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## FORCES INFLUENCING INTERNATIONAL AIR TRAVEL TO AND FROM NORTH AMERICA

*A Summary by David E. Raphael, SRI International, of a Workshop held at the Fifty-Ninth TRB Annual Meeting, January 14-15, 1980, Washington, D.C., David E. Raphael, presiding.*

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### SUMMARY

The Aviation Demand Forecasting Committee of the Transportation Research Board, National Research Council, presented a two-day workshop on 14-15 January 1980 in Washington, D.C. on the forces influencing air travel to and from North America during the 1980s. This subject was chosen due to the accelerating growth of travel and the significant changes in travel patterns, air fares, regulatory procedures, jet fuel prices, airport congestion, new markets and gateways that have emerged during the past two years, and the considerable uncertainty about these trends for the 1980s.

A plenary session the second day summarized the results of the five individual sessions held on the first day: implications of energy and jet fuel, regulatory and market policies, international airports, and the implications of changing patterns of travel in two major air travel regions -- a perspective from New York, and one from Canada. Participants from leading air travel organizations, airframe manufacturers, airlines, oil companies, consultants, government officials, airports, and universities, were invited to make presentations at the individual sessions. The moderator of each session presented his group's findings at the plenary session, which was moderated by workshop chairman, David E. Raphael. Moderators of the individual sessions were:

Roderick Heitmeyer, International Civil  
Aviation Organization (ICAO), Montreal  
George Sarames, Lockheed California Company  
Adib Kanafani, University of California  
George Howard, Port Authority of New York  
and New Jersey  
William Tucker, Air Transport Canada

### Major Findings

Considerable uncertainty prevails about future levels of jet fuel and jet fuel prices. Workshop participants in the energy and jet fuel session believed

that shortages of jet fuel during the 1980s could be disruptive to air travel in terms of reduced airline schedules and number of flights as well as possible sharp increases in jet fuel prices that would continue to push air fares to higher levels. Presently, most commercial airlines use kerosene, which represents about 85 percent of total jet fuel production, and wide cut fuels (JP-4). There are two possible alternative solutions to fuel shortages. More kerosene could be produced at the expense of other products; present kerosene refinery production is averaging about 6 percent, but refinery capacity in the North American region could be raised to the 10 percent to 14 percent range. In addition, specifications for kerosene could be broadened slightly permitting a larger portion of the middle barrel distillates to be used in jet engines. Secondly, greater utilization of wide cut fuels can be made in jet engines where appropriate. Moreover, kerosene and JP-4 can be burned at the same time during flight.

An important finding by the workshop participants is that further fuel efficiencies will permit major savings in jet fuel during this decade. Even though air traffic growth (in terms of revenue passenger miles) may expand at an average 6 percent to 7 percent rate through the 1980s, U.S. jet fuel consumption will probably grow at a 2.8 percent annual rate while global jet fuel requirements will expand at a 5.2 percent pace. Estimates of between 15 percent to 20 percent less fuel consumption worldwide, compared to historical trends, is possible due to technological improvement in engine component efficiencies, advanced aerodynamics, laminar flow, and advanced materials. Moreover, important fuel savings can be realized through additional economic, operational and administrative factors (more efficient ground transportation systems, greater use of direct flights, and greater attention to fuel savings through operational measures as jet fuel prices rise through the decade).

Most participants felt that jet fuel prices, worldwide, could rise at an annual rate of 3 percent faster than the overall inflation rate, but that a

deterioration in world oil markets and economic conditions might produce higher rates of fuel price increases. By 1990, U.S. jet fuel consumption will probably reach 14 billion gallons/year while global jet fuel consumption will rise to 48 billion gallons/year, in the base case scenario.

A finding by the session on aviation policy was that U.S. international aviation policy -- as a follow-on from U.S. domestic deregulation -- has moved away from protectionism toward a less restrictive and competitive environment. Under this policy, the U.S. government has been willing to trade traffic rights (new routes/gateways to foreign carriers) in exchange for a more competitive posture and lower fares. However, this new liberal international regulatory environment appears to have had little impact on total demand for international travel. Changes in the regulatory environment have been offset by numerous other factors: the devaluation of the dollar, the availability and price of fuel, inflation, and differing rates of economic growth in different countries. During the 1980s, international travel will continue to be affected by these economic and fuel factors -- probably more so than changes in regulations, particularly if there is a swing back to a "balance of benefits" approach rather than the liberal approach in providing new rights to foreign carriers.

Workshop participants concluded, however, that there have been structural changes in the market, which have affected routes, traffic flows, frequency of service, and aircraft size. For example, there have been seven important bilateral agreements (in the Netherlands, Israel, Germany, Belgium, Jamaica, Korea, and Singapore) during 1978 and 1979, all of which have added new U.S. gateways, liberalized charter activities, and provided unlimited designation of airlines. In addition, there have been greater market fragmentation (for example, there has been a doubling of U.S. and Canadian gateway cities) and increased fare diversity in the past few years. A number of new carriers have acquired routes (such as from the United States to Amsterdam, Brussels, and Frankfurt); this has added new services and lower fares. (In 1978, there was one flight from Miami to Amsterdam, and in 1979, there were seven; there were seven flights from San Francisco to Frankfurt in 1978, one year later there were thirteen.) These and other factors contributed to the relatively stronger U.S.-European growth by U.S. carriers, compared to foreign carriers.

Participants in the workshop session on international airports concluded that federal inspection services (F.I.S.) provided at ports of entry may be an important constraint on the future growth of international travel facilities. The growing percentage of non-U.S. travelers, each requiring a longer service time than U.S. passengers in moving through customs, passport control, and package search, means that methods of streamlining F.I.S. will have to be provided. One solution may be to use pre-clearance procedures while passengers are in departure status to help speed up arrival processing times.

Expanding international traffic also places heavy loads on airport access and landside facilities that could raise potential barriers in the decade ahead. New facilities will have to be provided, particularly for groups traveling by large aircraft or by charter travel which usually results in increased congestion due to limited arrival and departure facilities, and added baggage. Longer lines and larger accumulation of passengers are expected to be visible as more travelers arrive (travelers who are transferring through U.S. ports

to other destinations, in contrast with the past when most passengers made the United States a point of entry).

There will also be a growing demand for streamlining passenger services at U.S. airports such as the greater use of non-U.S. languages, standardization of pictograms (illustrations that provide the message without relying on language, such as a picture of baggage to denote baggage storage areas), currency exchange services, and transport (air and surface) information systems. U.S. airports -- and cities frequently visited by foreign passengers -- will take on a much more international aspect as larger numbers of offshore passengers visit the United States.

In the session that viewed international travel from a Canadian perspective, participants concluded that the long-term outlook for Canadian liquid petroleum supply is favorable and aviation supplies should be adequate. Presently, jet fuel is a small portion of total fuel consumption, and no major problems are foreseen in providing sufficient fuel to cover airline needs, but a supply shortfall could develop if governments place too low a priority on aviation fuel in the decade ahead. Moreover, jet fuel prices are expected to rise faster than inflation for the rest of the 1980s.

While many parallels between United States and Canadian international travel continue to persist, one important difference in the past two years has been that Canada did not share in the travel boom to and from the United Kingdom. One reason is that there were fewer low fares offered between the United Kingdom and Canada during this period. However, both Canada and the United States continue to be a "good buy" for Europeans, and continued growth is expected as European residents travel to North America.

A number of new factors are becoming important in determining future travel expansion. At least three cost components influence the air passenger: the total cost of the trip (including land costs, accommodations, meals, and so forth), the changing sensitivity of travelers to air fares, and exchange rate differences. One example is that many Canadians are no longer traveling to Europe for summer vacations, but rather are choosing trips to North American "sunspots" such as the Caribbean or Florida in the winter. Seasonality, low fares, and relative differences in exchange rates contribute to shifts from summer to winter travel and from Europe to intra-North American travel.

In the workshop session on the New York perspective, attendees heard some of the preliminary findings about the recent Port Authority of New York and New Jersey's survey of international travel. New York's share of the transatlantic market declined from 75 percent in the mid-1960s to 60 percent in 1972. Since 1972, this percentage has been roughly the same despite the opening up of new gateways in other cities and the declining share of New York's gross national product relative to other cities. Participants in the workshop expressed the view that the recent stability of market share may be attributed to the introduction of wide-bodied jets and the economies of scale that kept air fares from rising as rapidly as in other markets.

In 1978 and 1979, New York realized rapid growth in the number of European visitors to the United States. In fact, there was a 50 percent increase in the last two years, compared to a very small increase in U.S. travel to Europe. In the transatlantic market, foreign travel to the United States is now about equal to the travel by

U.S. citizens overseas. A travel cost index for travel in Europe was constructed, and the index shows that the cost of traveling in Europe has virtually tripled since 1970. Conversely, travel by Europeans to the United States represents a solid bargain in terms of the air travel and total trip cost. In the future, the increasing cost of American travel to Europe will probably result in an emphasis on strategies that focus on lower cost accommodations, trips of shorter length, and fewer destinations on the same trip.

