AVIATION MAINTENANCE PARAMETERS

Aviation maintenance operates as an indispensable element in support of the larger U.S. aviation industry. A review of human factors issues affecting the quality and efficiency of aviation maintenance personnel should be conducted with an understanding of industry parameters. An overview of the industry will illustrate the scope and diversity of maintenance requirements faced by the industry.

The mix of aircraft in the air carrier and general aviation fleets is shown in Table 1. The data for air carriers in Table 1 include scheduled, supplemental, commuter, air taxi, and air cargo carriers. These data illustrate who primary attention is being given to air carrier operations today. The carrier fleet constitutes almost exactly two percent of the entire number of aircraft operating within the United States. However, this fleet carries four times the passenger load of other classes of aircraft. In terms of safety of the general public, air carrier operations warrant the first look. However, no one should be insensitive to the fact that over 100 million passengers also are carried annually in general aviation operations.

TABLE 1
U.S. AIRCRAFT FLEET
(1986)

Aircraft	Air Carrier	General Aviation
Turbine	4,063	10,500
Piston	364	195,700
Rotorcraft	4	6,900
Passengers Carried	419 million	119 million

Air Transport Association (ATA)

Table 2 shows the projected growth of the U.S. aircraft fleet over the next ten years. This shows that growth as foreseen will take place in air carrier operations and in commuter airlines. No growth is projected for general aviation over this ten year period. New general aviation aircraft will enter the fleet but certainly not at the rate seen in 1978, the peak production year. Other aircraft will retire during this period, and as a result there will be no growth for general aviation.

TABLE 2
PROJECTED GROWTH OF
U.S. AIRCRAFT FLEET
(1987 - 1999)

Fleet	Forecast Annual Growth
Air Carrier	2.6%
Commuter	2.9
General Aviation	0.0
Domestic Passenger Load	4.6

Note: In past two years, 759 large jet aircraft were delivered.
Very few older aircraft were retired.

Federal Aviation Administration (FAA) (1988)

Table 2 also shows that during the past two years, 759 large jet aircraft have been delivered to the airlines. Over that same time period, very few older aircraft - the DC-9s and early 727s - have been retired. This illustrates the changing dynamics in fleet characteristics.

An important characteristic of both the air carrier fleet and the general aviation fleet is that each is growing older. Table 3 shows the average age for a group of selected aircraft currently in use in the U.S. air carrier fleet. While these aircraft obviously were selected to demonstrate the aging characteristic, nonetheless they are representative of aircraft used in current operations. Note that four of these aircraft have an average age in excess of 20 years. Also, considering that these data are current as of the end of 1987, the average age of the aircraft shown is now somewhat greater that indicated.

TABLE 3
AGE OF SELECTED AIRCRAFT
IN U.S. AIR CARRIER FLEET

Aircraft	Number	Average Age
DC-8-50	16	23.1
727-100	344	21.7
BAC-1-11	38	21.6
DC-9-10	91	21.0
707	35	19.8
737-100	20	19.2
DC-8-70	85	19.2
747	167	13.9

Average age of all aircraft in U.S. air carrier fleet = 12.1 years. Data as of year-end 1987.

ATA(1988)

The age of the U.S. general aviation fleet is depicted in Figure 1. It is obvious that general aviation has the same problem with aging aircraft as the air carriers. Considering that these data now are probably two-years old and thus are shifted to the right slightly, the average age for the entire general aviation fleet is in the order of 20 years, with some aircraft more than 35 years old. It is also interesting to note that every year the data in Figure 1. are being pushed to the right slightly because of the fact that aircraft are not being retired from the general aviation fleet as had been initially anticipated and very few new aircraft are being introduced.

