Table 3. Average fuel expenses and total operating expenses per available tonne-kilometre for world's scheduled airlines. (Figures expressed in U.S. cents.)

Year	Fuel and Oil Expenses	Total Operating Expenses	Fuel and Oil as Percent of Total
1961	2.8	21.4	13.1
1962	2.6	20.2	12.9
1963	2.5	19.3	13.0
1964	2.28	18.3	12.5
1965	2.12	17.5	12.1
1966	2.06	17.1	12.0
1967	1.99	16.2	12.3
1968	1.88	15.6	12.1
1969	1.88	15.4	12.2
1970	1.82	16.2	11.2
1971	1.83	16.5	11.1
1972	1.94	17.6	11.0
1973	2.25	18.9	11.9
1974	4.34	22.7	19.1
1975	4.83	24.9	19.4
1976	4.85	25.2	19.2
1977	5.28	27.5	19.2

Source: Airline financial data reported to ICAO

Note: Tables selected from an ICAO publication, Aviation Fuel: Prospects to the Year 2000, cited in the ICAO Bulletin, December 1979.

SELECTED CHARTS ON ENERGY AND JET FUEL AVAILABILITY AND PRICE

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Introduction

Kerosene jet fuel availability and price are two major problem areas of concern to air carriers through the 1980s. Availability and price are functions of many variables: world oil supply and consumption, conservation and efficiencies in all consuming sectors, substitution of other forms of energy for petroleum, technical efficiency of aircraft, introduction of new equipment during the 1980s, traffic trends, and utilization of equipment. (Figures 1 and 2)

These factors are integrated here to obtain estimates of kerosene jet fuel consumption and price during the 1980s for air carriers in the intra-North America and overseas-to and from-North America markets. (North America, as used here, includes Canada and the United States.) (Figure 3)

Allocation priorities were not considered as a factor in this discussion.

Aircraft Turbine Efficiency

Turbine efficiencies returned to the range of the compound piston engine and turboprop with the introduction of the turbofan engine. Potential engine efficiency gains are possible if higher pressure ratios can be attained. The major engine manufacturers are initiating programs to improve component efficiencies by 15 to 20 percent compared with current engines. (Figure 4)

Potential Technology Improvements in Air Transportation Fuel Efficiency

The U.S. commercial air transportation system is a complex blend of ground and air systems. The technology areas showing promise for improving the fuel efficiency of the system are shown in Figure 5. The airplane itself will benefit from advanced aerodynamic and structural technology; the propulsion system from new and advanced engines. Flight operations will benefit through improved air traffic control, four-dimensional navigation systems, and automatic flight management of the airplane and engines.

These technology applications will take many years to develop and to emplace in the air transportation system. These gains may not all be additive, and a realistic appraisal indicates a potential fleet fuel saving (less than a single new aircraft saving) of 15 percent due to technical advances will be incorporated in the system by 1990, as compared to a 1979 baseline. Further technical improvements are likely to be introduced around year 2000. Airline equipment currently has a useful life of about 20 years, and new technology therefore requires many years for full utilization in the system.

Airline Fleet Mix

Standard-body aircraft make up about 80 percent of the domestic trunk airline fleet today. (Since trunk airline fuel consumption is about 87 percent of total domestic airline fuel consumption, the trunk fleet conposition is representative of the domestic fleet.) The standard body share will drop to about 47 percent by 1985 and 25 percent by 1990. The new airline programs will comprise 24 percent of the fleet by 1985 and about 50 percent by 1990. (Figure 6)

The fleet mix serving the overseas-to-North America market is now heavily weighted with wide body and more fuel-efficient aircraft. Also, since the route segments are longer on overseas routes compared to domestic routes, international operators can attain greater fuel efficiencies with the existing standard body and wide body equipment. Aircraft developed in the new airplane programs will replace standard body aircraft used in shorter overseas routes.

Revenue Passenger-Mile Estimate

Revenue passenger-miles (RPMs) are projected for the domestic North American service and the overseas-to-North America market. The potential and conservative estimates on a world-wide and U.S. carriers-only basis are also shown for comparison. (Figure 7)

Load Factor Estimate

Load factors in the intra-North America area will probably rise to about .64 by 1990. Time-of-day, day-of-week, and seasonality effects will prevent attaining load factors much above this. (Figure 8)

Load factors in the overseas-to-North America market will probably rise to about .65 by 1990 as operators attempt to offset higher fuel costs.