SUMMARY OF WORKSHOP SESSION 1:  
Energy and Jet Fuel Implications

Roderick Heitmeyer, International Civil Aviation Organization, Moderator

I appreciate this opportunity to speak to you today about energy and fuel availability as a factor influencing the demand for air travel to and from North America. What I have to say is based upon the very useful workshop meeting we held on this subject yesterday. We also took advantage of the recent ICAO study on the future availability of aviation fuel. Energy and jet fuel availability is a complex subject with many interrelated aspects. It is a rapidly changing one and unfortunately does not lack a certain measure of uncertainty.

The obvious way in which this factor can negatively affect air travel is if there is insufficient jet fuel to operate the quantity of air services required to satisfy demand and/or if the price of jet fuel is such as to require air fares to be increased in real terms beyond "acceptable" levels.

Another consideration is the effect that future developments in the energy field -- in terms of availability and rising cost -- may be expected to have on rates of economic development and inflation, and in this way also influence the demand for air travel. For example, SRI estimates for the United States that every 10 percent increase in crude oil prices will lead to a .2 percent decline in gross national product and .4 percent increase in the consumer price index.

Demand for Energy

Oil presently provides about 50 percent of energy needs and is the most important single source of world energy. The transport sector accounts for about 40 percent of oil consumption in market economies. Aviation fuel accounts for about 4.5 percent and civil aviation alone for less than 4 percent.

The consumption of oil has tended to increase at a faster rate than the consumption of energy as a whole. However, after the escalation of oil prices in 1973 there was an interruption in this pattern in the market economies, both in the growth of energy and particularly in oil consumption.

As to the future, unconstrained projections of future oil demand anticipate lower growth rates than experienced in the past in both total energy and oil consumption. They also anticipate that oil will account for a declining share of total energy consumption. This is expected to be the result of continued high oil prices and related conservation efforts.

The substitution of other fuels for oil will also become increasingly important. Economic activities vary in their ability to use substitute fuels. The use of oil in the industrial, household and commercial sectors is expected to decline.

This should relieve some of the pressure of demand on oil. However, in the transport sector, including aviation in particular, oil is expected to continue to satisfy nearly all energy needs over the next 20 years.

Supply - Oil and Alternative Energy Sources

1) Oil

Since oil based jet fuels will have to supply air transport's fuel needs for many years to come the total oil supply picture is highly relevant.

The potential availability of oil to meet future demand will be determined by the level of proven reserves, additions to reserves, consumption rates and production and distribution capacity.

However, actual availability (production rates and exports) will depend largely on the policies of the producing countries.

Estimates of ultimately recoverable world crude oil reserves range from 1600 to 3000 billion barrels (most center on 2000 b. bbls).

This compares with a total of about 640 billion barrels of recoverable proven crude oil reserves and a present (1978) world consumption rate of 22 billion barrels.

Compared with the total amount of crude oil expected to become available in terms of ultimately recoverable reserves, this corresponds to 70 to 135 years of consumption at the 1978 level, or about 35 - 55 years if consumption were to increase by 3 percent per year.

In other words we are talking about a finite resource. It must be expected that long before total depletion, limitations on the rate of output, high oil prices, and the development and use of alternative energy sources will cause crude oil consumption to level off and then decline.

The timing of this transitional process will largely depend on:

- a) The policies of the oil importing countries concerning fuel conservation and the development of new energy sources;
- b) The policies of the oil exporting countries concerning output and pricing.

Annual production rates in the OPEC states as a whole have tended to level off during the past few years and some of these states have recently indicated planned reductions in their levels of production. Temporary shortages of oil and aviation fuel are therefore entirely possible.

Our oil industry participant stressed that a lot will depend -- in the very short term at least -- on Saudi Arabia's level of production in particular, as to whether there can or cannot be growth in oil use by aviation this year.

Allocations of scarce supplies of aviation fuel may again be necessary in the short term.

2) Alternative Energy Resources

A great deal of attention is now being focused on the development and use of alternative energy sources. The world's resources of fossil fuels are extensive and additional reserves of other energy sources (particularly radioactive and geothermal) are available. The longer term prospects are therefore encouraging.

There are also encouraging longer term prospects for the production of significant volumes of synthetic fuels (including aviation fuels) from coal, heavy oil, shale, and tar sands. The attractiveness of such projects increases with the rising price of crude oil and much of the basic

technology already exists. However, it will take some time before synthetic fuels can make a major contribution to world energy needs. The investments involved are large; there are environmental considerations; and there are long time lags before commercial production can commence. Rapid expansion of the production of synthetic crude oil and fuels is therefore not considered likely until the 1990s. Several members of the workshop thought that the whole process might be speeded up considerably if it were given all the priority of a "Manhattan Project."

#### Aviation Fuel Supply

When it comes to the supply of aviation fuel there are some special additional aspects to consider.

Its availability depends not only on the availability of crude oil but also on the competition aviation faces from other petroleum fuels in the same distillation range and on the refineries' ability to produce the required amount from the crude available.

Most commercial airlines use kerosene jet fuel - which accounts for about 85 percent of the jet fuel total. The remainder consists of wide cut jet fuels (JP-4).

More kerosene could be produced from the average barrel of crude but only at the expense of gasoline and/or fuel oil. The maximum proportion of kerosene that could be produced is in the order of up to 10 percent to 14 percent or 15 percent. This compares with an average of about 6 percent at present (for aviation and other kerosene users). This technical possibility for expansion sounds encouraging, but it would mean that proportionately less of other products could be produced. A significant increase in the kerosene cut may not be commercially feasible in the short-term at least.

Two short-term measures that have been suggested to ease jet fuel supply problems are:

- 1) A broadening of certain kerosene jet fuel specifications.
- 2) Greater use of the alternative jet fuel, wide cut JP-4.  
(Kerosene jet fuel and JP-4 can be mixed in the same aircraft.)

#### Airline Fuel Requirements

A positive factor concerning the availability of aviation fuel for airline operation is the continuing trend toward increased efficiency in the use of fuel.

In the past, fuel efficiency has improved as the result of:

- 1) Increased engine efficiency
- 2) Increased aircraft size
- 3) Operational measures.

In the United States, fuel consumed per available ton kilometer (ATK) decreased by 30 percent from 1962 to 1977.

The contributions to savings in fuel consumption per ATK from a changing aircraft fleet composition and technological and operational improvements according to ICAO estimates are likely to approach 20 percent over the 1978 to 1990 period. A similar worldwide improvement in fuel efficiency appears to be possible during the 1990s. Boeing estimates 20 percent improvement in fuel efficiency in air services within North America to 1990.

Taking these assumed improvements in efficiency into account, if capacity operated increases between 6 percent and 10 percent per annum from 1978 to 1990, aviation fuel requirements would then increase by a factor of from 1.6 to 2.5 by 1990.

During the 1990s aviation fuel requirements will probably grow at a slower rate (assuming slower prospective traffic growth and further improvements in fuel efficiency).

Provided aviation fuel prices do not increase drastically in real terms, this means that the global demand for aviation fuel may be expected to grow considerably by the year 2000 to between 2 and 4 times the present level of consumption.

#### Price Trends

The historical development of crude oil prices since 1973 is quite well known including the most recent OPEC price increases. With supply and pricing expected to be decided by the oil exporting countries and with the demand for oil in the importing countries being relatively inflexible in the short-term, the price of oil may continue to vary substantially. The long-term is uncertain but may be one of slowly increasing prices in real terms. For example, SRI thought that a \$42 OPEC base price per barrel by 1985 probable.

Similar trends and fluctuations may also occur in the price of jet fuel. The relative proportion of the jet fuel price accounted for by transportation, refining, and distribution might increase in the future, because:

- 1) Refining costs for aviation fuel might change depending on the types of crude oil available and because of possible changes in aviation fuel specifications.
- 2) If the transport sector accounts for an increasing share of total demand for oil products there may be changes in price relationships between aviation fuel and other products depending on developments in demand.

Fuel costs now account for a much higher percentage of airline costs than they did in the past. The figure for U.S. carriers is now 30 percent of operating costs. This means that the impact on total airline costs of any large increases in fuel prices in real terms would be greater than the impact of similar increases in the past. The consequential effects on air fares would therefore also be greater. Fare increases in the United States during the past year (generated by fuel price increases) have been around 30 percent.

The Air Transport Association (ATA) estimates the U.S. carrier fuel bill at \$4 billion 1978, \$6 billion 1979, and \$9 billion 1980. ATA quotes a present fuel price in the United States of around 91¢ per gallon. In Europe it is around \$1.08 to \$1.18 and Boeing anticipates an international price of \$2.00 per gallon by 1985.