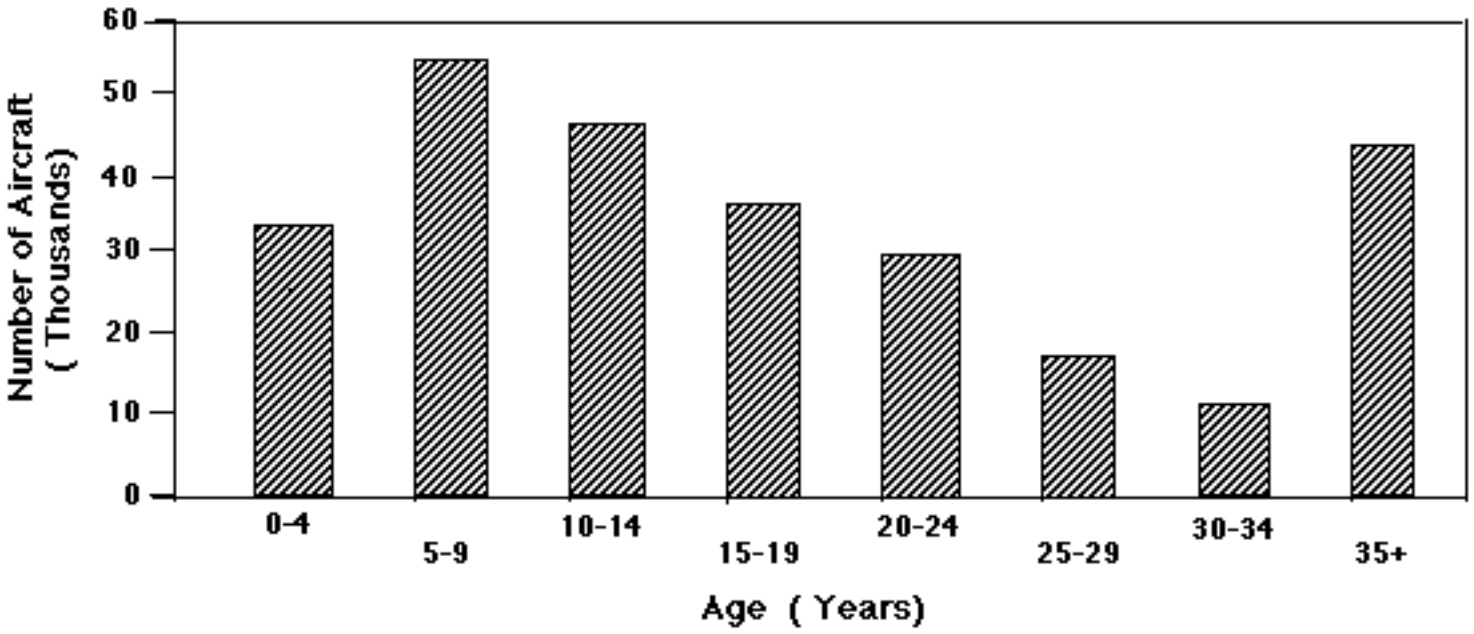

Figure 1 Age of U.S general aviation aircraft. (FAA, 1987)

While the age of an airplane is important, maintenance requirements for air carrier aircraft are determined more directly by the number of landing cycles and pressurization cycle. Table 4 shows the "economic design life objective" established by Boeing for four of it's widely used commercial aircraft. Note that for each airplane a twenty-year service-use objective is set. Objectives for landing cycles vary, however, depending on anticipated use patterns (short flights- many landing vs. long flights-few landings).

TABLE 4
ECONOMIC DESIGN LIFE OBJECTIVES
FOR FOUR AIRCRAFT

Aircraft	Landing Cycles	Hours	Years
707	20,000	60,000	20
727	60,000	50,000	20
737	75,000	51,000	20
747	20,000	60,000	20

Boeing Commercial Airplanes, 1989.

Figure 2 shows for nine aircraft types the number of landing cycles made by the high-time airplane compared with the economic design life objective for that aircraft type. In many instances, the landing cycle for the high-time airplane exceeds by a considerable amount the cycles established initially as an objective. This does not mean, of course, that these aircraft are in danger of falling apart at any moment. Each of these aircraft has been periodically inspected and maintained, with worn parts and systems replaced, as these landing cycles were accumulated. "Economic life objective" is simply a concept established during the design of the airplane. The objective is not set as a limitation on the airplane.