Available Seat Miles and Type of Aircraft

As the new and larger aircraft are introduced into the fleet, and older aircraft retired, the proportion of available seat-miles provided by the more efficient aircraft will increase significantly in the next ten years.

As shown in Figure 9, seat-miles provided by standard-body aircraft are already a small proportion of total overseas-North America traffic. New aircraft will replace these and the major portion of growth provided by current wide body types.

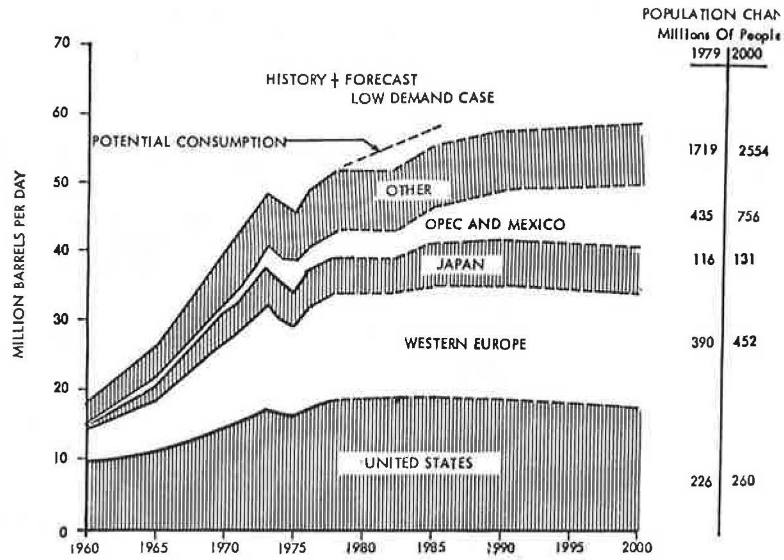
New program aircraft will probably carry about half of the available seat-miles by 1990 in the intra-North American market.

Fleet Fuel Efficiency Estimate

Fuel efficiency will improve as the fleet composition changes from the present standard and wide body mix to a mix including new technology aircraft and fewer standard-body aircraft. (Figure 10)

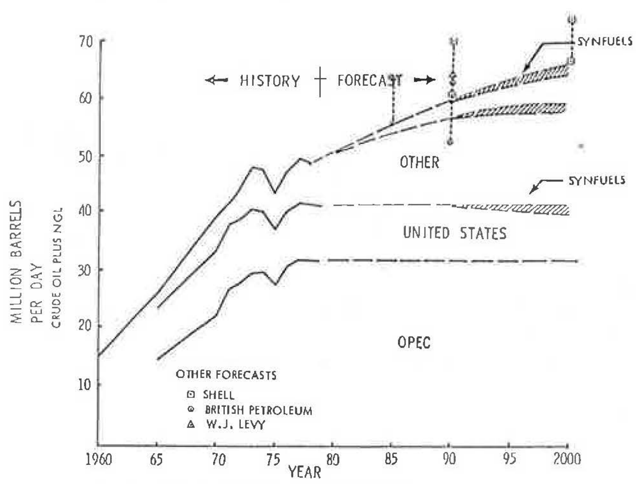
Fuel efficiency improvement will be greater in the domestic market than in the overseas-to-North America market. Over 80 percent of air seat-miles in the overseas-to-North America market are already provided by fuel efficient wide-body aircraft, compared to only about 34 percent of air seat-miles in the intra-North America market. (Figures 11-13)

Figure 1. World oil consumption (excluding USSR, Eastern Europe, and the Peoples Republic of China).



SOURCE: API Statistics

Figure 2. Potential world oil production (excluding USSR, Eastern Europe, and the Peoples Republic of China).



Source: British Petroleum Statistical Annual Review of the World Oil Industry

Figure 3. U.S. consumption of petroleum products: history and forecast.