#### Workshop Conclusions

- 1) World energy demand is expected to increase less rapidly than in the past, due to effects of price, conservation, greater efficiency in the use of energy, and slower rates of economic growth.
- 2) Within total energy demand, use of oil is expected to level off and then decline slowly from its present 50 percent share.

- a) There will be an increase in the use of alternative energy sources (coal, hydroelectricity, nuclear, solar, etc.)
- b) There will be an increase in the development of synthetic fuels. Dollar share may be expected to be small initially, becoming more significant after 1985 and particularly 1990.
- c) It will probably be several years, however, before some of these shifts to alternative and new energy sources can be sufficiently significant to relieve the pressure of demand for oil.

- 3) The supply situation for aviation fuel in the short-term will most likely remain tight. It may be eased by:

- a) Continued changes in the fleet mix.
- b) Operational measures.
- c) Possible changes in jet fuel specifications.
- d) Greater use of JP-4 wide cut jet fuel where possible.
- e) Further rationalization of route structures, frequencies, and charter operations.
- f) Low rates of growth in market economies.

- 4) The possibility of a serious situation developing in the Middle East affecting oil and jet fuel supply should not be overlooked.

- 5) If traffic growth is not excessive (say below 10 percent) - particularly over the medium to longer term - sufficient fuel may be expected to be available under normal circumstances given the factors cited above.

- 6) The price of aviation fuel is high and may be expected to show a long-term upward trend in real terms. Because fuel costs now represent a much larger share of total airline costs, fare levels will be more sensitive to further increases, particularly any large increases in real terms.

- 7) Fuel "pass-through" arrangements may extend to the international sector in the near future. Increases in fares may, however, be less than the percent increase in fuel price due partly to improved fuel efficiency.

- 8) To end on a positive note, in the longer term anticipated developments in the total energy picture and in civil aviation should permit continued growth of air transport at least in the moderate 6 percent to 9 percent range.

- 9) Possibilities for further research were identified:

- a) There is a need to develop fuel specifications for synthetic commercial aviation fuel. Some industry groups (manufacturers, airlines, oil companies, and governments) are already examining

- fuel specifications for conventional (non-synthetic) aviation fuels.
- b) Research is needed on what energy policies are necessary to produce synthetic fuels. A guaranteed price level would be required to make synthetic fuel facilities economically viable.

Table 1. Comparison of world energy as a whole and oil\* consumption, 1965-1978. (Totals expressed in million barrels per day of oil equivalent.)

Year	Market Economies		Centrally Planned Economies		World Total	
	Energy	Oil	Energy	Oil	Energy	Oil
1965	57	27	22	4	79	31
1970	76	40	28	7	104	47
1971	78	42	30	7	108	49
1972	82	45	30	8	112	53
1973	86	48	32	9	118	57
1974	85	46	33	10	118	56
1975	83	45	35	10	118	55
1976	88	48	37	11	125	59
1977	90	49	39	12	129	61
1978	93	51	41	12	134	63

In accordance with United Nations Terminology, countries of the world are divided into these two groups: Centrally Planned Economies includes socialist States in Asia and Eastern Europe. \*Note that about 10 percent of oil consumption is for non-energy purposes. Source: BP Statistical Review of the World Oil Industry, British Petroleum Co. Ltd., 1975 and 1978 editions.

Table 2. Trend in crude oil prices, based on a market price index\* developed by the Organization for Economic Cooperation and Development (OECD), 1961-1974.

Year	Estimated Market Price	Real Estimated Market Price
1961	104	104
1962	101	102
1963	100	100
1964	95	93
1965	95	92
1966	95	90
1967	95	90
1968	93	89
1969	91	83
1970	90	78
1971	95	79
1972	125	96
1973	206	137
1974	546	325

\*1963=100. Real Estimated Market Price is deflated by export prices of industrialized countries expressed in U.S. dollars. Source: Energy Prospects to 1985, OECD, 1974.

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

John B. Brackbill, Boeing Commercial Airplane Company

#### 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 composition 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).

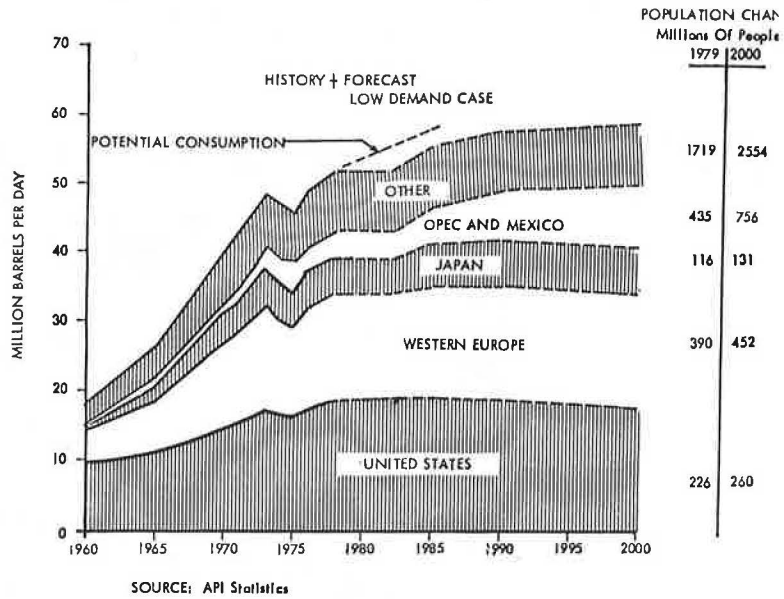


Figure 2. Potential world oil production (excluding USSR, Eastern Europe, and the Peoples Republic of China).

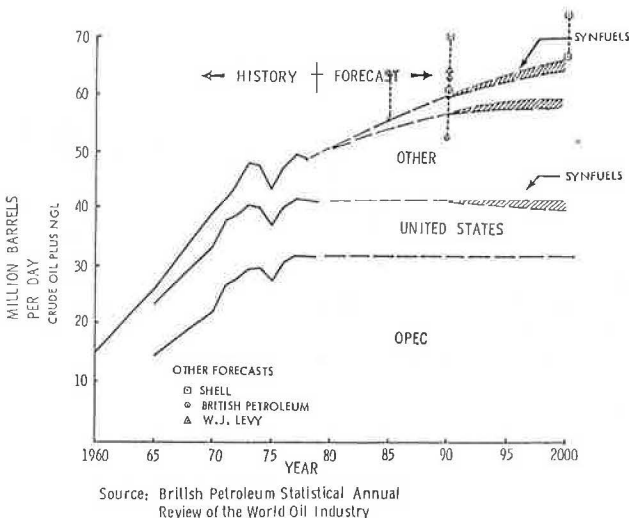


Figure 3. U.S. consumption of petroleum products: history and forecast.

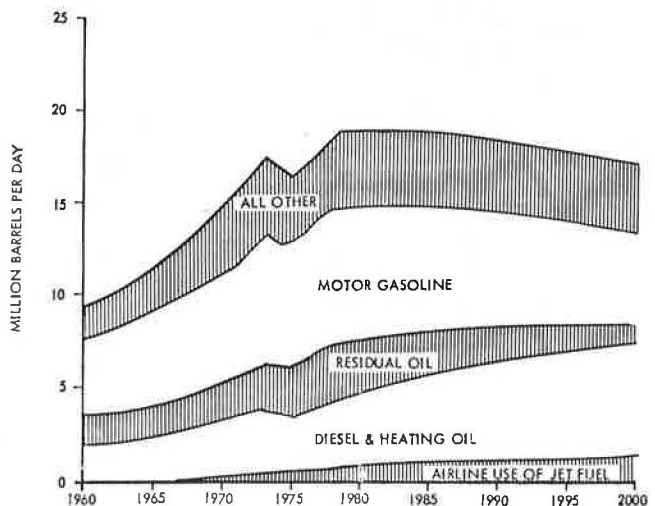
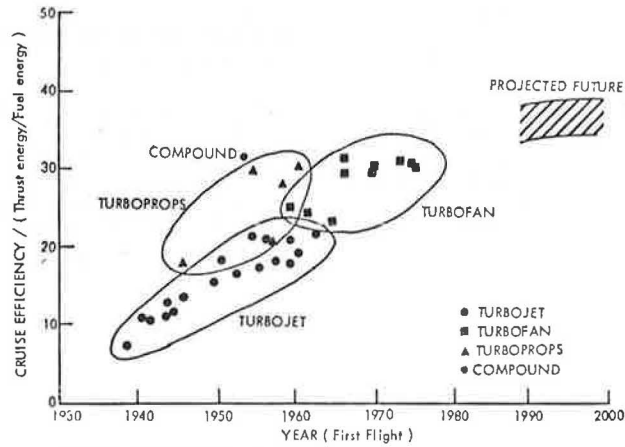


Figure 4. Aircraft turbine efficiency.