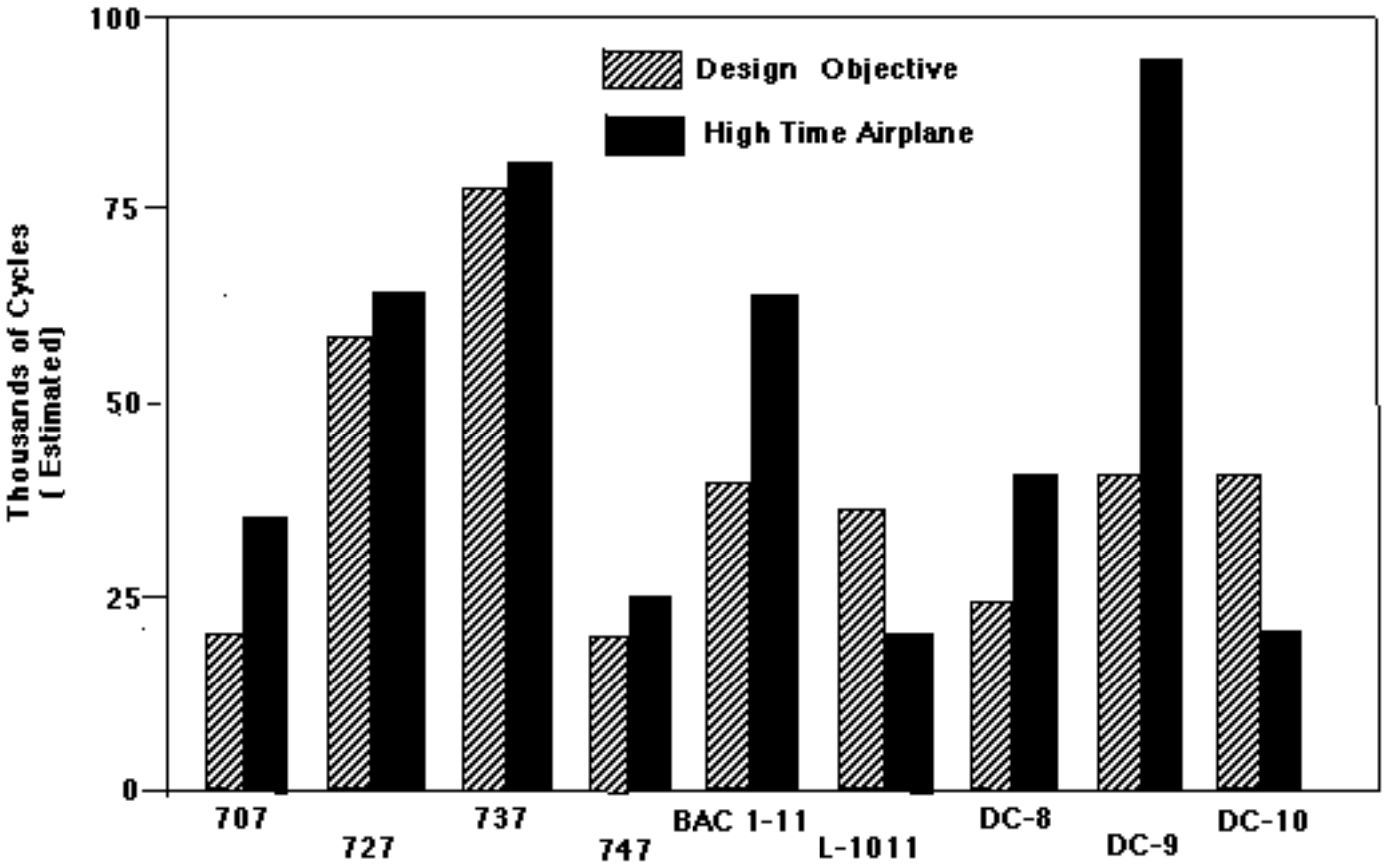

Figure 2 Landing cycles for selected active air carrier aircraft.

As the commercial aircraft fleet in the United States ages, and as landing cycles increase, the burden on maintenance grows. The maintenance industry today is large and continues to grow in parallel with the expansion of airline operations. Table 5 shows that over 50,000 mechanics are employed today, with a total cost for maintenance operations which exceeds $6 billion per year. At the present time, about eleven percent (11%) of maintenance activities are contracted, with the major part of maintenance being accomplished by the airlines themselves. The $6 billion cost for maintenance shown in Table 5 represents an outlay of some eleven percent (11%) of airlines operating revenues. Maintenance is expensive.

