whether airline industry growth could be as vigorous as it would otherwise be.

Perhaps more critical is the question of whether any seriously reduced propensity to innovate on the part of the manufacturers of aircraft and components will delay the advent of such equipment as the projected hypersonic vehicle and, at the other extreme, the tilt-rotor aircraft.

Consolidation means greater control of the market by fewer airlines. If the lessons of other industries are a valid guide, such consolidation inevitably will lead to a reduced

propensity to accept innovation from manufacturers. In turn, this will influence the latter's own propensities to implant advanced technology.

The extent and character of the pace and direction of technological change in aircraft and components may well be substantially determined by the extent to which airline consolidation becomes a global phenomenon. If consolidation is constrained in some nations, theintercarrier competition that remains may nevertheless be enough to enable the waning number of aircraft producers to continue to pursue innovation as a means of product differentiation and cost reduction.

Fleet Commonality

One of the main reasons for aircraft purchases in large numbers is fleet commonality. The Boeing 757 and 767 have common type-rating requirements, a distinct advantage to the carriers operating both types, as well as a strong inducement for airlines that are operating either model. The new generation of the 737 family provides various models with identical cockpits and seating from 100 to 180 passengers, which offers airlines using such models greater flexibility for planning new routes. Commonality is also apparent in the Airbus series. The A320/321 and the A330/340 share many of the same component parts and flight deck instrumentation.

Engine choice is offered on almost all new transports having 200 or more seats, an important factor in decisions to buy a particular type. Usually, the selection is based on power plant commonality with other aircraft in the operator's fleet. Sometimes, it is a politically motivated decision, especially when the air carrier involved is government-owned or heavily subsidized.

Long-Range Aircraft

The Boeing 777, launched in 1990, is aimed at markets between the 767 and 747. It competes directly with the A330/340 series and the MD-11. The 777 is the first commercial airliner with the option of folding wings, allowing it to fit its otherwise long wings (for required range) in most existing airport gates. However, as of early 2006, no aircraft operator had ordered a 777 with this option due to high costs (\$2 million per aircraft). In 2008, Boeing will launch the 787 Dreamliner, a mid-sized twin-engine wide body aircraft that will carry between 250 and 300 passengers. This aircraft will compete against Airbus' 350, a 250- to 300-passenger long-range aircraft that will be available in 2010.

Because of the hub-and-spoke system's drawbacks, airlines are currently rethinking route structures and are considering new aircraft that can economically bypass hubs and provide point-to-point service. This would certainly win friends among the traveling public. Point-to-point service has always been popular, but the concept has even more appeal for travelers today because of their increasing frustration with air traffic delays and mounting congestion at major hub terminals. Bombardier's Canadair CRJ series and Embraer's EMB-135 and EMB-145 regional jets are aiming at this market niche.

Since the events of September 11, 2001, many airlines have refocused on point-to-point services to cut costs. In most cases, the regional jet is used because of efficient operational costs and reduced load-factor requirements compared to other aircraft.

The Trend Toward Leasing

The choice for an airline interested in financing a new airplane is, ultimately, to lease or purchase the aircraft. Before the 1980s, most established airlines chose purchase. Indeed, in 1984, only approximately 20 percent of the world's commercial aircraft were leased. By 2006, however, leasing had become far more popular, accounting for well over half of all aircraft acquisitions.

Two factors in particular explain why leasing tended to be more attractive in the late 1980s. First, the 1986 Tax Reform Act eliminated the investment tax credit associated with purchase. Under the investment tax credit legislation, taxpaying companies could deduct a fixed percentage (7 to 10 percent, depending on the type of asset) of the cost of the asset directly from their tax liability. Such credits constituted an effective reduction in the price of the asset to the acquirer, assuming that taxes were owed. These credits have no value to tax-exempt investors or to firms that are not profitable. Second, the act reduced allowable deductions from taxable income for depreciation. Accelerated depreciation allows firms to depreciate more than the actual depreciation of an asset for tax purposes. This has the effect of postponing taxes over the life of the asset, thereby increasing the rate of return on the asset. For financial reporting (separate from tax reporting), aircraft were depreciated over 12 to 15 years on a straight-line basis to a 15 or 20 percent salvage value. Specifically, Congress passed an alternative minimum tax provision such that profitable companies could not reduce their tax bills to zero with depreciation and other noncash charges. Under the alternative minimum tax, all noncash expense deductions after a certain threshold were disallowed or deferred, thereby reducing their value.

There are two types of leases, operating and financial. An **operating lease** is a noncancelable short-term lease. Other than noncancelability, perhaps the most important characteristic of an operating lease is that at the end of the lease, the lessor retains full title to the asset and bears any market risk as to its value at that time. Also, the lessee shows no debt on its books because operating lease obligations are offered only as a footnote to the balance sheet. Similar to other leases, when an operating lease is signed and the asset is put into service, there is no large initial cash outflow from the lessee.

The other type of lease is a **financial (capital) lease.** With these leases, the financial effect is the same as a loan except that title to the asset remains with the lessor until all lease payments have been made. Under a financial lease, title passes at the end of the lease to the lessee for a preagreed-upon sum. The result is that there is no market risk on the value of the asset borne by the lessor unless there is default. Financial leases are required to be reported in virtually the same manner as loans. That is, the value of the leased asset shows in the assets of the corporation and the present value of the lease payments shows as a liability.

The operating costs of maintenance, insurance, and taxes are normally the same for both ownership and leasing. This occurs because under most operating leases, the lessee is responsible for maintaining the asset in good condition. The nature of the responsibilities of the lessee is revealed in the term "net-net-net lease," signifying that the lease payments are net of maintenance, taxes, and insurance.

Before 1990, default was not perceived as a major cost in the airline leasing business, either because airlines seldom ran out of cash or because in the unusual situations when they did, aircraft could easily be repossessed and placed with other airlines, often with only a quick change in the paint job. Thus, the default risk borne by the lessor was no more or no less than for a normal secured lender.

The advent of new leasing companies in the mid-1980s added a new dimension to the air transportation industry. Although sales and lease-backs with banks and other financial institutions have been around a long time, organizations such as GPA Group of Shannon, Ireland, and International Lease Finance Corporation (ILFC) of Beverly Hills, California, were suddenly purchasing new airliners in rather spectacular numbers to lease to existing U.S. and foreign carriers. For the smaller carriers that lacked the huge amounts of cash needed to buy a couple of planes, leasing firms provided an attractive avenue to acquisition. Leasing also gave the smaller carrier the flexibility to trade up by exchanging (with its lessor) a smaller model for a larger one, as traffic dictated. By buying in quantity, of course, leasing companies get lower unit prices, a benefit reflected in the relatively reasonable rental rates they charge their customers.