SOURCE: WILLIAM SENS, PRAIT & WHITNEY

Figure 5. Technology improvement (new program efficiency).

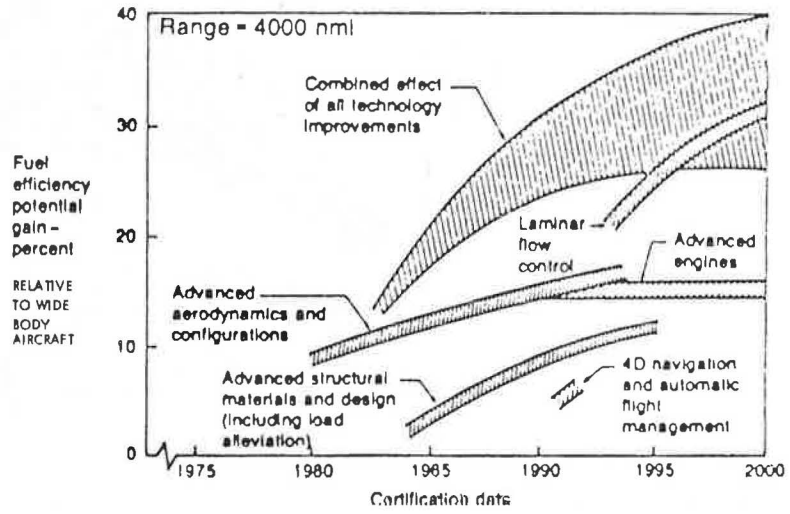


Figure 6. U.S. trunk airline fleet mix.

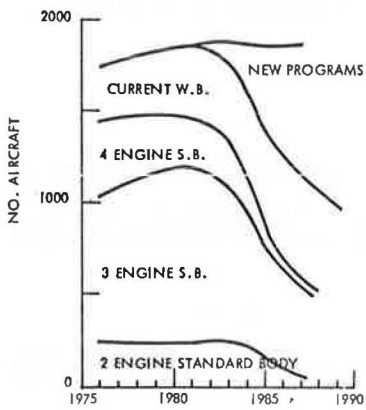
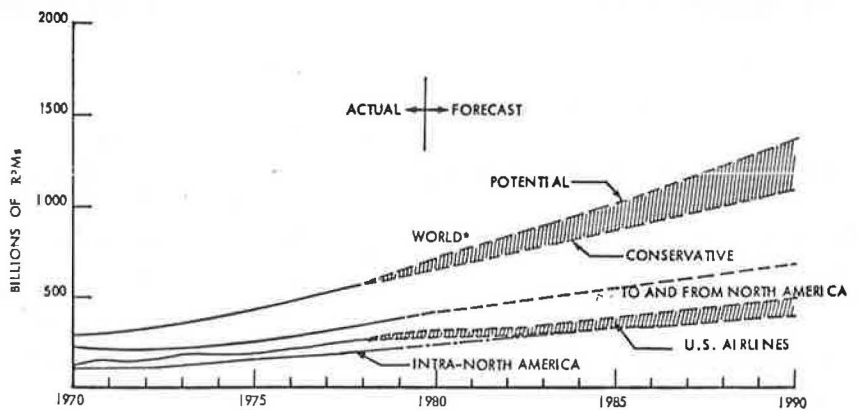


Figure 7. Revenue passenger-miles.



\* EXCLUDING USSR & PRC

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



Figure 8. Load factor estimates.

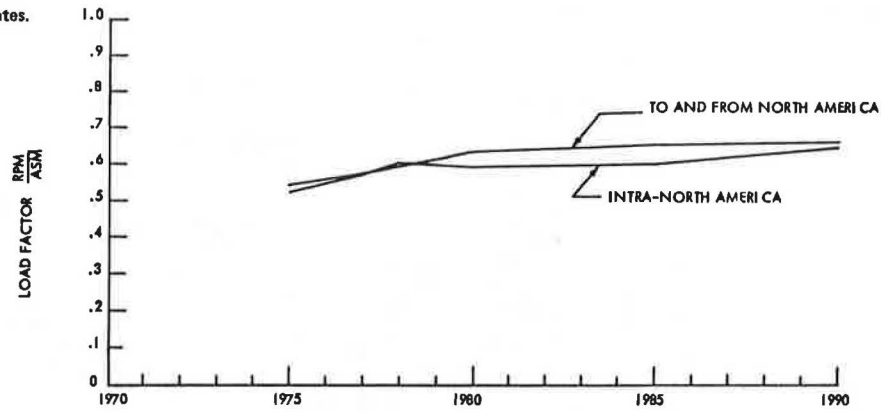


Figure 9. ASMs and type of aircraft.

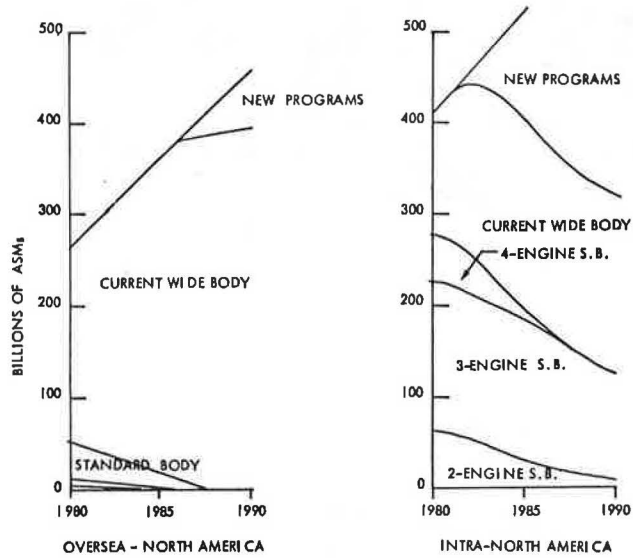


Figure 11. Kerosene jet fuel consumption estimate.

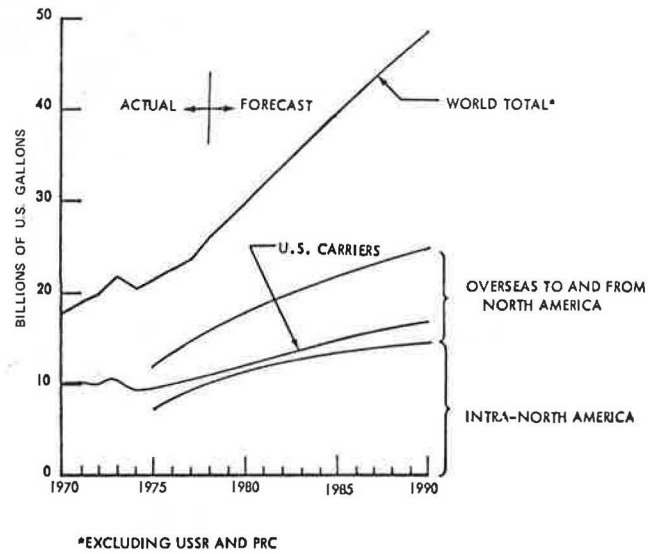


Figure 10. Fleet fuel efficiency estimate.

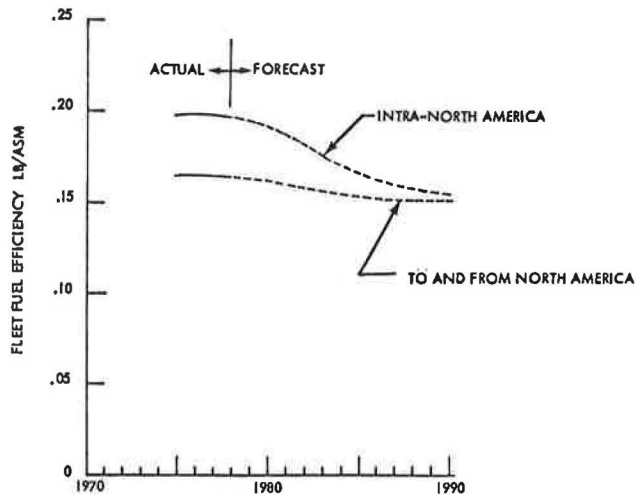


Figure 12. Alternative fuel cost (1979 dollars).