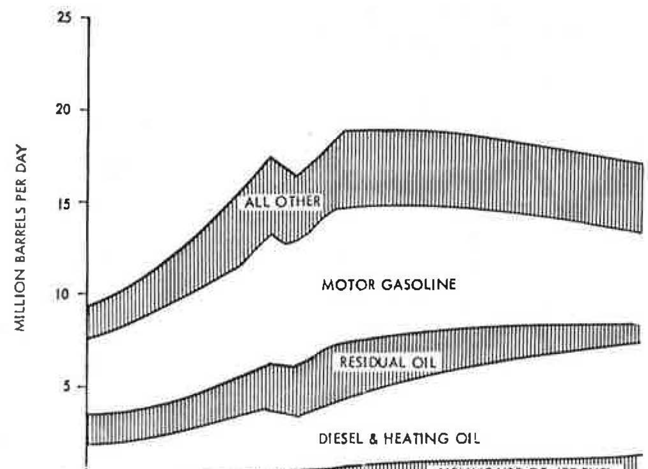
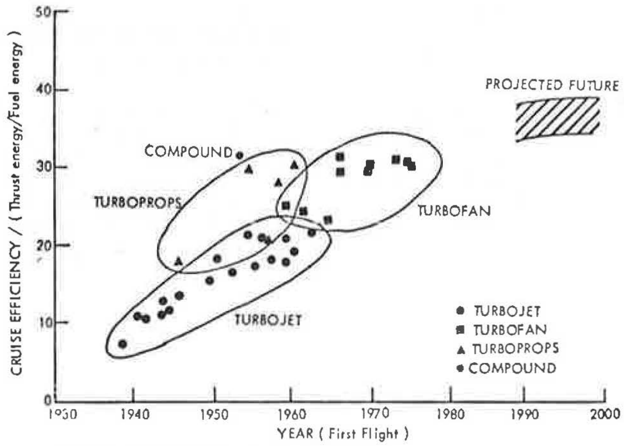


Figure 4. Aircraft turbine efficiency.



SOURCE: WILLIAM SENS, PRATT & WHITNEY

Figure 5. Technology improvement (new program efficiency).

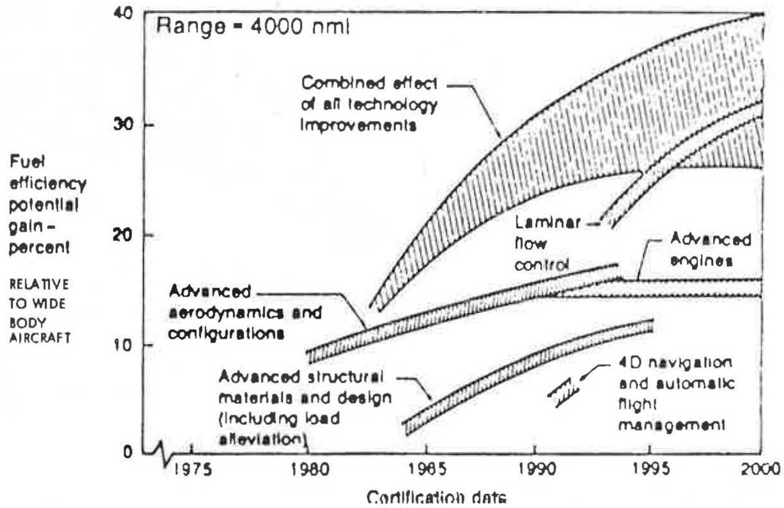


Figure 6. U.S. trunk airline fleet mix.