In fact, the leasing enterprise became so successful that the firms engaged in it became the airframe manufacturers' biggest clients. ILFC ordered 130 assorted aircraft in May 1988; then in April 1989, GPA Group bought a staggering 308 transports, valued at over \$17 billion, the largest order ever in terms of units. United topped that dollar figure in October 1990 with a \$22 billion order (with options) for 68 Boeing 777s and 60 Boeing 747-400s (half of each type being firm orders).

Naturally, these record volume orders obligated large-scale airframe production. As a result, GPA Group and ILFC also created a new market for themselves. Airlines that had previously ordered equipment directly from manufacturers found that they were unable to get deliveries when they needed the planes. To solve their problem, they turned to leasing companies. Indeed, financing has become a significant part of the air transportation business these days.

Moreover, because of the troubled state of the airline industry during the early 1990s, many financial institutions awaited the outcome of the bankruptcy of several major carriers. The aircraft manufacturers offered special incentives to boost sales. Boeing accepted a substantial amount of United stock around the time United ordered its new aircraft. Airbus Industrie arranged a sizable loan for Northwest Airlines when the carrier converted options for 75 A320s into firm orders. Even the engine manufacturers have helped to arrange financing. In an unprecedented move in 1996, Boeing signed a contract with American Airlines and Delta to become their exclusive supplier of planes.

Why do so many airlines need new equipment? For a number of reasons, not the least of which is the fact that air travel became more accessible to more people in the 1980s. More people were flying, and the airlines simply did not have enough capacity to move them all. Most orders originated to replace the aging aircraft in the world fleet. Once new models were delivered, it soon became clear that the modern aircraft would be supplementing rather than replacing the older jets.

On the other hand, the older Boeing 727s and Douglas DC-9s will not be flying forever. Ever-increasing maintenance costs and fuel-inefficient turbines make older models much more expensive to fly. Operators of these planes must also contend with the public perception that they are unsafe. Ever since the top of the fuselage peeled off an aging 737 in flight in April 1988, the news media have been targeting the "sorry state" of the airline fleet. Yet it has been shown that an older plane, properly maintained, is as safe as the news to ne in service.

Noise Restrictions

Most early orders for new-generation aircraft were conceived as direct replacements of older planes—usually with models of roughly the same size. But as it became obvious that air travel was increasing beyond early projections, the carriers started looking for larger aircraft with more seats to obviate the need to add more flights. This led to orders for models such as the Boeing 757 to replace the 727s and the McDonnell-Douglas MD-80 to supplant the DC-9s. More than 2,000 new jet transports were on order for delivery during the 1990s, indicating that the days for aging airliners in the fleet were undoubtedly numbered. Higher maintenance costs, higher noise levels, and higher fuel consumption make them candidates for replacement by newer-generation models.

What will happen to these planes that have served the public so well for so many years? Some old 727s have, in fact, found a new home with Federal Express; hushkits have been developed so that they can meet the new noise rules. However, FedEx can absorb only so many; other aging units may be headed for South America or Africa, where noise is not yet a major issue.

Additionally, Valsan offered a re-engining program especially for the 727. But the retrofit's high cost might discourage most prospects, who would still be left with an older airplane. UPS and Rolls-Royce planned to re-engine 727 freight haulers to meet Stage 3 noise standards.

Table 13-1 lists the number of aircraft that ATA member airlines had on order as of December 31, 2002. As of early 2006, no updated data was available from ATA.

	Number		Firm Order Delivery Dates			
- Aircraft Type	Firm	Options	2003	2004	2005	2006+
Airbus						
A300	66	42	8	8	8	42
A318	15	8	-	-	-	15
A319	25	274	14	1	4	6
A320	82	55	17	14	14	37
A331	13	_	-	-	3	10
A330	25	28	5	7	6	7
A380	10	10	-	_	-	10
Boeing						
B717	25	-	11	12	2	-
B737	308	474	40	36	62	170
B747	1	-	-	_	-	1
B757	27	75	14	8	5	-
B767	14	65	14	-	-	-
B777	16	82	2	-	2	12
Total	627	1,113	125	86	106	310

TABLE 13-1Number of Aircraft on Order by ATA Members, as of December 31,2004

Source: Air Transportation Association Annual Report, 2003.

^aThe value of firm aircraft orders was \$29.0 billion.

Many factors must be considered before reaching the critical decision to acquire a specific number of a particular aircraft. All operating departments become involved in determining the number and type of aircraft required to implement the corporate strategy in future periods. This process is referred to as **fleet planning**, or the aircraft selection process. However, before getting into the specifics of the process from an individual airline's standpoint, it is important to look at some of the problems faced by the manufacturer in designing and building a new aircraft.

DESIGN AND DEVELOPMENT—THE MANUFACTURER'S VIEWPOINT

The Boeing Approach

The design and development stages for a new jetliner can take from five to six years. In the case of the Boeing 757 and 767 models, the concept of a more fuel-efficient aircraft was born in the mid-1970s with the skyrocketing price of fuel. When the 757 was being planned, engineers for Boeing, working with the airlines, were hoping for a 10 percent reduction in operating costs compared to the 727 jetliner that the new aircraft was designed to replace. In fact, Boeing had very modest ambitions for the 757. The original plan was essentially to modify the 727 to operate with two highly efficient engines instead of the three less efficient engines used on the 727. But as the months passed, Boeing's engineers kept making changes, and they finally decided to build the airplane more along the lines of the 767. About 60 percent of the parts in the 757 are interchangeable with parts in the 767; only 6 percent of the parts in the 757 are the same as those used in the 727. It should be noted, production of the 757 ended in October 2004 after 1,050 had been built.

Boeing promised a 22 percent improvement in operating costs over the 727—more than double the original estimate. The improvements are based primarily on the fact that a fully loaded 757 is 42 percent more fuel efficient than a full Boeing 727, the most popular commercial aircraft ever produced and the mainstay of the major carriers. The 757 is about the same size as the 727, but design improvements allow it to carry up to 63 more passengers with the 757-300 model. That is one reason for the reduction in operating costs. In addition, Boeing was able to use lighter-weight components, newly designed wings, and more efficient engines manufactured by Rolls-Royce and Pratt & Whitney. Despite the reduced need for fuel, the engines are so powerful that only two are needed to power the 757, rather than the three used on the 727.