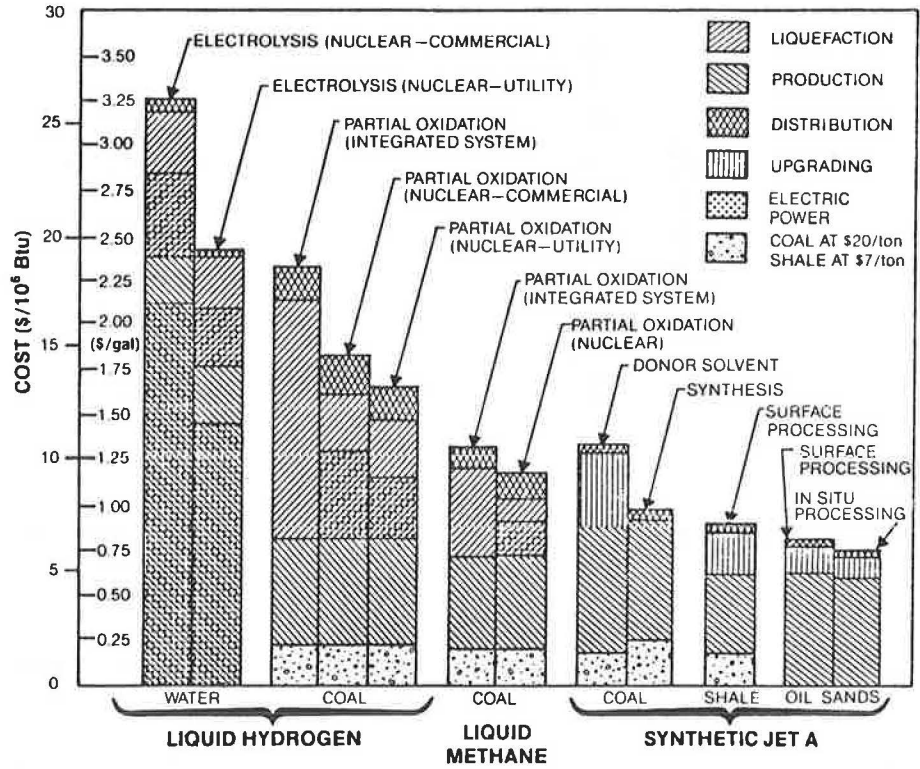
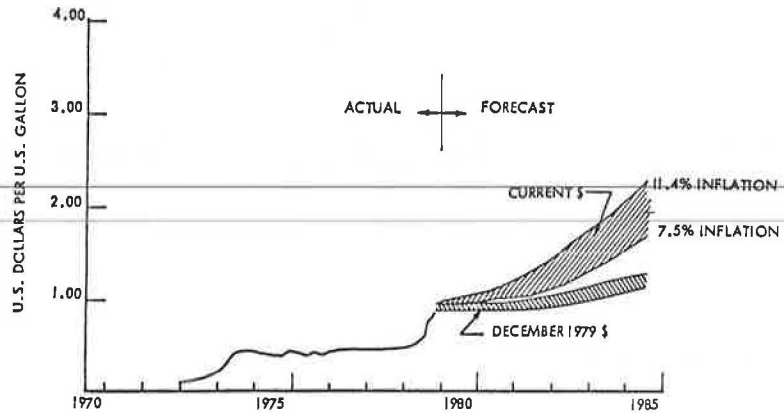


Figure 13. World kerosene jet fuel price estimate.



SUMMARY OF WORKSHOP SESSION 2:  
Policy Implication

George H. Sarames, Lockheed California Company,  
Moderator

The "Policy Implication" workshop had as its topic for discussion the impact of recent changes in the international regulatory environment on the demand for international air travel and hence on the activities of the major operational/functional components of the air transport industry: the airlines, the airports, and the aircraft manufacturers.

The theme relates not so much as to what is or appears to be the aviation policies of the various governments, but rather on how these policies are perceived by the above groups and how they are reacting or planning to react to the new environment.

U.S. international aviation policy, growing out of domestic deregulation policies, has moved away from protectionism toward a less restrictive and competitive environment. Under this policy, the U.S. government has been willing to trade traffic rights (new routes/gateways to foreign carriers) in exchange for a more competitive posture, lower fares, etc. This has been done to give the consumer more service choices at lower fares than would have been experienced under the previous regulatory environment. The United States is attempting to use its market power to achieve a "free market" internationally via bilateralism.

Since policy does not take place in a "ceteris paribus" environment, the impact of other factors on the work's political economy -- the continuing fuel crisis and environmental factors such as noise, pollution and airport congestion, that support or contradict the goals of the new regulatory policy -- should also be discussed.

The consensus of the workshop is that the new international regulatory environment has had very little impact on total demand for international travel. This is true even to/from Europe which has been affected the most by recent liberal bilaterals. (Figure 14). However, there have been structural changes in the market, which have affected routes, traffic flows, frequency of service, and aircraft size.

The geographic and airline distribution of the total U.S. to Europe air traffic has changed as routes have been awarded to different U.S. carriers

and as foreign carriers have received rights to new U.S. gateways. There was also a shift from charter to scheduled services as scheduled services were able to compete with charter and as charter carriers were able to offer scheduled services. (Figures 15-18).

The most significant factors influencing the demand for air travel -- even as U.S. gateways redoing new routes -- have been the devaluation of the dollar, growth in the world economy, varying rates of inflation, economic growth in different countries, and the fuel problems. (Figures 19-21).

Thus, the impact of "international deregulation" on airlines varies by carrier and reflects the degree to which they receive any new routes. However, the other factors mentioned above are the more dominant in affecting the airlines' activities. There is also a growing opinion, especially in Congress, that the United States will not be so liberal in the future in giving away new rights. The pendulum may swing back to the "balance of benefits" approach rather than the expanding opportunities approach to U.S. bilaterals. It seems there are market infrastructure constraints that have made it difficult for U.S. airlines to break into foreign local markets. Since foreign carriers do not experience such constraints in the United States, the end result was detrimental to U.S. carriers.

The changing structure of demand has made it more difficult for the aircraft manufacturers to do long range planning with regard to payload/range requirements of new aircraft. This is due to the uncertainty not only regarding new gateways/routes and market fragmentation but also as to which carriers will be serving these markets in the future. This uncertainty as to future routes also makes it difficult for the airlines to plan very far into the future with regard to their aircraft needs and for the airport operators to have adequate facilities, both of which have relatively long lead times before availability.

In summary, this new regulatory environment has not had much of an impact internationally. The changes in the regulatory environment have been overwhelmed by the economic factors: the devaluation of the dollar, the availability and price of fuel, inflation, and differing rates of economic growth in different countries. It is felt that these factors will also be the key factors influencing future demand for international travel.

Figure 14. New liberal bilaterals.

	NETHERLANDS MARCH 1978	ISRAEL AUGUST 1978	GERMANY OCTOBER 1978	BELGIUM NOVEMBER 1978	JAMAICA MARCH 1979	KOREA MARCH 1979	SINGAPORE JUNE 1979
FARE COMPETITION (DUAL DISAPPROVAL)	NO COUNTRY OF ORIGIN	YES	NO COUNTRY OF ORIGIN	YES	YES	YES	YES
LIBERALIZATION OF CHARTERS	YES	YES	YES	YES	YES	YES	YES
ELIMINATION OF RESTRICTIONS (CAPACITY AND 5TH/6TH FREEDOM TRAFFIC)	YES		YES	YES	YES	YES	YES
UNLIMITED DESIGNATION OF AIRLINES	YES	YES	YES	YES	YES	YES	YES
ADDITIONAL U.S. GATEWAYS	YES	YES	YES	YES	YES	YES	YES

Figure 15. International marketing environment: North Atlantic.

- GREATER MARKET FRAGMENTATION:
  - U.S. AND CANADIAN GATEWAY CITIES "DOUBLE" (THERE WERE 10 IN THE U.S., NOW 21)
  - ADDITIONAL U.S. CARRIERS WITH TRANS-ATLANTIC AUTHORITY (I.E. BRANIFF, DELTA, NORTHWEST)
  - ADDITIONAL NON-U.S., NON-EUROPEAN CARRIERS
  - INCREASED DIRECT SERVICES TO NORTH AMERICA FROM THE MIDDLE EAST, AFRICA AND EAST EUROPEAN POINTS
- INCREASED FARE DIVERSITY--SOME LEADING TO REDUCED STOPOVER OPPORTUNITIES.

Figure 16. Market fragmentation: increase in number of gateways to Europe.



Figure 17. New carriers.

FROM U.S. TO:	BN	CL	DL	KL	LH	NA	PA	SN	TV	TW
AMSTERDAM										
SUMMER 1978	-	-	-	*	*	*	*	-	-	-
SUMMER 1979	*	-	-	*	-	*	-	-	*	-
BRUSSELS										
SUMMER 1978	-	-	-	-	-	-	*	*	-	*
SUMMER 1979	*	*	-	-	-	-	*	*	-	-
FRANKFURT										
SUMMER 1978	-	-	*	-	*	*	*	-	-	*
SUMMER 1979	*	-	*	-	*	*	*	-	-	*

Figure 19. U.S.-Brussels low fares: peak season.