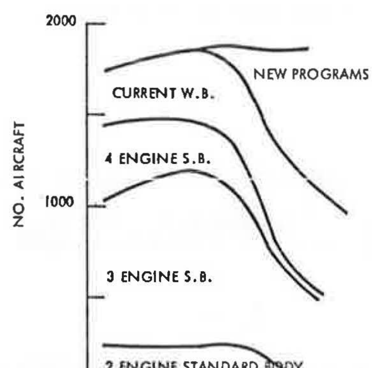
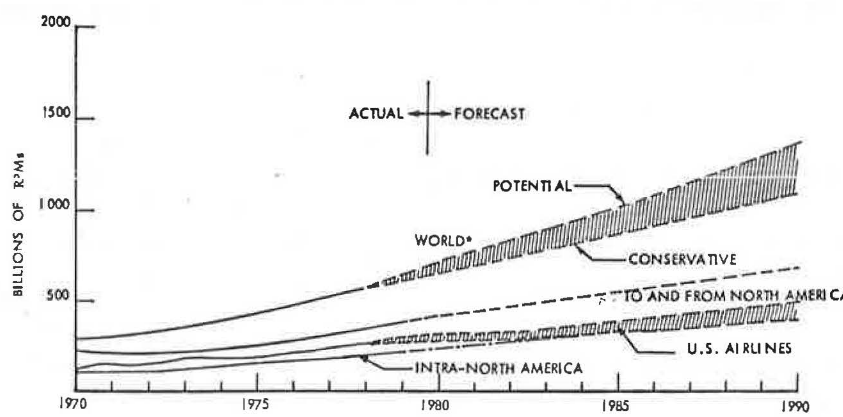


Figure 7. Revenue passenger-miles.



*EXCLUDING USSR & PRC

SOURCE: BOEING DIMENSIONS OF AIRLINE GROWTH, FEB. 1979, AND MARKET RESEARCH GROUP

Figure 8. Load factor estimates.

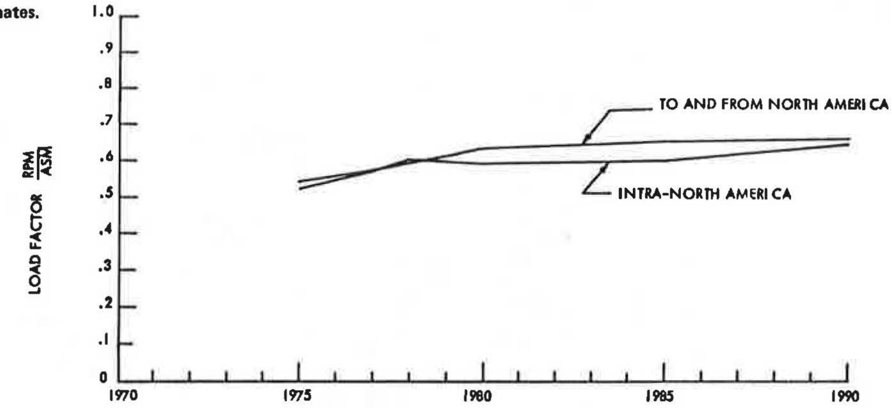


Figure 9. ASMs and type of aircraft.

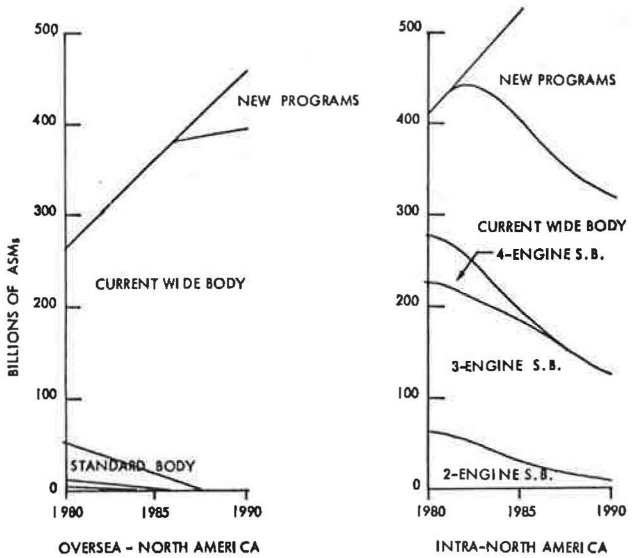
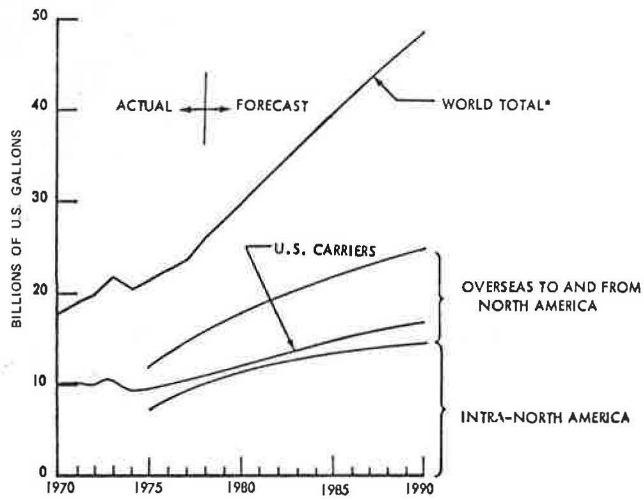


Figure 11. Kerosene jet fuel consumption estimate.