The use of electronic monitoring devices and navigational aids allows the 757 to be flown by two pilots, as opposed to three for the 727, another improvement in operating costs. In the 757 cockpit, many of the common mechanical gauges and control systems are replaced by video screens and computers. The flight control systems are so advanced that, beginning shortly after takeoff, the plane can fly and even land by itself.

Like the 727, the 757 is a narrow-body aircraft with only one aisle. But passengers will notice many differences. For one thing, interior design changes, including higher ceilings, oversized storage bins, and wider window frames, give the 757 something of a wide-body appearance. For another, the lavatories have been moved to a more convenient location closer to the center of the airplane to help keep flight attendants out of the way of passengers and vice versa.

The 757 represents a compromise product that attempts to meet the basic need for a fuelefficient aircraft by the major U.S. carriers. Understandably, the different carriers had their own ideas about a replacement for the 727. Some carriers were primarily interested in a medium-size, medium-range aircraft with two engines. Others were primarily interested in an aircraft with transcontinental range, over-the-water capability, and three engines. The problem became even more complicated as more carriers offered their own ideas. Boeing's answer was to develop a family of aircraft—the 757, the 767, and the 777—that attempts to respond to the needs of most carriers.

This is extremely important to a manufacturer because of the tremendous development costs of a new aircraft. It is impossible to have a single airplane or even several aircraft tailor-made, even for a major carrier. Because the break-even production point for a manufacturer can be anywhere from 200 to 600 aircraft, depending on the level of technology, a number of carriers must be interested in a particular aircraft before a manufacturer will make the necessary investment. Consequently, manufacturers bring in the airlines at the earliest possible time in order to get their ideas and to begin focusing on generic aircraft categories.

Designing and developing an appropriate family of aircraft to meet a majority of the airlines' needs has become even more difficult since deregulation. With new competition from other established carriers and from the newcomers, most of the large carriers are still in the process of rationalizing their current and future route structures in an attempt to determine where they want to be in 5 or 10 years. The major carriers have been dropping low-density routes and concentrating on their high-density, long-haul routes with more standardized fleets, the motivation being to improve efficiency (load factors and utilization). This specialization among the different levels of carriers presents a problem for the manufacturer that tries to develop an aircraft whose users' needs vary considerably. The custom of prederegulation days, when each carrier had various models of aircraft from different manufacturers, seems to be over.

Another important step in the process of designing and developing a new aircraft is taking an objective look at the company's product in comparison with its competition. It is important to select those characteristics for comparison that are of particular concern to the potential airline customer. Figure 13-1 shows a few of the characteristics of competing commercial aircraft of concern to a particular manufacturer. Here, we see comparative data on block speed, payload, unit operating cost, and return on investment. With comparative data such as these, the manufacturer can make judgments as to the relative importance in the eyes of the customer of, say, differences in speed and range and return on invested capital.

Challenges from Airbus

Before the Boeing and McDonnell-Douglas merger in 1997, Boeing's chief competitors for the 757 and 767 were McDonnell-Douglas's MD-80, MD-90, and MD-11, and Airbus Industrie's A300, A320, A330, and A340. By 1996, the global market share for McDonnell-Douglas commercial airplanes fell to 4 percent of new sales. Boeing's proposal to acquire McDonnell-Douglas drew severe objections from the European aviation community and served to intensify the competition for new-generation aircraft. In 2001, Airbus surpassed Boeing in terms of market share to become the world's largest aircraft manufacturer. Although Airbus is delivering more planes than Boeing, and has won the order battle

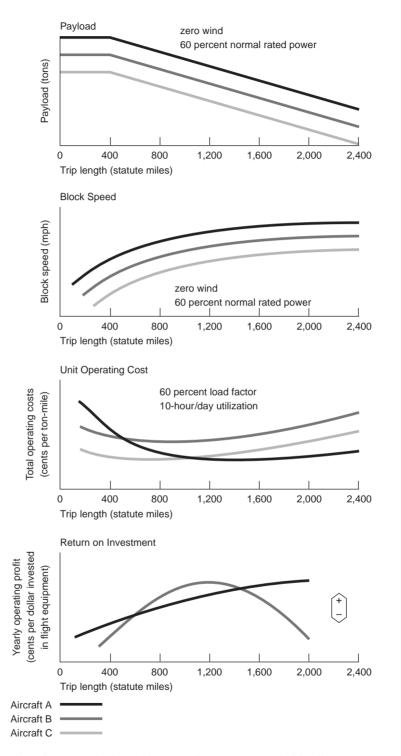


FIGURE 13-1 Major characteristics of competing commercial jetliners (hypothetical data).

each year since 2001, many industry analysts believe Boeing ended 2005 in a much better position than its rival, owing in large measure to the sales success of its 787 Dreamliner and the 777, which is crushing the Airbus A340 in market share.

Airbus Industrie is determined to correct what its officials see as the abnormal situation of U.S. manufacturers dominating sales to the Western world. The founding partners, France and Germany, each had a 37.9 percent interest in the Airbus Industrie consortium. British Aerospace held 20 percent and Spain the remaining 4.2 percent. Today, Airbus Industrie is co-owned by European Aeronautic Defense and Space (EADS), with 80 percent interest, and BAE Systems PLC, with 20 percent interest.

Three huge transport planes, whalelike aircraft known as SuperGuppies, continually ferry German fuselages, British-made wings, and other airliner sections to Toulouse, France, where the assembly plant is located. Many smaller parts and components are manufactured in the United States and shipped to Europe. Europe has obviously learned that one company or one country alone cannot make it in aviation manufacturing. In the 1960s and 1970s, there were a lot of good European aircraft—the Caravelle, the Mercure, the Trident, the BAC One Eleven, and the Concorde—but none was able to broaden its market significantly beyond Europe. Airbus Industrie receives no subsidies from member countries, and although participating governments contribute funds for research and development, all such assistance is paid back out of aircraft sales. But the European venture undoubtedly benefits from some of its political connections. The Airbus has been ordered by several state-owned airlines, and top management is sprinkled with former political leaders.

Although the Airbus might have benefited from political help, most industry observers attribute its success not to politics, but to timing. The Airbus was the first large twin-engine aircraft on the market, competing successfully against Lockheed 1011s and McDonnell Douglas DC-10s, both three-engine aircraft that consume more fuel.