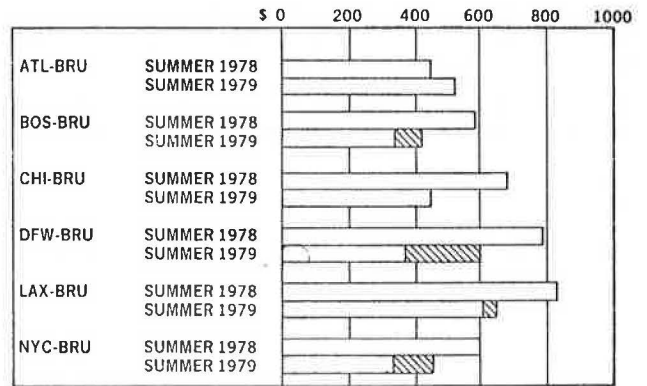


Figure 18. New services.

FROM:	ATLANTA	BOSTON	CHICAGO	DALLAS	HOUSTON	LOS ANGELES	MIAMI	NEW YORK CITY	PHILADELPHIA	SAN FRANCISCO	TOTAL
TO: AMSTERDAM											
SUMMER 1978	-	7	7	-	-	12	1	18	-	-	45
SUMMER 1979	-	2	7	2	-	5	7	28	-	-	51
TO: BRUSSELS											
SUMMER 1978	4	-	-	-	-	-	-	16	-	-	20
SUMMER 1979	4	3	1	1	-	7	-	14	-	-	30
TO: FRANKFURT											
SUMMER 1978	-	14	7	-	7	7	4	41	7	7	94
SUMMER 1979	4	10	11	-	7	7	6	40	13	13	111

Figure 20. Real yield growth: 1970-1978.

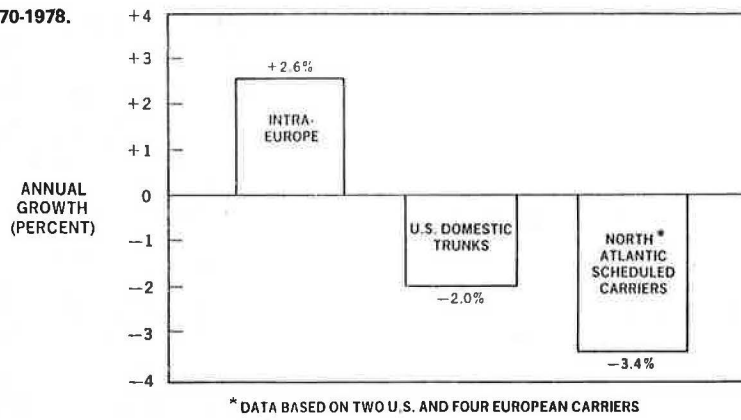
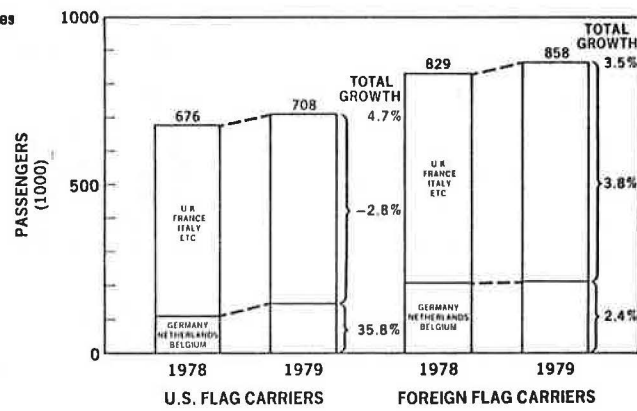


Figure 21. Air travel between United States and Europe: scheduled and charter, September 1978/79.



SUMMARY OF WORKSHOP SESSION 3  
Factors Affecting Airports

Adib Kanafani, University of California, Berkeley,  
Moderator

Problem

Recent developments in air travel demand may have been unprecedented and unpredictable, for two reasons:

- 1) Changes in exchange rates and relative cost of living levels have facilitated travel to the United States.
- 2) The deregulation of the U.S. domestic airline industry and the moves toward deregulation of some international markets have resulted in many discount fares.

The second of these two factors may have resulted in a more dramatic and dramatized immediate effect, but the first is likely to have a more important and lasting effect.

The first factor results in a dramatic decline in the value of the dollar and a consequent increase, in real terms, of travel costs to U.S. travelers, and the opposite for overseas travelers, particularly in Europe but also including Japan. The effect is a change in the mix of international travelers with a significantly higher proportion of non-U.S. travelers, which will have possible long range impacts in terms of airport operation on federal inspection facilities (F.I.S.), access, and passenger facilitation and processing activities.

The second factor has brought about some increase in overall traffic, but mostly in vacation and other nonbusiness categories. (The increase has not been very high.) But more importantly, the following changes may be occurring that have had an impact on airport services:

- 1) changes in route structure
- 2) new routes, internationalization of airports hitherto domestic
- 3) aircraft technology/compatibility
- 4) higher seating densities and higher load factors
- 5) increased standby and long lead time passengers
- 6) shifting seasonality effects.

Summary of Conclusions

The subcommittee's consensus was that the following six issues are the major items that should be addressed and from which a research agenda might be developed.

- 1) F.I.S. appears as the most critical constraint on the future development of international travel facilities. There is a growing percentage of non-U.S. travelers moving through U.S. airports. They require a longer processing time than U.S. passengers. Methods of streamlining F.I.S. should be investigated and adequate space and staffing for F.I.S. should be provided. Pre-clearance upon departure should be pursued. Agricultural inspection presents a particularly difficult problem and will add to time delays and expenses.
- 2) Airport Access and Land Side Facilities. International traffic characteristics

that place a heavy load on the system include: large aircraft or higher load factors on average size aircraft, groups and charter, and increased peaking due to limited arrival and departure facilities (such as check-in windows and baggage). Nonresident travel implies added demand for restrooms, telephones, passenger aid facilities, taxis, buses, and limos.

Large accumulations of passengers are expected in the future either due to early arrival at the departing airports, or due to transfer through U.S. ports. The design of "sterile areas" (separation of passengers from visitors or friends seeing them off at the airport) on the airside interface should be researched.

Design procedures may need to be revised, especially for smaller airports or ones with not much experience in international traffic.

- 3) Streamlining Passenger Processing Service. Higher needs for information and signage were seen as major issues: choice of languages, standardization of pictograms, currency exchange services, and transport information systems.
- 4) Aircraft Technology. Noise is a major issue that is exacerbated by heavier aircraft and longer runways. The noise impact should be seen as a research item, especially during night operations and curfews (U.S. and foreign cities).
- 5) Institutional. Airports not currently handling international traffic may need assistance and should begin to prepare for it. It was felt that airports currently doing this could provide such advice.

Government negotiations of bilaterals and the granting of international routes should be conducted with the participation of the affected airport operators.

- 6) Forecasting is not an issue specific to this matter but added uncertainties, lack of data, and often the inapplicability of models make international forecasting particularly elusive.

SUMMARY OF WORKSHOP SESSION 4  
Perspectives from New York

George Howard, Port Authority of New York and New Jersey, Moderator

The panel discussed some of the preliminary findings of the 1979 travel survey conducted by the Port Authority of New York and New Jersey. The discussion included the following comments:

New York's share of the transatlantic market declined from 75 percent in the middle of the 1960s to 60 percent in 1972. Since 1972, this percentage has been reasonably stable despite the opening up of new gateways and New York's declining share of the gross national product. Panelists expressed the view that New York's share has been relatively steady since 1971 because of the introduction of the wide-bodied jets, their favorable economics, and the relatively lower fares realized due to the wide-bodied economics and large traffic volumes to and from New York. This may have

constrained the further opening of new secondary gateways.

In 1978 and 1979, New York benefited from rapid growth in the number of European visitors to the United States. There was a 50 percent increase in the last two years, as contrasted to a very small increase in U.S. citizen travel to Europe. Of the entire U.S. transatlantic market, foreign travel to the United States is now about equal to U.S. citizen travel abroad. (Figures 22-25)

Most of the panelists felt that this surge in travel to the United States can be explained largely by the declining value of the U.S. dollar compared to most European currencies. The United States has become a travel bargain. Conversely, travel in Europe for Americans has become very expensive. Since 1977, the value of the dollar has dropped about 15 percent while the European Price Index (see charts) has continued to increase sharply. The cost of traveling in Europe in current prices has virtually tripled since 1970. (Figure 26)

During the next five to ten years, there are a number of factors that will affect New York's 60 percent market share of air travel. (Figures 27-28) Some of the negative factors that suggest a declining market share include the prospect that New York's share of the national economy is expected to show further declines in this decade. In addition, in many new bilateral agreements, the United States and foreign carriers have been authorized to serve many U.S. cities outside New York and many of these authorizations are now operational. Also, the relatively strong growth in Latin American and Caribbean travel, possibly a diversion from travel to Europe, could divert from the New York gateway, favoring travel through southern gateways.