*EXCLUDING USSR AND PRC

Figure 10. Fleet fuel efficiency estimate.

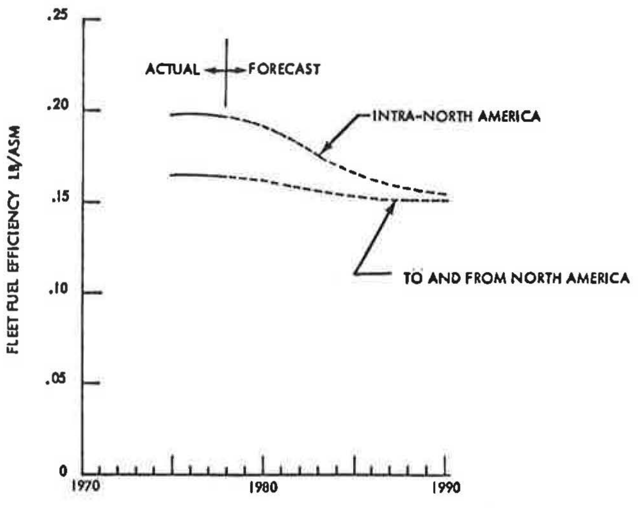


Figure 12. Alternative fuel cost (1979 dollars).

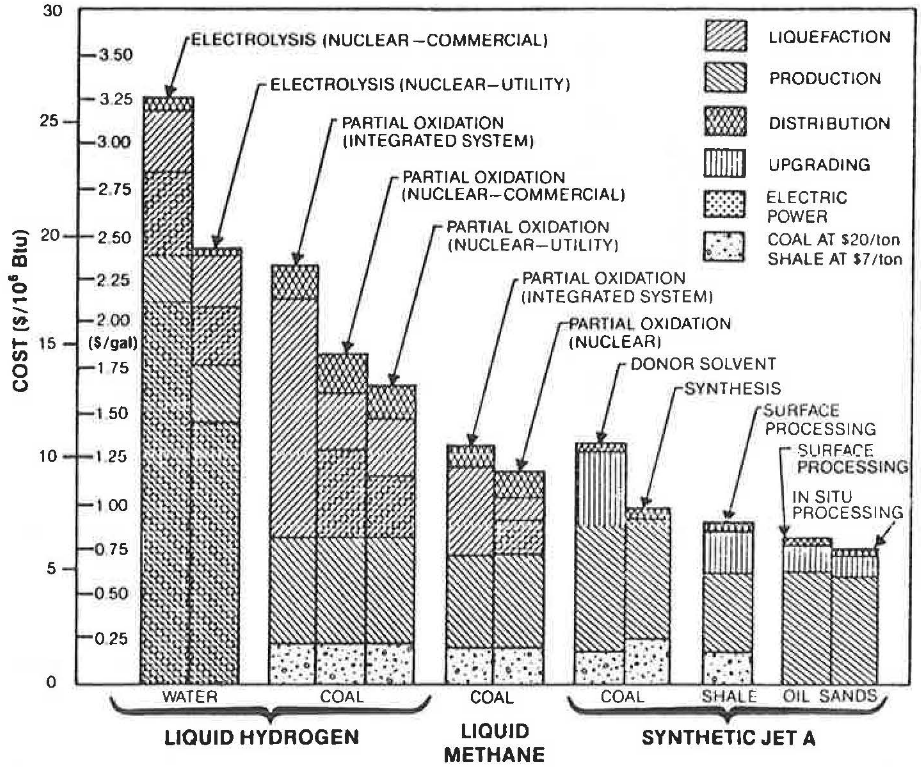


Figure 13. World kerosene jet fuel price estimate.