Airbus Industrie's program for production of the long-range A340 and the medium- to long-range A330 was formally launched at the Paris Air Show in June 1987. The A340, which took Airbus Industrie into the long-range market for the first time, is available in two versions. The A340-300 carries 295 passengers in a three-class layout a distance of 6,850 nautical miles. The A340-200 carries 262 passengers up to 7,700 nautical miles. Both types have a maximum takeoff weight of 542,300 pounds and are powered by CFM 56-5C-1 engines, a more efficient and more powerful version of the CFM International engine that is used on the A320.

The A330, a two-aisle, twin-engine aircraft, can transport 328 passengers in a two-class layout a distance of 5,000 nautical miles. It has a maximum takeoff weight of 454,100 pounds and can be powered by either General Electric CF6-8OC2 or Pratt & Whitney PW4000 engines. The A330 and the A340 are also offered in passenger/freight combination versions.

The design of the new models continues Airbus Industrie's policy of maintaining a high degree of commonality in the systems, power plants, equipment, and structures of all its models. This allows operators to realize many savings in training costs and in spares holdings and investments.

The A330 and A340 have common landing gear and a common fuselage, with the A340-300 eight frames longer than the A340-200. Airframe commonality between the A330 and A340 has been raised to the high overall level of 85 percent.

The two models have an all-new, highly advanced wing, which Airbus claims produces a lift/drag ratio up to 40 percent better than early wide-body aircraft and will allow the

aspect ratio to be increased from 26 to 34 percent. The variable-camber wing incorporates automatic load alleviation for maximum structural efficiency, adapting its profile automatically during flight to match changing conditions of weight, speed, and altitude. The only differences between the wings of the A330 and the A340 are those required for installation of the outboard engines on the A340.

The A330 and A340 also share a common two-member cockpit crew similar to that of the A320, incorporating the latest glass cockpit instrumentation and sidestick controls instead of a yoke.

Airbus estimates that the program will eventually achieve sales of about 1,000 aircraft, shared equally between the two types, and will give Airbus a full range of airliners to match carrier needs. This achievement of a full product line has been a long-held goal of the company.

In 1988, Boeing introduced its 747-400, which is capable of flying 412 passengers more than 7,200 nautical miles, 1,000 more than the 747-300. This means that Northwest Airlines, the first to use these aircraft, is easily able to fly nonstop from New York to Tokyo without weight restrictions.

The 747-400 represents a natural progression in the 747 family, which began service life in 1970 with Pan Am. Boeing's sales of the 747 reached 1,200 aircraft by the turn of the 21st century, covering the 747-100 and its long-range, short-fuselage variant, the SP; the increased-takeoff-weight 747-200; the stretched-upper-deck 300; and the 400.

In basic design, the latest model is substantially the same as that of the 300, with identical fuselage, flight controls, and wing section (as far as the wing tips). There are, however, three major differences: (1) the wings are extended by 6 feet and have 6-foothigh winglets; (2) an all-digital two-person-crew flight deck is substituted for the three-person, conventionally instrumented original; and (3) the aircraft is offered with new engines—the Pratt & Whitney PW4000, General Electric CF6-8OC2, or Rolls-Royce RB 211-524134a. The 747-400 also has capacity in its horizontal stabilizer for 3,000 gallons of extra fuel, bringing capacity to over 56,500 gallons. In November 2005, Boeing announced a new model called the 747-800. Technology will be based on the 787 and will be capable of flying up to 350 passengers in a three-class configuration up to 8,000 nautical miles.

Other changes include the use of new aluminum alloys developed for the Boeing 757 and 767; a change to carbon brakes, saving 1,800 pounds in weight; and a completely redesigned interior, providing greater seating flexibility, larger overhead storage bins, and a wireless cabin entertainment system, in which radio and visual signals are picked up from floor-mounted transmitters, greatly simplifying rearrangement of the interior.

Other Factors in Design and Development

Another important factor in the design and development stage is the ability of individual carriers to finance the proposed new aircraft. There is a direct relationship between aircraft orders and airline profitability.

Although airline profitability is a key element in the design and development of any new aircraft, forecasting earnings and orders for some future period is a difficult task. Furthermore, forecasting the breakdown of orders by manufacturer and by type of aircraft for each manufacturer becomes an even more difficult task. Yet this important step must be taken before plans can be made to invest millions of dollars in the design and development of a new aircraft. Finally, manufacturers must be concerned with the proliferation of government regulations regarding the design and development of a new aircraft through the certification stage. These regulations cover everything from safety to noise and emission standards. Consequently, manufacturers work closely with government regulatory agencies, including the FAA, throughout all of the production stages.

THE FLEET-PLANNING PROCESS

From an individual airline's standpoint, the aircraft selection process is an ongoing function coordinated by a generalist group, such as corporate planning, with major help from technical, or specialist, administrations such as finance and property, marketing, line maintenance, engineering and maintenance, and flight operations. The existing fleet of an operator also is a significant factor in an operator's fleet-planning decisions. Substantial savings in terms of training, spares inventories, and operations can be achieved by operating a common fleet of aircraft.

Information Needed

Basically, corporate planning is interested in information on four different areas in the fleet-planning process: the carrier's current resources, corporate objectives, projected industry environments, and marketing strategy.

Current Resources. The carrier's **current resources** include its present fleet inventory by type of aircraft, use, and month (see Table 13-2). Also included are financial and technical data on aircraft on order. Financial data include acquisition costs (purchase or lease), start-up costs (primarily maintenance and flight training), and unit operating costs. Technical data on aircraft currently on order include payload-range figures, cruise performance information, runway requirements, noise levels, parts and service availability, and flight characteristics. Labor resources are also included under current resources. Maintenance capability in terms of type and availability of personnel to be trained on the new equipment must be considered, and lead times must be established. Similarly, flight crews must be prepared in advance of delivery dates of aircraft currently on order. In short, the corporate planning unit must completely analyze the carrier's current resources—what it has now, what it has on order—as a starting point in the aircraft selection process.

TABLE 13-2 A Carrier's Current Inventory of 737s (hypothetical data)

200X	Own Plus Leased	Scheduled Service	Charter Service	Other ^a	
January	11	11	0	0	
February	14	12	0	2	
March	16	12	0	4	
April	18	14	2	2	
May	21	14	3	4	
June	22	14	4	6	

^aOther assignment: maintenance, training, overhaul, line reserve, new aircraft in preoperational assignment.