There are a number of positive factors that suggest New York's market share may not drop as in the past, such as continued escalation of fuel prices which could slow down the fragmentation of the market. On a seat mile basis, the larger, wide-bodied aircraft are the most fuel efficient and the most cost efficient if sufficient traffic volumes are forthcoming. New York City and the airports of New York and New Jersey have the facilities to support the large jet aircraft. In-flight surveys (taken in 1978) show that New York's transfer market has maintained its share of the total market since 1972, suggesting that the economies of scale for large aircraft are being utilized. In addition, New York City is undoubtedly one of the great urban tourist attractions of the nation, and foreign visitors will put New York on their U.S. itineraries for many years in the future.

Panelists also concluded that some changes were forthcoming as a result of growth in the transatlantic market. The increasing costs of travel to Europe should put the emphasis on marketing strategies that feature lower cost accommodations, shorter trip lengths, fewer stops on the same trip, "other than big city travel", tour packaging, and similar programs. Moreover, the vast potential for travel by Europeans to the United States was recognized, as well as the inadequacy of accommodations, services, and facilitation. The cut in the U.S. Travel Service budget seems to be shortsighted in the face of the foreign currencies brought into the United States by

foreign travelers. In order to plan for further growth and changes in New York's market, panelists reaffirmed the critical need for true Origin and Destination (O&D) data for international travel.

Figure 22. U.S. Trans-Atlantic market.

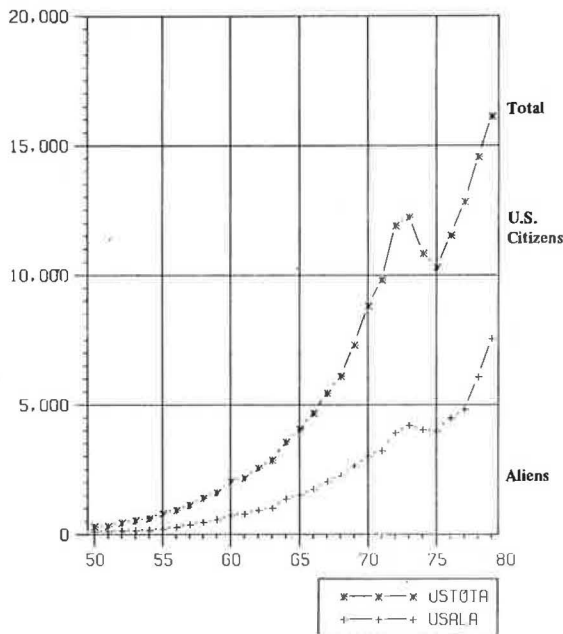


Figure 23. U.S. Trans-Atlantic market.

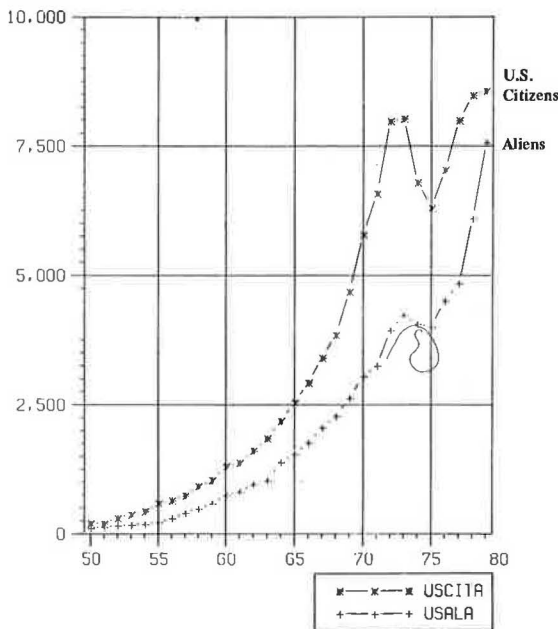


Figure 24. U.S. citizens international travel.

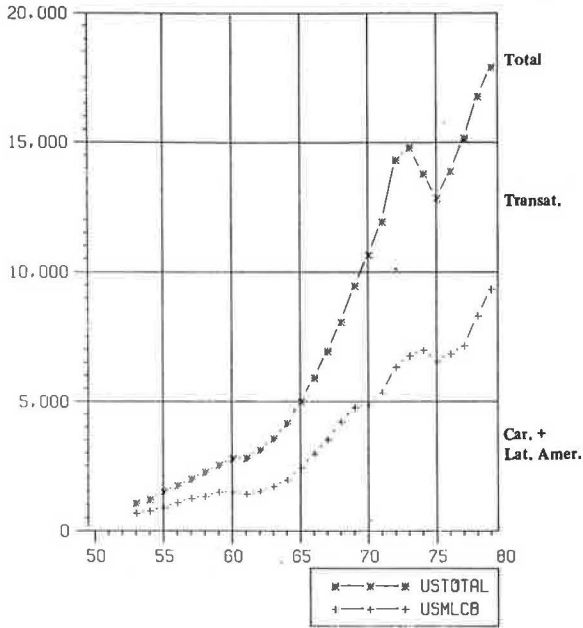


Figure 26. Cost index for travel in Europe.

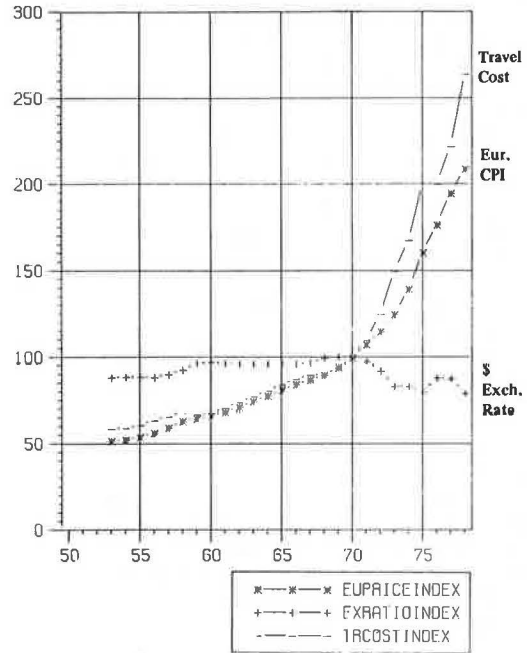


Figure 25. U.S. citizens international travel.

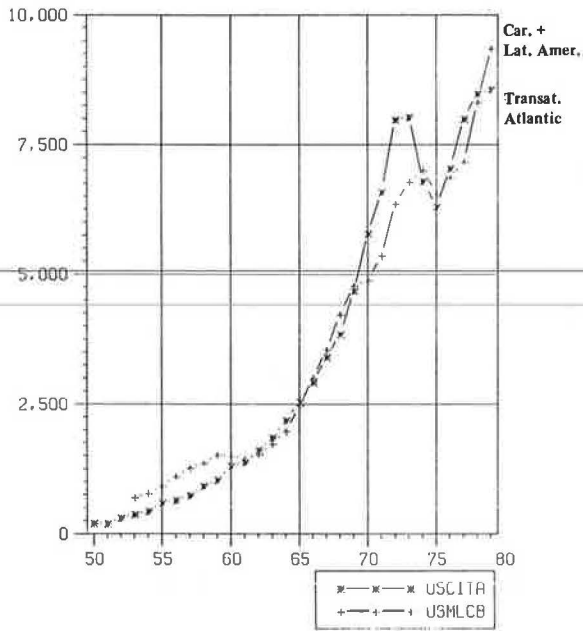


Figure 27. N.Y. share of U.S. market.