TABLE 5
MAINTENANCE PARAMETERS
FOR U.S. SCHEDULED AIRLINES

Mechanics employed	=	51,233
Maintenance expenses	=	Over six billion dollars
Major carriers contract 11% of maintenance work		

ATA (1988); Office of Technology Assessment(OTA) (1988)

Maintenance costs as a percentage of total operating costs is important but it may not be the best indicator of maintenance expense. The percentage will be influenced by the contribution to operating costs made by fuel costs and non-maintenance labor, both of which are known to have wide fluctuations. Therefore, maintenance expense trends for specific aircraft are considered more meaningful. Figure 3 shows the average flight equipment maintenance expense for the B727-200 fleet. This shows that for each revenue aircraft departure since 1982, there has been an almost steady increase in maintenance expense.

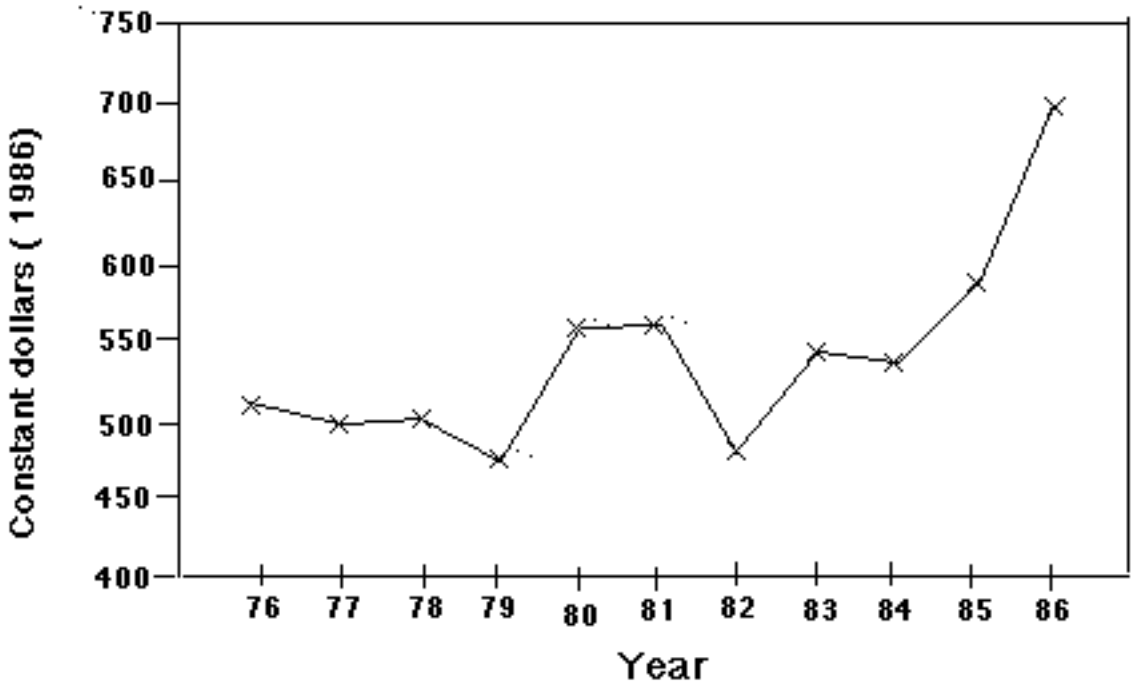

Figure 3 Average flight equipment maintenance expense for B727-200 fleet.

In summary, data describing the U.S. aviation industry and its supporting maintenance base show an expanding industry in which the average age of aircraft used both by commercial airlines and by general aviation increases each year. There is a corresponding increase in maintenance costs. Both of these trends point to a need to ensure that aircraft maintenance, and the use of maintenance personnel, is conducted as efficiently as possible. The safety of the public and the economies of air transportation support programs to optimize maintenance operations.

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