Corporate Objectives. Top management's objectives for the company, or **corporate objectives**, include forecasted profitability (operating revenues and expenses, operating income, net earnings, earnings per common share, and return on investment), systemwide load factors, acceptable levels of cash on hand, market share on prime routes, debt/equity ratio, and general guidelines regarding new-aircraft acquisition. Other objectives include labor productivity improvement targets and cost-saving goals. Corporate objectives are broad and emphasize what is to be achieved, but not necessarily how it is to be done.

Projected Industry Environments. Projected industry environments include the outlook for the national economy, the outlook for the industry, and the carrier's performance within the industry. First and foremost, corporate planning is concerned with the national economic outlook: the gross national product, national income, personal income, disposable income, and level of consumer income in the next 1-year, 5-year, and 10-year periods. Next to be considered is the air transport industry forecast within the overall economy, including such items as revenue passengers and cargo tonnage, RPMs, ASMs, cargo tonmiles, revenue block hours, and so forth. This is followed by a forecast of the carrier's traffic statistics within the industry. In addition, the carrier makes certain assumptions regarding passenger traffic mix (business versus pleasure), cargo directionality, and price elasticity of demand in selected long- and short-haul markets.

Marketing Strategy. This is a key piece of information, requiring considerable interplay among corporate planning and other administrations, primarily marketing. Given the company's current resources and corporate objectives and the projected industry environments, how is the carrier to implement its plan, or marketing strategy? Significant items to be considered include how much service to provide between key city-pairs, how much emphasis to place on long-haul or short-haul markets or both, which weak markets to penetrate now or later or to eliminate, and in which markets to trade off profit for market share or vice versa. A critical area of consideration is fare and rate structure levels in various markets for both passenger and cargo service.

The Fleet-Planning Model

Computer models have been developed to translate this information into a fleetplanning model that is used in determining future aircraft acquisition requirements, aircraft assignment requirements, financial requirements, and operating conditions over various planning periods (2 and 3 years ahead for order versus option decisions, 4 and 5 years ahead to ensure that the purchases made in years 2 and 3 were consistent with long-term developments, and possibly 7 to 10 years ahead to ensure consistency and to gain insight into financial and facility needs in the long term). This fleetplanning model is commonly referred to as the *unconstrained operating plan*, because it ignores system constraints in order to ensure a full range of opportunities to be considered.

Computer-generated fleet-planning models provide corporate planning with the basic output—the number and type of aircraft to be acquired, the times of acquisition, and the timing of trade-in or phaseout of existing fleet. But they also allow management to assess the impact of altering the information fed in, primarily corporate objectives, industry environment, and marketing strategy.

System Constraints

The next step in the fleet-planning process is the application of **system constraints** to the model output that has been derived. Generally, system constraints become more amenable to relief as lead time increases. In other words, over a 10-year period, the normal period for a fleet-planning model, the original constraints might be eliminated. Some constraints are external to the airline, such as facility requirements at airports into which the airline flies, including runway capacity, gate capacity, terminal capacity (parking, ground access, passenger processing), and community noise. Government regulatory bodies may impose constraints on the airline's operating strategies, with consequences for the aircraft designed to implement that strategy. For example, the State Department might decide after negotiations with another country that there is enough service between selected cities in that country, despite the fact that a carrier wants to expand its service. Airplane availability can also impose an external constraint, as can environmental considerations.

There are a number of internal constraints, including such economic realities as the airline's profitability or lack thereof. Suppose the model called for the acquisition of seven wide-body jets. If the funds cannot be raised to make the purchase, the company might want to consider leasing. Other internal constraints include maintenance facility requirements, crew-training facilities, and capability of existing personnel to implement the fleet-planning model.

After the system constraints have been applied to the fleet-planning model, corporate planning is left with a **constrained operating plan**, or *optimization model*. Basically, the airline has now broken down aircraft types needed to implement its plan according to characteristics such as range (long, medium, short), passenger or cargo capacity, and direct operating costs.

Aircraft Evaluation

The aircraft evaluation process can be broken down into five areas: consideration of design characteristics, physical performance, maintenance needs, acquisition costs, and operating economics.

Design Characteristics. Design characteristics include such factors as the aircraft's dimensions, weight profile (including maximum zero-fuel weight and operator's empty weight), fuel capacity, type of power plants, systems (electrical, hydraulic, and environmental), seating configuration, containers and pallets, bulk volume, and total volume.

It is difficult to compare these various characteristics for competing aircraft, and the problem is compounded by the many options available on each aircraft. For example, Boeing's high-cruise-speed 747-300 with the upper-deck extension has many seating arrangements. In the upper deck, on the economy side, with seats at 34-inch pitch, 69 passengers can be carried. At the same pitch, so can 81, 85, or 91. At 32-inch pitch, the maximum number of economy passengers is 96. Either 42, 52, or 63 business-class passengers can be carried at 36-inch pitch. On the first-class side, 38 passengers at 40- or 42-inch pitch or 26 first-class sleepers at 62-inch pitch can be carried. Varied lower-deck-forward arrangements include 18 first-class sleepers at 62-inch pitch plus 63 business

passengers, or 41 first-class sleepers at 57-inch pitch. There also are arrangements for 40 first-class sleepers at 60-inch pitch or 36 first-class sleepers at the same pitch.

A high-density all-passenger-configuration 747-300 could carry as many as 624 people. By comparison, the 747-300 combi (combination passengers and freight) can carry 278 passengers and 12 pallets or 360 passengers and 6 pallets. A choice of engines from Pratt & Whitney, General Electric, or Rolls-Royce is available.

Physical Performance. The technical parameters normally considered under this area are referred to as the **physical performance factors**. These include such items as payload-range diagrams, takeoff and landing data, cruise and approach speeds, runway requirements, and noise performance. *Payload-range diagrams* demonstrate the relationship between payload (passengers and cargo) and the distance an aircraft can fly. For each aircraft under evaluation, there is a maximum payload that can be carried over a particular range. Beyond that point, payload must be reduced to accommodate more fuel. Also, for routes over mountains, there must be consideration given to the maximum altitude that the aircraft can fly.