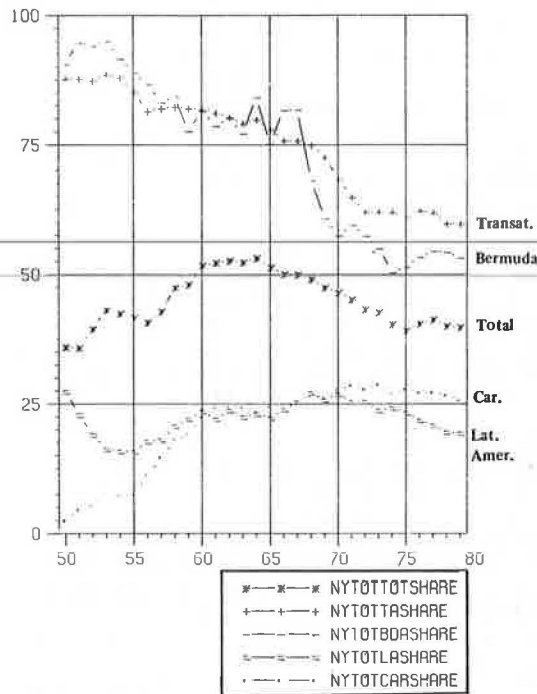
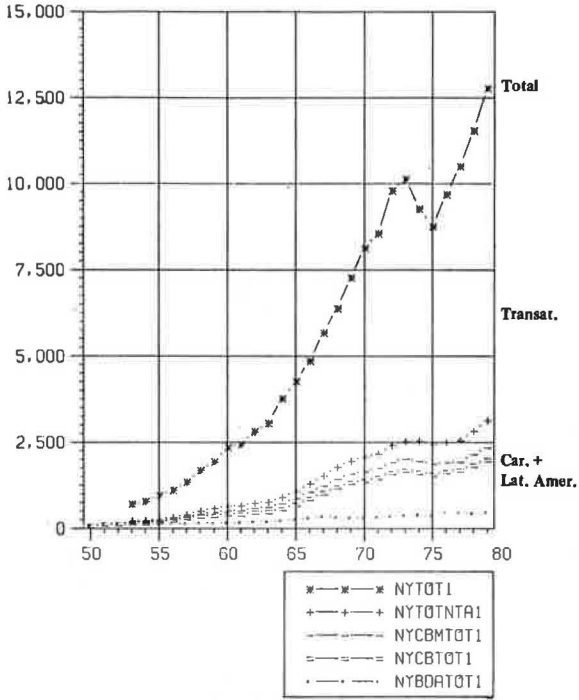




Figure 28. N.Y. international travel market.



SUMMARY OF WORKSHOP SESSION 5  
Perspectives from Canada

William T. Tucker, Air Transport Canada,  
Moderator

A number of factors identified as important determinants of air travel demand fell into four major groups: non-aviation industry economics, aviation industry trends, consumer characteristics and behavior, and the political and economic environment outside North America. Specific examples of these factors included:

- \* Fuel--price and availability (crude oil levels and refinery output)
- \* Fares--elasticity (price sensitivity), inflation rates, discretionary (real) income growth rates, currency exchange rates
- \* Capacity supply--airline profitability and cash flow
- \* Alternative consumer opportunities to air travel (changing destination interests, new choices of how to use their leisure time or money)
- \* Political instability that would be disruptive of travel (such as in the Middle East or in certain parts of the Caribbean)
- \* International migration, international trade (stimulus to travel)
- \* Market maturity levels

Concerning these factors, jet fuel availability and prices seemed to be of major importance in affecting travel to and from Canada. Jet fuel prices during the 1980s are likely to rise faster than inflation rates but there should be adequate crude oil supply through the year 2020. Even though aviation organizations use about 5 percent of total fuel in Canada, the impact of a supply shortfall on air travel can be quite large if governments assign a low priority to fuel supplied to aviation users in difficult times.

A novel study that looked at "factors affecting demand for international travel to and from Australia" used a combination of factors that proved helpful in assessing consumer preferences, market behavior, and different levels of fares and convenience. A value matrix was developed for various fares and different types of passengers so that business and nonbusiness models could be estimated. Air travel demand for leisure (non-business) travel was dependent upon fares, real incomes, exchange rates, and the percentage of Australians who were born in the country of destination. Business travel was dependent upon fares, international trade with the country of destination, and time spent in travel. This report looked specifically at point to point travel patterns (Australia to Canada, for example) and appears to provide some measure of price sensitivity that incorporates the value of time spent in travel.

Air fare elasticity (sensitivity) was discussed and it was concluded that forecasters must proceed with caution in using historical values for future price elasticity since present air fares are substantially higher than when the price elasticity values were measured several years ago.

The international air traveler (especially leisure or tourist) is affected by three cost components: the air travel fare, the cost of travel and accommodations in the country of destination, and the exchange rate. The air travel fare portion

can be quite time sensitive. A low fare to the Canadian Prairies (for example, Saskatchewan) in February would be much less effective in stimulating air travel than in July when weather is more moderate.

There are many parallels between United States and Canadian travel trends but one difference is important. The Canadian-United Kingdom traffic did not have a recent "travel surge" as did the United States-United Kingdom market, due to the lower Canadian availability of low fares and the exchange rate differentials. An important similarity is that both Canada and the United States represent a good buy for the foreign traveler, suggesting relatively strong growth of European travel to Canada and the United States for the next few years.

An example of the relative purchasing power between Germany and the United States points out the relative increased cost of travel to Europe. Comparing the average per capita income of Americans and foreign residents at home and in Germany for the years 1968 and 1978, one panelist concluded that the average American's purchasing power in the United States increased 27 percent in the ten year period, but his purchasing power in West Germany dropped about 30 percent. Conversely, the average German resident has experienced increased purchasing power of 69 percent at home versus 200 percent in the United States. Similar patterns, although less dramatic, were found for other pairs of North American and European countries.

Panelists also discussed the shift in destinations for many Canadian air passengers. Recent information shows strength in the domestic market and a tendency for Canadians to travel to the "sunspots" (destinations where warm, sunny climates prevail) rather than to Europe. This has implications for future travel, particularly in forecasting seasonal changes. Travelers may fly to the Caribbean or Florida in the winter instead of going to Europe in the summer. These shifts, if they continue, will make it necessary for airlines, inspection services, and ground facilities to adjust for the new patterns of growth and slack at different times than in the past.

The workshop session identified five topics as "Possible Areas for Research." These are as follows:

1. To what degree (if any) are small carriers more vulnerable than large carriers in an era of high "spot market" prices for aviation fuel?
2. Further research into air fare "fences."
  - The term "fences" is used to refer to fare characteristics such as prepurchase, minimum stay, stopover privileges, etc. From the consumer's viewpoint, the question is "What is their value (or cost)?" e.g., discount required before willing to prepay, or acceptable fare premium for stopover privileges. The carrier is interested in the effectiveness of the "fences" in attracting new traffic while avoiding undue fare dilution.
3. Further research into the quantification of level of service variables and their effect on demand.
  - What is the effect of new aircraft (e.g., Concorde and B747SP) and of new (interior) North American gateways on total trip time, and hence on demand? Can increased load factors (and perhaps reduced in-

- flight service) be quantified as a lower level of service and can the effect on demand be quantified?
4. Seasonal variations in price elasticity of demand.
    - It is generally agreed that price elasticity of demand is a useful concept in aviation forecasting. However, it may be useful to consider seasonality in the application of this concept. For example, North Americans would likely show a greater reaction to a southern market fare discount in the winter than in the summer or to a corresponding discount to Europe in the winter.
  5. Research on "The availability and use of perfect information" (re: fares, routes, etc.) or "The trip decision process."
    - The analyst generally assumes that travelers react rationally to accurate information, e.g., real fare increases, total trip cost, etc. It is more relevant to consider the traveler's true decision-making process. Perhaps the traveler reacts to nominal air fare increases (or gasoline prices). Factors considered probably include: time (of year, of week, or even of day), trip duration, destination, fare, other trip costs, ground package availability and cost, etc. When are the various component decisions made during the process and how important is each factor? Mr. A. T. Wiley of Air Canada indicated a willingness to provide input to research in this area.

#### MODERATORS AND PANELISTS

##### Workshop Session 1: Energy and Jet Fuel Availability and Price

Moderator: Roderick Heitmeyer, International Civil Aviation Organization

##### Panelists

John B. Brackbill, Boeing Commercial Airplane Company  
 Kathy Arjiropoulos, Air Transport Association of America  
 Neville Small, Mobil Oil Corporation  
 David E. Raphael, SRI International

##### Workshop Session 2: Policy Implications

Moderator: George H. Sarames, Lockheed California Company

##### Panelists

Bruce Cunningham, Pan American World Airways, Inc.  
 Bruce Kutzke, Northwest Airlines, Inc.  
 Robert Cohn, Butler, Binion, Rice, Cook and Knapp  
 Peter Reveley, Dade County Aviation Department  
 William Messecar, McDonald Douglas Corporation

##### Workshop Session 3: Factors Affecting Airports

Moderator: Adib Kanafani, University of California, Berkeley

##### Panelists

Laurence A. Schaefer, Port Authority of New York and New Jersey  
 George Bean, Hillsborough County Aviation Authority  
 Philip H. Agee, Air Transport Association of America  
 Geoffrey Gosling, University of California, Berkeley

##### Workshop Session 4: Perspectives From New York

Moderator: George Howard, Port Authority of New York and New Jersey

##### Panelists

Johannes Augustinus, Port Authority of New York and New Jersey  
 J. Casson, American Express  
 George Sarames, Lockheed California Company  
 Edward Barrol, Olgivy and Mather

##### Workshop Session 5: Perspectives From Canada

Moderator: William Tucker, Air Transport Canada

##### Panelists

R. B. White, National Research Council, Canada  
 Andrew Smith, International Civil Aviation Organization  
 A. T. Wiley, Air Canada  
 Andrew P. Elek, Peat, Marwick and Partners, Canada

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