Flight test results with Pratt & Whitney's JT9D-7R4G2 turbine engines show that the 747-300's long-range cruise speed is mach 0.01 faster than that of the 747-200; its mach 0.85 fuel mileage is within an average of 0.5 percent at typical cruise weights. On climbout, fuel consumption is 3 to 5 percent better than that of the 747-200. On a 5,000-nautical-mile mission, at a speed of mach 0.85, the 747-300 takes 35 minutes less trip time than a DC-10-30 flying at mach 0.82. Carrying 496 passengers, fuel burn is 10 percent less per passenger than that of the 747-200B carrying 452 passengers and flying at mach 0.84. The 747-300 has the same range as the 200B, and its holding fuel flow is 3 percent better at 20,000 feet, 2 percent better at 15,000 feet, and 5 percent better at 1,500 feet. Adding to the fuel efficiency of the 747-300 is the Boeing/ Delco 747 performance management system. Economy cruise mode, cranked into its computer, advises pilots of the minimum-cost cruise based on the airline's specified fuel and time costs. Another item basic to the 747-300 is the improved Autoland system, which is said to give better lateral performance during localizer beam capture, approach, and landing; better longitudinal performance in flare and go-around; and better Category III A success rate. (Airport weather minimums for Category I are a runway visual range [RVR] of 2,400 feet and decision height [DH] of 200 feet; for Category II, RVR of 1,200 feet and DH of 100 feet; and for Category III A, RVR of 700 feet and no DH.)

Runway requirements are another important physical performance factor in the selection of an aircraft for those airlines operating out of airports situated well above sea level or in extremely hot climates. Finally, aircraft noise requirements continue to change airline priorities with respect to equipment decisions.

Maintenance Needs. Maintenance needs include such considerations as spare parts availability, aircraft compatibility with the rest of the fleet, product support, technical record keeping, and training support in terms of visual and audio aids. Maintenance cost comparisons over the expected service life of the equipment must be studied. These expenses are influenced by a number of factors, including stage lengths flown and amounts paid for outside services.

The corporate planning department works closely with the engineering and maintenance and flight-operations administrations in evaluating the technical factors (design characteristics, physical performance, and maintenance considerations). Contacts are also made with other airlines that have ordered or are considering similar equipment. And the airline's technical personnel make extensive on-site inspections.

Having narrowed the choice of aircraft on the basis of these technical factors, the airline must consider the final two, the acquisition costs, including payment terms and financing, and the operating economics of the aircraft.

Acquisition Costs. Acquisition costs include the cost of the aircraft itself plus spare parts, ground equipment needed, maintenance and flight training required, and the cost of the money itself if the aircraft is to be financed through debt financing (borrowing from various financial intermediaries, such as insurance companies or commercial banks) or equity financing (sale of bonds or stocks). The manufacturer's warranties and prepayment schedule must be closely examined. Although the actual price of one aircraft may be less than that of another, the total cost, taking these other factors into account, may be more. For example, one manufacturer may require more money in the form of *progress payments* — payments the airline makes to the manufacturer while the aircraft is under production. Another manufacturer's total costs may involve higher start-up costs. Consequently, it is important for the corporate planning department, working with finance and property people, to examine the cumulative capital investment requirements thoroughly.

The availability of new aircraft is another important consideration. The manufacturers, not wanting to experience the same tremendous layoffs that occurred back in the early 1970s when they were geared up to turn out a considerable number of the early widebodies, have chosen to spread out their production and add names to a waiting list that might extend to three years for some aircraft.

Airlines must also consider the possibility of trade-ins and compare the potential advantage of leasing versus purchase. The option of purchasing used aircraft cannot be overlooked. Finally, consideration must be given to any tax benefits if the decision is between a new and a used aircraft.

Operating Economics. Operating economics is perhaps the most difficult area to evaluate. It includes the potential aircraft's contribution to the company's profitability. Revenue potential and direct operating costs in terms of airplane miles and seat-miles must be examined. However, these items depend on and are related to a number of other factors, including the carrier's route structure, traffic flow and composition, existing traffic volumes, potential future growth, seating density, load factors, and utilization. Caution must be exercised, because there is really no one direct operating cost per seat-mile. For a particular aircraft, operating costs will vary with range. Furthermore, although the airplane under consideration might have a low direct operating cost per seat-mile, the seats must be filled with paying passengers for the airline to experience the low cost per mile. Consequently, the wide-bodies, with their higher seating capacities, are normally scheduled on high-density routes.

Flight crew expenses and fuel costs represent a significant portion of direct operating expenses, and the new-generation aircraft (Boeing 757 and 767, A-300, A-310, A-320, and MD-80) were built with this in mind. The 757, with its 2-plus-2 concept (two pilots and two power plants), represents a 22 percent improvement in direct operating cost over the 727, which utilizes a crew of three and three engines. A fully loaded 757 is 42 percent more fuel-efficient than a fully loaded 727.

Tentative Fleet Planning and Financial Evaluation

After the aircraft evaluation, corporate planning prepares a projected earnings statement and cash flow for the expanded fleet. Then it makes recommendations for specific aircraft additions to and retirements from the fleet over a given time period, generally up to 10 years. Included with the recommendations is an order-option-plan mix. *Orders* include proposed firm orders; *options* (to purchase) permit the acquisition of relatively favorable delivery positions but provide flexibility to meet changing circumstances. Options enable the carrier to change its plans without as severe a financial penalty as might otherwise be the case in the event that the option is cancelled. *Plan* aircraft are long-range future aircraft acquisitions that permit activation of long-lead-time items, such as facility renovations, while permitting further study of shorter-lead-time elements. Also included with the recommendations are a forecast of new funds to support the fleet purchase and a preliminary appraisal of the alternative methods of financing (equity, debt, lease, mix).

Presentation and Management Approval

Progress reviews are done periodically during the fleet-planning process, which not only ensures the full input of management's views but also minimizes the amount of new material to be covered during the final presentation. Major capital commitments normally must be cleared by the board of directors. Upon approval of the plan (in adjusted form if necessary), negotiations with the manufacturers and finance community move into their final phases. The fleet plan also becomes a key source of other planning data, including personnel and facilities.

THE DECISION TO UPGRADE OR REPLACE

In late 1995, a major U.S. carrier faced the problem of how to replace its fleet of older, late-1960s and 1970s vintage twin jets with newer, more efficient, and more noise compliant 110-seat jets. A number of factors unique to that airline were influencing its fleet decision making. The aircraft in question, a fleet of DC-9-30s, were operating largely on short segments, averaging 500 miles. The nature of these routes was twofold. First, the pointto-point service portion of the route was highly competitive, even hypercompetitive. Fares were determined by intense competitive pressure, and therefore, setting fares was largely outside the control of the airline. Second, a portion of the traffic represented highly valuable feed between the origination point and major hubs, where it would interconnect with longer-haul, less competitive, and higher-profit service provided by the airline beyond the hub. Although the connecting, or feeder, traffic was viewed as having strategic importance to the airline, overall, profit margins on the routes were very thin.

The airline also had to begin replacing the DC-9-30s because they did not meet Stage III noise compliance standards. The DC-9s could be replaced with newer, noise-compliant model(s) or, alternatively, be retrofitted with hushkit devices that would bring the aircraft into compliance with the more stringent noise regulations. If the engine retrofit were performed, the airline could also, at additional investment, perform a number of heavy maintenance procedures to refurbish the aircraft and extend their useful life. Included in this work could be a major cosmetic overhaul, replacing the seats, galleys, sanitation facilities, and passenger comfort items, which would create the impression of a new aircraft

from a passenger's perspective. The total investment was estimated at about \$5 million, in addition to the airline's existing book investment of less than \$1 million. Retrofitted and refurbished, the fleet of DC-9s would be certified for more than 100,000 lifetime cycles (a cycle is one takeoff and landing). Because the fleet had, on average, an age of about 50,000 cycles and an estimated use of 2,900 cycles per year, these refurbished aircraft conceivably could operate another 8 to 12 years. The downside included higher and harder-to-forecast maintenance expenses compared with new aircraft and the adverse impact of higher fuel prices (translated into higher fuel expenses), because the older, now hushkitted aircraft would burn more fuel than a new model.

The airline narrowed its choice of replacement new aircraft to a single alternative, and then it began, with the assistance of an outside consultant, to choose between replacement or retrofit. In this analysis, the data were compared on a cost per block hour basis; because the aircraft were operated on numerous and varied routes, a route-by-route comparison was not appropriate.

The DC-9s had close to a 20 percent operating cost disadvantage (\$1,450 versus \$1,200 operating cost per block hour) compared with the new aircraft. However, the estimated capital cost per block hour favored the DC-9s (\$400 versus \$1,100 capital cost per block hour). The DC-9s also had a much lower ownership cost compared with the new aircraft, which cost four times as much. The net overall cost per block hour was nearly 20 percent lower for the old aircraft versus the new because the capital or ownership costs were less than half the new aircraft's cost on a block hour basis.

The original description of the routes on which these aircraft operate noted that the operating margins are very thin. The airline concluded that, whatever its long-term needs might prove to be (the implication being that the retrofit represented only an intermediate-term solution), the basic economics of these hypercompetitive routes would not support new aircraft with an overall block hour cost much higher than the estimated block hour costs of the refurbished DC-9s. The difference for the airline means literally flying or not flying the routes.

There are some tradeoffs and risks involved. The most important risk is the likelihood that some of the operating expense components may differ in actual experience, compared with the forecasted assumptions made in the analysis. Fuel remains a real vulnerability, although in this case the airline concluded that fuel prices would need to rise sharply and remain high over a sustained period to offset the ownership cost differential. Maintenance also remains a vulnerability; however, the airline's experience with the aircraft (in its fleet for nearly a quarter of a century) enables it to have an adequate level of confidence in the aircraft's maintenance requirements. There always remains the risk of a major price/ performance breakthrough in similar new-manufacture aircraft development. This is actually the largest risk in the analysis. However, the payback period on the retrofit is so short (about three and one-half years) that the attractiveness of refurbished aircraft is hard to resist. It is important in all of the analyses to distinguish between efficiency and the cost of necessary levels of efficiency.

Even today, many valuation methods would give little credence to this particular aircraft because they often fail to take into account the value-in-use or revenue-generating capacity of a specific type of aircraft, with specific operating economics, operating on a specific mission. It is the specificity of the fit, the definition within context, that gives rise to value. Obviously, not every aircraft and every mission shows similar results. Also, the economics of one aircraft size cannot necessarily be extrapolated to other classes of jets.

KEY TERMS

operating leaseconfinancial (capital) leasedefleet planningphcurrent resourcesmacorporate objectiveaccprojected industry environmentopsystem constraintsystem

constrained operating plan design characteristic physical performance maintenance need acquisition cost operating economics

REVIEW QUESTIONS

- 1. Discuss the importance of the fleet-planning process to both short-term and longterm management decision making in an airline. How is this process in a sense betting on the future? What effect has deregulation had on the fleet-planning process? Discuss the implications of the hub-and-spoke system and industry consolidation on fleet planning.
- 2. What are some of the advantages of fleet commonality? Why has there been a trend toward leasing? Distinguish between an operating and a financial lease. How will noise restrictions affect future aircraft purchases?
- 3. What are some of the factors an aircraft manufacturer has to take into consideration during the design and development stage of a new commercial jetliner? What is meant by "designing and developing an appropriate family of jets for the airlines"? What is Airbus Industrie? How was it able to capture a foothold in the new-generation aircraft market? Do you think it has an unfair advantage over domestic manufacturers? Why? Give some examples of government regulations that a manufacturer must take into consideration in designing and developing a new aircraft.
- 4. Describe what is included in each of the four basic inputs (informational needs) to the fleet-planning process. Marketing strategy was referred to as the "how-to" function. What does that mean? And why is this such a key piece of information?
- 5. What is meant by the *unconstrained operating plan*? What are the basic purpose of and data derived from fleet-planning models? Give several examples of external and internal system constraints. Define the *constrained operating plan*.
- 6. Give some examples of items to be considered under the following areas in the aircraft evaluation process: design characteristics, physical performance, maintenance needs, acquisition costs, and operating economics. Give some examples of difficulties encountered by airline management in comparing aircraft. What are some of the difficulties in examining a single model, such as the Boeing 747-300? The new-generation jetliners were designed with what primary consideration in mind?
- 7. What are some of the items included in corporate planning's recommendations of a fleet plan to top management? Why is top management apprised of developments as the fleet-planning process progresses?

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APPENDIX: FLEET PLANNING AT AMERICAN AIRLINES

It has been said that airline executives never know for sure whether they have bought the right airplane until they have used it for 10 or 15 years. The purchase decision, whipsawed by the same variables that rob executives of early affirmation of their judgments, is clearly the largest and one of the longest-term commitments an airline ever makes. It determines much of the operational flexibility, risk, cost structure, and related investment for the company.

The first step in the American aircraft selection process is defining the airplane's mission, including such particulars as general descriptions of size, range, and passenger/cargo loads. An additional element of this step at American, and at other airlines with two-tier crew pay scales, is deciding whether the aircraft is for expansion or for replacement of older aircraft.

If the answer is replacement, then the aircraft cannot be credited with the benefits of growth economics, since the employees necessary to fly it and support it will merely be moved from an old aircraft to a new one. A growth aircraft, on the other hand, can be staffed fully with new employees at market rates. Such agreements make it in the airline's best interests to expand, for by expanding and bringing in new employees at lower wages and zero seniority, the airline's average wage burden decreases. This, too, was the point of the 1985 United strike as management delayed what was expected to be a massive expansion until a critical two-tier wage agreement was in place.

The decision on approximate aircraft size has to take into account the big versus small issue. In boom times, carriers with large airplanes have the opportunity to make a great deal more money than carriers whose capacity is constrained with small units. The leverage in large aircraft is tremendous. On the other side of the issue, you cannot lose money operating small aircraft with high load factors. The balance is between opportunity and caution. However, since deregulation, the vast majority of new orders have been for small to medium-size aircraft.

Once the mission is defined and a decision made on whether to credit the purchase with growth economics, American examines the airframe and engine alternatives in a conventional manner using, for example, the type of information often seen on charts plotting seat-mile and aircraft-mile costs versus capacity.

The engine selection process is more influenced by engineering assessments than by financial analysis. Competition among manufacturers with engines on the same aircraft is intense and helps keep the overall price down. This competition is not surprising when one considers that over 15 to 20 years the purchaser will spend three to six times an engine's original worth on spare parts.

When the engine and airframe alternatives are understood, American factors in the revenue impact and operating costs of each alternative applied to the defined mission. The decision process, on generally secure, empirical grounds until now, definitely gets into some very speculative areas as future traffic and yields are predicted. It requires defining the overall size and competitive shape of the industry at some future date.

Once that difficult judgment is made, American applies a number of models and formulas to determine the revenue impact of a particular aircraft type operating in its route system.

First of these models is called *spill*, which calculates the increase in passengers that can be accommodated if a larger aircraft is bought to place on a densely traveled route, or,

on the other hand, how many more passengers will be "spilled" off a flight if a smaller aircraft is purchased. For example, with a 142-seat Super 80, when the load factor reaches 60 percent, some passengers, at some times of the year, on some flights, on some days are not being accommodated. Clearly, if you substitute a 124-seat 737-300, additional passengers would be lost. The value of that lost contribution must be used to offset the benefit of lower operating costs on the smaller airplane.

But a passenger bumped off one flight is not necessarily lost to the airline, so another model is used to forecast how many passengers are *recaptured* by another American flight. If, for example, a passenger is bumped off one of American's four flights between Cities A and B, he or she has a choice of the other three American flights or, let's say, eight offered by competing airlines. The chances of holding the passenger might be expressed simply as 3 out of 11, or 27 percent. High load factors on the other flights would decrease the chance of recapture, but the brand loyalty created by a frequent-flier program would increase the capture rate.

Examination of revenue impact does not end with spill and recapture. The industry concentration on hub-and-spoke systems gives added importance to up-line and down-line factors affecting route traffic. There is a high probability that a person gained or lost has come up-line from, or will go down-line to, another American Airlines flight. Thus, a revenue impact analysis must include an examination of the contribution of the capacity of an aircraft on a hub-bound route to other routes onward from the hub (up-line) and, conversely, the contribution of the other routes feeding the route through the hub (down-line). If American loses a passenger on the first segment because the aircraft is too small, there is a high probability they will lose that passenger on the connecting segment even if the aircraft on that up-line or down-line segment has seats available.

The final route revenue impact factor to be examined is *pushdown*. When a new aircraft enters the fleet, it is assigned to high-pressure routes flown by smaller aircraft or low-pressure routes flown by bigger aircraft, in both cases increasing the efficiency of the operation. For example, American's new Boeing 767s were used on dense 727-200 routes where load factors were close to 88 percent. This load factor on the 144-seat 727 translated into a 62 percent load factor in the 204-seat 767. However, use of the larger aircraft decreases the spill from the highly loaded 727s, pushing the actual load factor on the 767s closer to 75 percent.

All the fleets below the 767 in size are pushed down progressively onto lower and lower demand routings, with the smallest and/or oldest aircraft in the fleet—the 727-100 in American's case—pushed onto the marginal routes or onto the block for sale. Meanwhile, as more and more 767s arrive, there are fewer high-pressure 727 routes to take over, so the overall 767 fleet load factor drops. Looked at another way, the revenue value of the first five 767s is greater than the revenue value of the last five. This forces American to come to grips with the issue of optimal fleet size—too many units may force deployment on routes where the incremental seats have little, if any, value.

The fleet size issue is a question of balance. In order to closely match airplanes to the markets to be served, a number of different types of airplanes are needed. Of course, each new type purchased brings along with it certain support, equipment, and training costs. While the costs of having to maintain a support infrastructure for a few airplanes may be seen by some to be too high a price to pay, others note the benefits of closely keying aircraft capabilities to the market, regardless of the fleet size.

The challenge is to find the right balance between fleet complexity and market fit. American has generally concluded that unless it can see a clear need for 15 to 20 units, the costs of fleet proliferation far outweigh the benefits of better market sizing.

Forecasts must be made about the operating environment of the future, and no matter how sophisticated, a forecast is still a forecast. To lessen the risk of making fleet decisions today based on forecasts about the future, American compares aircraft under a variety of future scenarios using a matrix approach and calculating the point at which the decision would change. For example, at what fuel price would American prefer a higher-priced new-technology airplane? This allows the decision makers to assess the degree of risk associated with each alternative.

Intangibles are those factors in the purchase decision process covering such items as the perception that passengers prefer wide-bodies, new airplanes, and no crowds. Also, some aircraft are more adaptable than others. But some of these intangibles have lost their pull in the deregulated environment, where the herd instinct is sharply diminished and an airline does not buy an aircraft just because a competitor bought it.

Once all the preceding questions have been answered, the candidate airplanes are compared in terms of a *defined service life*. It is a relatively simple matter to calculate the net present value of the future cash flows associated with each airplane under consideration, and this permits American to rank the various alternatives and establish an acceptable allin price for each airplane. With an acceptable price established, manufacturer negotiations begin.

This appendix was adapted from a speech given by Robert E. Martens, American Airlines Vice-President of Financial Planning and Analysis, in New York in May 1985, at a Lloyd's of London conference.